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Abstract

This document describes extensions to OSPFv3 to support intra-area Traffic Engineering (TE). This document extends OSPFv2 TE to handle IPv6 networks. A new TLV and several new sub-TLVs are defined to support IPv6 networks.

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1. Introduction

OSPFv3 has a very flexible mechanism for adding new LS types. Unknown LS types are flooded properly based on the flooding scope bits in the LS type [OSPFV3]. This document proposes the addition of the Intra-Area-TE LSA to OSPFv3.

For Traffic Engineering, this document uses "Traffic Engineering Extensions to OSPF" [TE] as a base for TLV definitions. New TLVs and sub-TLVs are added to [TE] to extend TE capabilities to IPv6 networks. Some existing TLVs and sub-TLVs require clarification for OSPFv3 applicability.

GMPLS [GMPLS] and the Diff-Serv MPLS Extensions [TE-DIFF] are based on [TE]. These functions can also be extended to OSPFv3 by utilizing the TLVs and sub-TLVs described in this document.

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 [RFC-KEYWORDS].

2. Intra-Area-TE-LSA

A new LS type is defined for the Intra-Area-TE LSA. This is different from OSPFv2 Traffic Engineering [TE] where opaque LSAs are used to advertise TE information [OPAQUE]. The LSA function code is 10, the U bit is set, and the scope is set to 01 for area-scoping. When the U bit is set to 1, an OSPFv3 router must flood the LSA at its defined flooding scope even if it does not recognize the LS type [OSPFV3].

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            LS age             |0|1|1|          10             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Link State ID                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Advertising Router                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    LS sequence number                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        LS checksum            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-                            TLVs                             -+
|                            ...                                |
```

OSPFv3 Intra-Area-TE-LSA

The Link State ID of an Intra-Area-TE LSA is an arbitrary value used to maintain multiple Traffic Engineering LSAs. The LSA ID has no topological significance.

The format of the TLVs within the body of a router information LSA is the same as the format used by the Traffic Engineering Extensions to OSPF [TE]. The LSA payload consists of one or more nested Type/Length/Value (TLV) triplets. The format of each TLV is:

