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OSPFv2 Link Traffic Engineering (TE) Attribute Reuse
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Abstract

Various link attributes have been defined in OSPFv2 in the context of the MPLS Traffic Engineering (TE) and GMPLS. Many of these link attributes can be used for purposes other than MPLS Traffic Engineering or GMPLS. This documents defines how to distribute such attributes in OSPFv2 for applications other than MPLS Traffic Engineering or GMPLS purposes.

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1. Introduction

Various link attributes have been defined in OSPFv2 [RFC2328] in the context of the MPLS traffic engineering and GMPLS. All these attributes are distributed by OSPFv2 as sub-TLVs of the Link-TLV advertised in the OSPFv2 TE Opaque LSA [RFC3630].

Many of these link attributes are useful outside of the traditional MPLS Traffic Engineering or GMPLS. This brings its own set of problems, in particular how to distribute these link attributes in OSPFv2 when MPLS TE or GMPLS are not deployed or are deployed in parallel with other applications that use these link attributes.

1.1. Requirements notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Link attributes examples

This section lists some of the link attributes originally defined for MPLS Traffic Engineering that can be used for other purposes in OSPFv2. The list doesn't necessarily contain all the required attributes.

1. Remote Interface IP address [RFC3630] - OSPFv2 currently cannot distinguish between parallel links between two OSPFv2 routers. As a result, the two-way connectivity check performed during SPF may succeed when the two routers disagree on which of the links to use for data traffic.

2. Link Local/Remote Identifiers - [RFC4203] - Used for the two-way connectivity check for parallel unnumbered links. Also used for identifying adjacencies for unnumbered links in Segment Routing traffic engineering.

3. Shared Risk Link Group (SRLG) [RFC4203] - In IPFRR, the SRLG is used to compute diverse backup paths [RFC5714].

4. Unidirectional Link Delay/Loss Metrics [RFC7471] - Could be used for the shortest path first (SPF) computation using alternate metrics within an OSPF area.

3. Advertising Link Attributes

This section outlines possible approaches for advertising link attributes originally defined for MPLS Traffic Engineering purposes or GMPLS when they are used for other applications.

3.1. TE Opaque LSA

One approach for advertising link attributes is to continue to use TE Opaque LSA ([RFC3630]). There are several problems with this approach:

1. Whenever the link is advertised in a TE Opaque LSA, the link becomes a part of the TE topology, which may not match IP routed topology. By making the link part of the TE topology, remote nodes may mistakenly believe that the link is available for MPLS TE or GMPLS, when, in fact, MPLS is not enabled on the link.

2. The TE Opaque LSA carries link attributes that are not used or required by MPLS TE or GMPLS. There is no mechanism in a TE Opaque LSA to indicate which of the link attributes are passed to MPLS TE application and which are used by other applications including OSPFv2 itself.

3. Link attributes used for non-TE purposes are partitioned across multiple LSAs - the TE Opaque LSA and the Extended Link Opaque LSA. This partitioning will require implementations to lookup multiple LSAs to extract link attributes for a single link, bringing needless complexity to OSPFv2 implementations.

The advantage of this approach is that there is no additional standardization requirement to advertise the TE/GMPL attributes for other applications. Additionally, link attributes are only advertised once when both OSPF TE and other applications are deployed on the same link. This is not expected to be a common deployment scenario.

3.2. Extended Link Opaque LSA

An alternative approach for advertising link attributes is to use Extended Link Opaque LSAs as defined in [RFC7684]. This LSA was defined as a generic container for distribution of the extended link attributes. There are several advantages in using Extended Link LSA:

1. Advertisement of the link attributes does not make the link part of the TE topology. It avoids any conflicts and is fully compatible with the [RFC3630].

2. The TE Opaque LSA remains truly opaque to OSPFv2 as originally defined in [RFC3630]. Its content is not inspected by OSPFv2 and OSPFv2 acts as a pure transport.

3. There is clear distinction between link attributes used by TE and link attributes used by other OSPFv2 applications.

4. All link attributes that are used by OSPFv2 applications are advertised in a single LSA, the Extended Link Opaque LSA.

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. Additionally, there will be additional standardization effort. However, this could also be viewed as an advantage as the non-TE use cases for the TE link attributes are documented and validated by the OSPF working group.

3.3. Selected Approach

It is RECOMMENDED to use the Extended Link Opaque LSA ([RFC7684] to advertise any link attributes used for non-TE purposes in OSPFv2, including those that have been originally defined for TE purposes. TE link attributes used for TE purposes continue to use TE Opaque LSA ([RFC3630]).

