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RFC 8920
OSPF 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 indication of which applications are using the advertised value for a given link. This document introduces new link attribute advertisements in OSPFv2 and OSPFv3 that address both of these shortcomings.

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1. Introduction

Advertisement of link attributes by the OSPFv2 [RFC2328] and OSPFv3 [RFC5340] protocols in support of traffic engineering (TE) was introduced by [RFC3630] and [RFC5329], respectively. It has been extended by [RFC4203], [RFC7308], and [RFC7471]. 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 that makes use of link attribute advertisements, examples of which are listed in Section 5.

In recent years, new applications have been introduced that have use cases for many of the link attributes historically used by RSVP-TE. Such applications include Segment Routing (SR) Policy [SEGMENT-ROUTING] 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 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 the path setup failure.

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 for 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 OSPF, 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 Segment Routing (SR). Included among these use cases is SR Policy, which is defined in [SEGMENT-ROUTING]. 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 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. Existing Advertisement of Link Attributes

There are existing advertisements used in support of RSVP-TE. These advertisements are carried in the OSPFv2 TE Opaque Link State Advertisement (LSA) [RFC3630] and OSPFv3 Intra-Area-TE-LSA [RFC5329]. Additional RSVP-TE link attributes have been defined by [RFC4203], [RFC7308], and [RFC7471].

Extended Link Opaque LSAs as defined in [RFC7684] for OSPFv2 and E-Router-LSAs [RFC8362] for OSPFv3 are used to advertise link attributes that are used by applications other than RSVP-TE or GMPLS [RFC4203]. These LSAs were defined as generic containers for distribution of the extended link attributes.

4. Advertisement of Link Attributes

This section outlines the solution for advertising link attributes originally defined for RSVP-TE or GMPLS when they are used for other applications.

4.1. OSPFv2 Extended Link Opaque LSA and OSPFv3 E-Router-LSA

The following are the advantages of Extended Link Opaque LSAs as defined in [RFC7684] for OSPFv2 and E-Router-LSAs [RFC8362] for OSPFv3 with respect to the advertisement of link attributes originally defined for RSVP-TE when used in packet networks and in GMPLS:

1. Advertisement of the link attributes does not make the link part of the RSVP-TE topology. It avoids any conflicts and is fully compatible with [RFC3630] and [RFC5329].
2. The OSPFv2 TE Opaque LSA and OSPFv3 Intra-Area-TE-LSA remain truly opaque to OSPFv2 and OSPFv3 as originally defined in [RFC3630] and [RFC5329], respectively. Their contents are not inspected by OSPF, which instead acts as a pure transport.
3. There is a clear distinction between link attributes used by RSVP-TE and link attributes used by other OSPFv2 or OSPFv3 applications.
4. All link attributes that are used by other applications are advertised in the Extended Link Opaque LSA in OSPFv2 [RFC7684] or the OSPFv3 E-Router-LSA [RFC8362] in OSPFv3.

The disadvantage of this approach is that in rare cases, the same link attribute is advertised in both the TE Opaque and Extended Link Attribute LSAs in OSPFv2 or the Intra-Area-TE-LSA and E-Router-LSA in OSPFv3.

The Extended Link Opaque LSA [RFC7684] and E-Router-LSA [RFC8362] are used to advertise any link attributes used for non-RSVP-TE applications in OSPFv2 or OSPFv3, respectively, including those that have been originally defined for RSVP-TE applications (see Section 6).

TE link attributes used for RSVP-TE/GMPLS continue to use the OSPFv2 TE Opaque LSA [RFC3630] and OSPFv3 Intra-Area-TE-LSA [RFC5329].

The format of the link attribute TLVs that have been defined for RSVP-TE applications will be kept unchanged even when they are used for non-RSVP-TE applications. Unique codepoints are allocated for these link attribute TLVs from the "OSPFv2 Extended Link TLV Sub-TLVs" registry [RFC7684] and from the "OSPFv3 Extended-LSA Sub-TLVs" registry [RFC8362], as specified in Section 14.

