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IS-IS TE Attributes per application
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Abstract

   Existing traffic engineering related link attribute advertisements
   have been defined and are used in RSVP-TE deployments. 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 draft introduces new link attribute advertisements which address
   both of these shortcomings. It also discusses backwards
   compatibility issues and how to minimize duplicate advertisements in
   the presence of routers which do not support the extensions defined
   in this document.

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.

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   and may be updated, replaced, or obsoleted by other documents at any
   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on October 10, 2019.

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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 Resource
   Reservation Protocol (RSVP) - more succinctly referred to as RSVP-TE.

   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)
   and Loop Free Alternates (LFA). 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, 141, 222, and 223
and TLVs for SRLG advertisement.

3.1. Legacy sub-TLVs

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

      Code Point/Attribute Name
      ----
       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, 141,
      222, and 223

      2)Application Specific Shared Risk Link Group (SRLG) TLV

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

      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.

```
   0 1 2 3 4 5 6 7
   +-+-+-+-+-+-+-+-+
   |    SABML+F     |  1 octet
   +-+-+-+-+-+-+-+-+
   |    UDABML+F    |  1 octet
   +-+-+-+-+-+-+-+-+
   |    SABM      ...  0 - 127 octets
   +-+-+-+-+-+-+-+-+
   |    UDABM     ...  0 - 127 octets
   +-+-+-+-+-+-+-+-+
```

   SABML+F (1 octet)
       Standard Application Bit Mask Length/Flags

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

     L-flag: Applications listed (both Standard and
      User Defined) MUST use the legacy advertisements
      for the corresponding link found in TLVs 22, 23,
      141, 222, and 223 or TLV 138 or TLV 139 as appropriate.

     SA-Length: Indicates the length in octets (0-127) of the Bit Mask
      for Standard Applications.

   UDABML+F (1 octet)
       User Defined Application Bit Mask Length/Flags

```
            0 1 2 3 4 5 6 7
           +-+-+-+-+-+-+-+-+
           |R| UDA-Length  |
           +-+-+-+-+-+-+-+-+
```

     R: Reserved. Transmitted as 0 and ignored on receipt

UDA-Length: Indicates the length in octets (0-127) of the Bit Mask
 for User Defined Applications.

SABM (variable length)
   Standard Application Bit Mask

   (SA-Length * 8) bits

   This is omitted if SA-Length is 0.

            0 1 2 3 4 5 6 7 ...
          +-+-+-+-+-+-+-+-+...
          |R|S|F|X| ...
          +-+-+-+-+-+-+-+-+...

      R-bit: RSVP-TE

      S-bit: Segment Routing Traffic Engineering

      F-bit: Loop Free Alternate

      X-bit: Flex-Algo

UDABM (variable length)
   User Defined Application Bit Mask

   (UDA Length * 8) bits

            0 1 2 3 4 5 6 7 ...
          +-+-+-+-+-+-+-+-+...
          | ...
          +-+-+-+-+-+-+-+-+...

   This is omitted if UDA-Length is 0.

NOTE: If both SA-length and UDA-Length are zero, then the
attributes associated with this attribute identifier bit mask
MAY be used by any Standard Application and any User Defined
Application.

Standard Application Bits are defined/sent starting with Bit 0.
Additional bit definitions that may be defined in the future SHOULD
be assigned in ascending bit order so as to minimize the number of
octets that will need to be transmitted. 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.

User Defined Application bits have no relationship to Standard
Application 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, 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 Bit Mask (as defined in Section 3.1)

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

When the L-flag is set in the Application Identifiers, all of the
applications specified in the bit mask MUST use the link attribute
sub-TLV advertisements listed in Section 3.1 for the corresponding
link. Application specific 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 Bit Masks and
all such advertisements MUST be ignored on receipt.

Multiple 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. A sub-sub-TLV is defined
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 identifer 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 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 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 Unreserved Bandwidth

Unreserved bandwidth is an attribute specific to RSVP. 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 Bit Mask. If an advertisement of Unreserved Bandwidth is received with bits other than the RSVP-TE bit set, the advertisement MUST be ignored.

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 (defined by [RFC5307]) and TLV 139 (defined by [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 Bit Mask (as defined in Section 3.1)
            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 type
          values are suggested and will be assigned by IANA - but as
          the formats are identical to existing sub-TLVs defined for
          TLVs 22, 23, 141, 222, and 223 the use of the suggested sub-TLV
          types is strongly encouraged.

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

       At least one set of link identifiers (IPv4, IPv6, or unnumbered) 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 Identifiers, 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 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. Deployment Considerations

       If link attributes are advertised associated with zero length
       application bit masks for both standard applications and user defined
       applications, then that set of link attributes MAY be used by any
       application. If support for a new application is introduced on any
       node in a network in the presence of such advertisements, these
       advertisements MAY 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. 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.

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.

In the case of Flex-Algo, advertisement of application specific link
attributes does NOT indicate enablement of Flex-Algo. Rather the
attributes are used to determine what links are included/excluded in
the algorithm specific constrained SPF. This is fully specified in
[I-D.ietf-lsr-flex-algo].

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 Bit Mask and the User Defined Application 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.

7. Interoperability, Backwards Compatibility and Migration Concerns

Existing deployments of RSVP-TE 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.

7.1. RSVP-TE only deployments

In deployments where RSVP-TE is the only application utilizing link
attribute advertisements, use of the the legacy advertisements can
continue without change.

7.2. 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-bit set and no
link attribute values. This avoids duplication of link attribute
advertisements.

7.3. Multiple Applications: All Attributes Not Shared w 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-bit 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.

7.4. Deprecating legacy advertisements

The extensions defined in this document support RSVP-TE as one of the
supported applications - so a long term goal for deployments would be
to deprecate use of the legacy advertisements in support of RSVP-TE.
This can be done in the following step-wise manner:

1)Upgrade all routers to support extensions in this document

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

3)Remove legacy advertisements

8. IANA Considerations

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

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

This document defines one new TLV:

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

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
```

This document requests a new IANA registry be created, under the
category of "Interior Gateway Protocol (IGP) Parameters", to control
the assignment of application bit identifiers. The suggested name of
the new registry is "Link Attribute Applications". The registration
policy for this registry is "Standards Action" ([RFC8126] and
[RFC7120]). 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)
   3     Flex Algorithm (X-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
```

9. Security Considerations

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

10. Acknowledgements

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