It is also RECOMMENDED to keep the format of the link attribute TLVs that have been defined for TE purposes unchanged even when they are used for non-TE purposes.

Finally, it is RECOMMENDED to allocate unique code points for link attribute TLVs that have been defined for TE purposes for the OSPFv2 Extended Link TLV Sub-TLV Registry as defined in [RFC7684]. For each reused TLV, the code point will be defined in an IETF document along with the expected usecase(s).

4. Reused TE link attributes

This section defines the use case and code points for the OSPFv2 Extended Link TLV Sub-TLV Registry for some of the link attributes that have been originally defined for TE or GMPLS purposes.

4.1. Remote interface IP address

The OSPFv2 description of an IP numbered point-to-point adjacency does not include the remote IP address. As described in Section 2, this makes the two-way connectivity check ambiguous in the presence of the parallel point-to-point links between two OSPFv2 routers.

The Remote IP address of the link can also be used for Segment Routing traffic engineering to identify the link in a set of parallel links between two OSPFv2 routers [I-D.ietf-ospf-segment-routing-extensions]. Similarly, the remote IP address is useful in identifying individual parallel OSPF links advertised in BGP Link-State as described in [I-D.ietf-idr-ls-distribution].

To advertise the Remote interface IP address in the OSPFv2 Extended Link TLV, the same format of the sub-TLV as defined in section 2.5.4. of [RFC3630] is used and TLV type TBD1 is used.

4.2. Link Local/Remote Identifiers

The OSPFv2 description of an IP unnumbered point-to-point adjacency does not include the remote link identifier. As described in Section 2, this makes the two-way connectivity check ambiguous in the presence of the parallel point-to-point IP unnumbered links between two OSPFv2 routers.

The local and remote link identifiers can also be used for Segment Routing traffic engineering to identify the link in a set of parallel IP unnumbered links between two OSPFv2 routers [I-D.ietf-ospf-segment-routing-extensions]. Similarly, these identifiers are useful in identifying individual parallel OSPF links advertised in BGP Link-State as described in [I-D.ietf-idr-ls-distribution].

To advertise the link Local/Remote identifiers in the OSPFv2 Extended Link TLV, the same format of the sub-TLV as defined in section 1.1. of [RFC4203] is used and TLV type TBD2 is used.

4.3. Shared Risk Link Group (SRLG)

The SRLG of a link can be used in IPFRR 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 of the sub-TLV as defined in section 1.3. of [RFC4203] is used and TLV type TBD3 is used.

4.4. Extended Metrics

[RFC3630] defines several link bandwidth types. [RFC7471] defines extended link metrics that are based on link bandwidth, delay and loss characteristics. All these can be used to compute best 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 of the sub-TLVs as defined in [RFC7471] is used with following TLV types:

TBD4 - Unidirectional Link Delay

TBD5 - Min/Max Unidirectional Link Delay

TBD6 - Unidirectional Delay Variation

TBD7 - Unidirectional Link Loss

TBD8 - Unidirectional Residual Bandwidth

TBD9 - Unidirectional Available Bandwidth

TBD10 - Unidirectional Utilized Bandwidth

5. Advertisement of Application Specific Values

Multiple applications can utilize link attributes that are flooded by OSPFv2. Some examples of applications using the link attributes are Segment Routing Traffic Engineering and LFA [RFC5286].

In some cases the link attribute only has a single value that is applicable to all applications. An example is a Remote interface IP address [Section 4.1] or Link Local/Remote Identifiers [Section 4.2].

In some cases the link attribute MAY have different values for different applications. An example could be SRLG [Section 4.3], where values used by LFA could be different then the values used by Segment Routing Traffic Engineering.