5. Advertisement of Application-Specific Values

To allow advertisement of the application-specific values of the link attribute, a new Application-Specific Link Attributes (ASLA) sub-TLV is defined. The ASLA sub-TLV is a sub-TLV of the OSPFv2 Extended Link TLV [RFC7684] and OSPFv3 Router-Link TLV [RFC8362].

In addition to advertising the link attributes for standardized applications, link attributes can be advertised for the purpose of applications that are not standardized. We call such an application a "user-defined application" or "UDA". These applications are not subject to standardization and are outside of the scope of this specification.

The ASLA sub-TLV is an optional sub-TLV of the OSPFv2 Extended Link TLV and OSPFv3 Router-Link TLV. Multiple ASLA sub-TLVs can be present in a parent TLV when different applications want to control different link attributes or when a different value of the same attribute needs to be advertised by multiple applications. The ASLA sub-TLV **MUST** be used for advertisement of the link attributes listed at the end of this section if these are advertised inside the OSPFv2 Extended Link TLV and OSPFv3 Router-Link TLV. It has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  SABM Length  |  UDABM Length |            Reserved           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Standard Application Identifier Bit Mask            |
+-                                                             -+
|                            ...                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           User-Defined Application Identifier Bit Mask        |
+-                                                             -+
|                            ...                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Link Attribute sub-sub-TLVs              |
+-                                                             -+
|                            ...                                |
```

where:

Type: 10 (OSPFv2), 11 (OSPFv3)

Length: Variable

SABM Length: Standard Application Identifier Bit Mask Length in octets. The value **MUST** be 0, 4, or 8. If the Standard Application Identifier Bit Mask is not present, the SABM Length **MUST** be set to 0.

UDABM Length: User-Defined Application Identifier Bit Mask Length in octets. The value **MUST** be 0, 4, or 8. If the User-Defined Application Identifier Bit Mask is not present, the UDABM Length **MUST** be set to 0.

Standard Application Identifier Bit Mask: Optional set of bits, where each bit represents a single standard application. Bits are defined in the "Link Attribute Applications" registry, which is defined in [RFC8919]. Current assignments are repeated here for informational purposes:

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

Bit 0 (R-bit): RSVP-TE.

Bit 1 (S-bit): Segment Routing Policy.

Bit 2 (F-bit): Loop-Free Alternate (LFA). Includes all LFA types.

User-Defined Application Identifier Bit Mask: Optional set of bits, where each bit represents a single user-defined application.

If the SABM or UDABM Length is other than 0, 4, or 8, the ASLA sub-TLV **MUST** be ignored by the receiver.

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

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 these bits be used starting with bit 0 so as to minimize the number of octets required to advertise all UDAs. 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.

If the link attribute advertisement is intended to be only used by a specific set of applications, corresponding bit masks **MUST** be present, and application-specific bit(s) **MUST** be set for all applications that use the link attributes advertised in the ASLA sub-TLV.

Application Identifier Bit Masks apply to all link attributes that support application-specific values and are advertised in the ASLA sub-TLV.

The advantage of not making the Application Identifier Bit Masks part of the attribute advertisement itself is that the format of any previously defined link attributes can be kept and reused when advertising them in the ASLA sub-TLV.

If the same attribute is advertised in more than one ASLA sub-TLVs with the application listed in the Application Identifier Bit Masks, the application **SHOULD** use the first instance of advertisement and ignore any subsequent advertisements of that attribute.

If link attributes are advertised 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. 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.

An application-specific advertisement (Application Identifier Bit Mask with a matching Application Identifier Bit set) for an attribute **MUST** always be preferred over the advertisement of the same attribute with the zero-length Application Identifier Bit Masks for both standard applications and user-defined applications on the same link.

This document defines the initial set of link attributes that **MUST** use the ASLA sub-TLV if advertised in the OSPFv2 Extended Link TLV or in the OSPFv3 Router-Link TLV. Documents that define new link attributes **MUST** state whether the new attributes support application-specific values and, as such, are advertised in an ASLA sub-TLV. The standard link attributes that are advertised in ASLA sub-TLVs are:

- Shared Risk Link Group [RFC4203]
- Unidirectional Link Delay [RFC7471]
- Min/Max Unidirectional Link Delay [RFC7471]
- Unidirectional Delay Variation [RFC7471]
- Unidirectional Link Loss [RFC7471]
- Unidirectional Residual Bandwidth [RFC7471]
- Unidirectional Available Bandwidth [RFC7471]
- Unidirectional Utilized Bandwidth [RFC7471]
- Administrative Group [RFC3630]
- Extended Administrative Group [RFC7308]
- TE Metric [RFC3630]

6. Reused TE Link Attributes

This section defines the use case and indicates the codepoints (Section 14) from the "OSPFv2 Extended Link TLV Sub-TLVs" registry and "OSPFv3 Extended-LSA Sub-TLVs" registry for some of the link attributes that have been originally defined for RSVP-TE or GMPLS.

6.1. Shared Risk Link Group (SRLG)

The SRLG of a link can be used in OSPF-calculated IPFRR (IP Fast Reroute) [RFC5714] to compute a backup path that does not share any SRLG group with the protected link.

To advertise the SRLG of the link in the OSPFv2 Extended Link TLV, the same format for the sub-TLV defined in Section 1.3 of [RFC4203] is used with TLV type 11. Similarly, for OSPFv3 to advertise the SRLG in the OSPFv3 Router-Link TLV, TLV type 12 is used.

6.2. Extended Metrics

[RFC3630] defines several link bandwidth types. [RFC7471] defines extended link metrics that are based on link bandwidth, delay, and loss characteristics. All of these can be used to compute primary and backup paths within an OSPF area to satisfy requirements for bandwidth, delay (nominal or worst case), or loss.

To advertise extended link metrics in the OSPFv2 Extended Link TLV, the same format for the sub-TLVs defined in [RFC7471] is used with the following TLV types:

12: Unidirectional Link Delay

13: Min/Max Unidirectional Link Delay

14: Unidirectional Delay Variation

15: Unidirectional Link Loss

16: Unidirectional Residual Bandwidth

17: Unidirectional Available Bandwidth

18: Unidirectional Utilized Bandwidth

To advertise extended link metrics in the Router-Link TLV inside the OSPFv3 E-Router-LSA, the same format for the sub-TLVs defined in [RFC7471] is used with the following TLV types:

13: Unidirectional Link Delay

14: Min/Max Unidirectional Link Delay

15: Unidirectional Delay Variation

16: Unidirectional Link Loss

17: Unidirectional Residual Bandwidth

18: Unidirectional Available Bandwidth

19: Unidirectional Utilized Bandwidth

6.3. Administrative Group

[RFC3630] and [RFC7308] define the Administrative Group and Extended Administrative Group sub-TLVs, respectively.

To advertise the Administrative Group and Extended Administrative Group in the OSPFv2 Extended Link TLV, the same format for the sub-TLVs defined in [RFC3630] and [RFC7308] is used with the following TLV types:

19: Administrative Group

20: Extended Administrative Group

To advertise the Administrative Group and Extended Administrative Group in the OSPFv3 Router-Link TLV, the same format for the sub-TLVs defined in [RFC3630] and [RFC7308] is used with the following TLV types:

20: Administrative Group

21: Extended Administrative Group

6.4. Traffic Engineering Metric

[RFC3630] defines the Traffic Engineering Metric.

To advertise the Traffic Engineering Metric in the OSPFv2 Extended Link TLV, the same format for the sub-TLV defined in Section 2.5.5 of [RFC3630] is used with TLV type 22. Similarly, for OSPFv3 to advertise the Traffic Engineering Metric in the OSPFv3 Router-Link TLV, TLV type 22 is used.

7. Maximum Link Bandwidth

Maximum link bandwidth is an application-independent attribute of the link that is defined in [RFC3630]. Because it is an application-independent attribute, it **MUST NOT** be advertised in the ASLA sub-TLV. Instead, it **MAY** be advertised as a sub-TLV of the Extended Link TLV in the Extended Link Opaque LSA in OSPFv2 [RFC7684] or as a sub-TLV of the Router-Link TLV in the E-Router-LSA Router-Link TLV in OSPFv3 [RFC8362].

To advertise the maximum link bandwidth in the OSPFv2 Extended Link TLV, the same format for the sub-TLV defined in [RFC3630] is used with TLV type 23.