To allow advertisement of the application specific values of the link attribute, a new Extended Link Attribute sub-TLV of the Extended Link TLV [RFC7471] is defined. The Extended Link Attribute sub-TLV is an optional sub-TLV and can appear multiple times in the Extended Link TLV. It has 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Application Bit-Mask Length  |          Reserved             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Application Bit-Mask                     |
+-                                                             -+
|                            ...                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Link Attribute sub-sub-TLVs              |
+-                                                             -+
|                            ...                                |
```

where:

Type: TBD11, suggested value 14

Length: variable

Application Bit-Mask Length: length of the Application Bit-Mask. If the Application Bit-Mask is not present, the Application Bit-Mask Length MUST be set to 0.

Application Bit-Mask: Optional set of bits, where each bit represents a single application. The following bits are defined by this document:

Bit-0: Segment Routing Traffic Engineering

Bit-1: LFA

Undefined bits in Application Bit-Mask 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.

If the link attribute advertisement is limited to be used by a specific set of applications, Application Bit-Mask MUST be present and application specific bit(s) MUST be set for all applications that use the link attributes advertised in the Extended Link Attribute sub-TLV.

Application Bit-Mask applies to all link attributes that support application specific values and are advertised in the Extended Link Attribute sub-TLV.

The advantage of not making the Application Bit-Mask part of the attribute advertisement itself is that we can keep the format of the link attributes that have been defined previously and reuse the same format when advertising them in the Extended Link Attribute sub-TLV.

If the link attribute is advertised and there is no Application Bit-Mask present in the Extended Link Attribute Sub-TLV, the link attribute advertisement MAY be used by any application. If, however, another advertisement of the same link attribute includes Application Bit-Mask in the Extended Link Attribute sub-TLV, applications that are listed in the Application Bit-Mask of such Extended Link Attribute sub-TLV SHOULD use the attribute advertisement which has the application specific bit set in the Application Bit-Mask.

If the same application is listed in the Application Bit-Mask of more then one Extended Link Attribute sub-TLV, the application SHOULD use the first advertisement and ignore any subsequent advertisements of the same attribute. This situation SHOULD be logged as an error.

This document defines the set of link attributes for which the Application Bit-Mask may be advertised. If the Application Bit-Mask is included in the Extended Link Attribute sub-TLV that advertises any link attribute(s) NOT listed below, the Application Bit-Mask MUST NOT be used for such link attribute(s). It MUST be used for those attribute(s) that support application specific values. Documents which define new link attributes MUST state whether the new attributes support application specific values. The link attributes to which the Application Bit-Mask may apply are:

- Shared Risk Link Group

- Unidirectional Link Delay

- Min/Max Unidirectional Link Delay

- Unidirectional Delay Variation

- Unidirectional Link Loss

- Unidirectional Residual Bandwidth

- Unidirectional Available Bandwidth

- Unidirectional Utilized Bandwidth

6. Backward Compatibility

Link attributes may be concurrently advertised in both the TE Opaque LSA [RFC3630] and the Extended Link Opaque LSA [RFC7684].

In fact, there is at least one OSPF implementation that utilizes the link attributes advertised in TE Opaque LSAs [RFC3630] for Non-RSVP TE applications. For example, this implementation of LFA and remote LFA utilizes links attributes such as Shared Risk Link Groups (SRLG) [RFC4203] and Admin Group [[RFC3630]advertised in TE Opaque LSAs. These applications are described in [RFC5286], [RFC7490], [I-D.ietf-rtgwg-lfa-manageability] and [I-D.psarkar-rtgwg-rlfa-node-protection].

When an OSPF routing domain includes routers using link attributes from TE Opaque LSAs for Non-RSVP TE applications such as LFA, OSPF routers in that domain should continue to advertise such TE Opaque LSAs. If there are also OSPF routers using the link attributes described herein for Non-RSVP applications, OSPF routers in the routing domain will also need to advertise these attributes in OSPF Extended Link Attributes LSAs [RFC7684]. In such a deployment, the advertised attributes SHOULD be the same and Non-RSVP application access to link attributes is a matter of local policy.

7. Security Considerations

Implementations must assure that malformed TLV and Sub-TLV permutations do not result in errors that cause hard OSPFv2 failures.

8. IANA Considerations

OSPFv2 Extended Link TLV Sub-TLVs registry [RFC7684] defines sub-TLVs at any level of nesting for OSPFv2 Extended Link TLVs. This specification updates OSPFv2 Extended Link TLV sub-TLVs registry with the following TLV types:

TBD1 (4 Recommended) - Remote interface IP address

TBD2 (5 Recommended) - Link Local/Remote Identifiers

TBD3 (6 Recommended) - Shared Risk Link Group

TBD4 (7 Recommended) - Unidirectional Link Delay

TBD5 (8 Recommended) - Min/Max Unidirectional Link Delay

TBD6 (9 Recommended) - Unidirectional Delay Variation

TBD7 (10 Recommended) - Unidirectional Link Loss

TBD8 (11 Recommended) - Unidirectional Residual Bandwidth

TBD9 (12 Recommended) - Unidirectional Available Bandwidth

TBD10 (13 Recommended) - Unidirectional Utilized Bandwidth

TBD11 (14 Recommended) - Extended Link Attribute

This specification defines a new Link-Attribute-Applicability Application Bits registry and defines following bits:

Bit-0 - Segment Routing Traffic Engineering

Bit-1 - LFA

9. Acknowledgments

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