To advertise the maximum link bandwidth in the OSPFv3 Router-Link TLV, the same format for the sub-TLV defined in [RFC3630] is used with TLV type 23.

8. Considerations for Extended TE Metrics

[RFC7471] 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 can be associated with all of the applications utilizing that link. This can be done either by explicitly specifying the applications in the Application Identifier Bit Mask or by using a zero-length Application Identifier Bit Mask.

9. Local Interface IPv6 Address Sub-TLV

The Local Interface IPv6 Address sub-TLV is an application-independent attribute of the link that is defined in [RFC5329]. Because it is an application-independent attribute, it **MUST NOT** be advertised in the ASLA sub-TLV. Instead, it **MAY** be advertised as a sub-TLV of the Router-Link TLV inside the OSPFv3 E-Router-LSA [RFC8362].

To advertise the Local Interface IPv6 Address sub-TLV in the OSPFv3 Router-Link TLV, the same format for the sub-TLV defined in [RFC5329] is used with TLV type 24.

10. Remote Interface IPv6 Address Sub-TLV

The Remote Interface IPv6 Address sub-TLV is an application-independent attribute of the link that is defined in [RFC5329]. Because it is an application-independent attribute, it **MUST NOT** be advertised in the ASLA sub-TLV. Instead, it **MAY** be advertised as a sub-TLV of the Router-Link TLV inside the OSPFv3 E-Router-LSA [RFC8362].

To advertise the Remote Interface IPv6 Address sub-TLV in the OSPFv3 Router-Link TLV, the same format for the sub-TLV defined in [RFC5329] is used with TLV type 25.

11. Attribute Advertisements and Enablement

This document defines extensions to support the advertisement of application-specific link attributes.

There are applications where the application enablement on the link is relevant; for example, with RSVP-TE, one needs to make sure that RSVP is enabled on the link before sending an RSVP-TE signaling message over it.

There are applications where the enablement of the application on the link is irrelevant and has nothing to do with the fact that some link attributes are advertised for the purpose of such application. An example of this is LFA.

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 has no implication of RSVP-TE being enabled on that link. The RSVP-TE enablement is solely derived from the information carried in the OSPFv2 TE Opaque LSA [RFC3630] and OSPFv3 Intra-Area-TE-LSA [RFC5329].

In the case of SR Policy, advertisement of application-specific link attributes does not indicate enablement of SR Policy. 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 application-specific link attributes 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 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 5). 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.

12. Deployment Considerations

12.1. Use of Legacy RSVP-TE LSA Advertisements

Bit identifiers for standard applications are defined in Section 5. 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 RSVP-TE LSA advertisements. The standard applications defined in this document may continue to use RSVP-TE LSA 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 RSVP-TE LSA 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 12.2.

New applications that future documents define to make use of the advertisements defined in this document **MUST NOT** make use of RSVP-TE LSA advertisements. This simplifies deployment of new applications by eliminating the need to support multiple ways to advertise attributes for the new applications.

12.2. 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.

12.2.1. 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 for RSVP-TE. Attributes for applications other than RSVP-TE **MUST** be advertised using application-specific advertisements. This results in duplicate advertisements for those attributes.

12.2.2. Multiple Applications: Some 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, interoperability is achieved by using legacy advertisements for RSVP-TE. Attributes for applications other than RSVP-TE **MUST** be advertised using application-specific advertisements. In cases where some link attributes are shared with RSVP-TE, this requires duplicate advertisements for those attributes.

12.2.3. Interoperability with Legacy Routers

For the 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. So long as there is any legacy router in the network that has any of the applications enabled, all routers **MUST** continue to advertise link attributes using legacy advertisements. In addition, the link attribute values associated with the set of applications supported by legacy routers (RSVP-TE, SR Policy, and/or LFA) are always shared since legacy routers have no way of advertising or processing application-specific values. Once all legacy routers have been upgraded, migration from legacy advertisements to application-specific advertisements can be achieved via the following steps:

1) Send new application-specific advertisements while continuing to advertise using the legacy advertisement (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) Keep legacy advertisements if needed for RSVP-TE purposes.

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

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.

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

The extensions defined in this document support RSVP-TE as one of the supported applications. It is, however, **RECOMMENDED** to advertise all link attributes for RSVP-TE in the existing OSPFv2 TE Opaque LSA [RFC3630] and OSPFv3 Intra-Area-TE-LSA [RFC5329] to maintain backwards compatibility. RSVP-TE can eventually utilize the application-specific advertisements for newly defined link attributes that are defined as application specific.

Link attributes that are not allowed to be advertised in the ASLA sub-TLV, such as maximum reservable link bandwidth and unreserved bandwidth, **MUST** use the OSPFv2 TE Opaque LSA [RFC3630] and OSPFv3 Intra-Area-TE-LSA [RFC5329] and **MUST NOT** be advertised in the ASLA sub-TLV.

13. Security Considerations

Existing security extensions as described in [RFC2328], [RFC5340], and [RFC8362] apply to extensions defined in this document. While OSPF is under a single administrative domain, there can be deployments where potential attackers have access to one or more networks in the OSPF routing domain. In these deployments, stronger authentication mechanisms such as those specified in [RFC5709], [RFC7474], [RFC4552], or [RFC7166] **SHOULD** be used.

Implementations must ensure that if any of the TLVs and sub-TLVs defined in this document are malformed, they are detected and do not facilitate a vulnerability for attackers to crash the OSPF router or routing process. Reception of a malformed TLV or sub-TLV **SHOULD** be counted and/or logged for further analysis. Logging of malformed TLVs and sub-TLVs **SHOULD** be rate-limited to prevent a denial-of-service (DoS) attack (distributed or otherwise) from overloading the OSPF control plane.

This document defines a new way to advertise link attributes. Tampering with the information defined in this document may have an effect on applications using it, including impacting traffic engineering, which uses various link attributes for its path computation. This is similar in nature to the impacts associated with, for example, [RFC3630]. As the advertisements defined in this document limit the scope to specific applications, the impact of tampering is similarly limited in scope.

14. IANA Considerations

This specification updates two existing registries:

- the "OSPFv2 Extended Link TLV Sub-TLVs" registry
- the "OSPFv3 Extended-LSA Sub-TLVs" registry

The new values defined in this document have been allocated using the IETF Review procedure as described in [RFC8126].

14.1. OSPFv2

The "OSPFv2 Extended Link TLV Sub-TLVs" registry [RFC7684] defines sub-TLVs at any level of nesting for OSPFv2 Extended Link TLVs. IANA has assigned the following sub-TLV types from the "OSPFv2 Extended Link TLV Sub-TLVs" registry:

10: Application-Specific Link Attributes

11: Shared Risk Link Group

12: Unidirectional Link Delay

13: Min/Max Unidirectional Link Delay

14: Unidirectional Delay Variation

15: Unidirectional Link Loss

16: Unidirectional Residual Bandwidth

17: Unidirectional Available Bandwidth

18: Unidirectional Utilized Bandwidth

19: Administrative Group

20: Extended Administrative Group

22: TE Metric

23: Maximum link bandwidth

14.2. OSPFv3

The "OSPFv3 Extended-LSA Sub-TLVs" registry [RFC8362] defines sub-TLVs at any level of nesting for OSPFv3 Extended LSAs. IANA has assigned the following sub-TLV types from the "OSPFv3 Extended-LSA Sub-TLVs" registry:

11: Application-Specific Link Attributes

12: Shared Risk Link Group

13: Unidirectional Link Delay

14: Min/Max Unidirectional Link Delay

15: Unidirectional Delay Variation

16: Unidirectional Link Loss

17: Unidirectional Residual Bandwidth

18: Unidirectional Available Bandwidth

19: Unidirectional Utilized Bandwidth

20: Administrative Group

21: Extended Administrative Group

22: TE Metric

23: Maximum link bandwidth

24: Local Interface IPv6 Address

25: Remote Interface IPv6 Address

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