```
 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            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Value...                           |
```

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

TLV Format

The Length field defines the length of the value portion in octets (thus a TLV with no value portion would have a length of zero). The TLV is padded to four-octet alignment; padding is not included in the length field (so a three octet value would have a length of three, but the total size of the TLV would be eight octets). Nested TLVs are also 32-bit aligned. For example, a one-byte value would have the length field set to 1, and three octets of padding would be added to the end of the value portion of the TLV. Unrecognized types are ignored.

2.1. Intra-Area-TE-LSA Payload

An Intra-Area-TE-LSA contains one top-level TLV. There are two applicable top-level TLVs:

2 - Link TLV

3 - Router IPv6 Address TLV

3. Router IPv6 Address TLV

The Router IPv6 Address TLV advertises a reachable IPv6 address. This is a stable IPv6 address that is always reachable if there is connectivity to the OSPFv3 router.

The Router IPv6 Address TLV has type 3, length 16, and a value containing a 16 octet local IPv6 address. It MUST appear in exactly one Traffic Engineering LSA originated by an OSPFv3 router supporting the TE extensions. The Router IPv6 Address TLV is a top-level TLV as defined in Traffic Engineering Extensions to OSPF [TE] and only one top-level TLV may be contained in an LSA.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              3                |            16                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-             Router IPv6 Address                -+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type A 16-bit field set to 3.
Length A 16-bit field that indicates the length of the value portion in octets. For this TLV it is always 16.
Value A stable and routable IPv6 address.

Router IPv6 Address TLV

4. Link TLV

The Link TLV describes a single link and consists of a set of sub-TLVs [TE]. All of the sub-TLVs in [TE] other than the Link ID sub-TLV are applicable to OSPFv3. The Link ID sub-TLV can't be used in OSPFv3 due to the protocol differences between OSPFv2 and OSPFv3.

Three new sub-TLVs for the Link TLV are defined:

18 - Neighbor ID (8 octets)

19 - Local Interface IPv6 Address (16N octets, where N is the number of IPv6 addresses)

20 - Remote Interface IPv6 Address (16N octets, where N is the number of IPv6 addresses)

The Neighbor ID Sub-TLV is mandatory for OSPF3 Traffic Engineering support. It MUST appear exactly once in a Link TLV. All other sub-TLVs defined in this document MAY occur at most once in a Link TLV.

4.1. Link ID Sub-TLV

The Link ID sub-TLV is used in OSPFv2 to identify the other end of the link. In OSPFv3, the Neighbor ID sub-TLV MUST be used for link identification. In OSPFv3, The Link ID sub-TLV SHOULD NOT be sent and MUST be ignored upon receipt.

4.2. Neighbor ID Sub-TLV

In OSPFv2, the Link ID is used to identify the other end of a link. In OSPFv3, the combination of Neighbor Interface ID and Neighbor Router ID is used for neighbor link identification. Both are advertised in the Neighbor ID Sub-TLV.

Neighbor Interface ID and Neighbor Router ID values are the same as described in RFC 2740 [OSPFV3] A.4.3 Router-LSAs.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              18               |             8                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Neighbor Interface ID                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|             Neighbor Router ID                                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type A 16-bit field set to 18.
Length A 16-bit field that indicates the length of the value portion in octets. For this sub-TLV it is always 8.
Value The neighbor's interface ID and router ID.

Neighbor ID Sub-TLV

4.3. Local Interface IPv6 Address Sub-TLV

The Local Interface IPv6 Address sub-TLV specifies the IPv6 address(es) of the interface corresponding to this link. If there are multiple local addresses assigned to the link then they MAY all be listed in this sub-TLV. Link-local addresses MUST NOT be included in this sub-TLV.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              19               |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-             Local Interface  IPv6 Address       -+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         o                                     |
|                         o                                     |
|                         o                                     |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-          Local Interface IPv6 Address          -+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type A 16-bit field set to 19.
Length A 16-bit field that indicates the length of the value portion in octets. For this sub-TLV, it MUST always be a multiple of 16 octets dependent on the number of IPv6 global addresses advertised.
Value A list of one or more local IPv6 interface addresses each consuming 16 octets.

Local Interface IPv6 Address Sub-TLV

4.4. Remote Interface IPv6 Address Sub-TLV

The Remote Interface IPv6 Address sub-TLV advertises the IPv6 address(es) associated with the neighbor's interface. This Sub-TLV and the Local Interface IPv6 address Sub-TLV are used to discern amongst parallel links between OSPFv3 routers. If the Link Type is multi-access, the Remote Interface IPv6 Address MAY be set to ::. Alternately, an implementation MAY choose not to send this sub-TLV. Link-local addresses MUST NOT be advertised in this sub-TLV. Neighbor addresses advertised in Link-LSAs with a prefix length of

128 and the LA bit set MAY be advertised.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              20               |              Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-             Remote Interface IPv6 Address       -+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         o                                     |
|                         o                                     |
|                         o                                     |
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-             Remote Interface IPv6 Address       -+-+-+-+
|                                                               |
+-+-+-+-                                                -+-+-+-+
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type A 16-bit field set to 20.
Length A 16-bit field that indicates the length of the value portion in octets. For this sub-TLV, it MUST be a multiple of 16 octets dependent on the number of IPv6 global addresses advertised.
Value A variable length remote interface IPv6 address list.

Remote Interface IPv6 Address Sub-TLV

5. Security Considerations

The function described in this document does not create any new security issues for the OSPFv3 protocol. Security considerations for the base OSPFv3 protocol are covered in [OSPFV3].

6. IANA Considerations

The following IANA assignments are to be made from existing registries:

1. The OSPFv3 LSA type function code 10 needs to be assigned to the OSPFv3 Intra-Area-TE-LSA.

2. The Router IPv6 Address TLV type 3 needs to be assigned from the existing registry for OSPF TE TLVs.

3. The Neighbor ID Sub-TLV (18), Local Interface IPv6 Address Sub-TLV (19), and Remote Interface IPv6 Address Sub-TLV (20), need to be assigned from the existing registry for OSPF TE Sub-TLVs.

7. References

7.1. Normative References

[OSPFV3] Coltun, R., Ferguson, D., and J. Moy, "OSPF for IPv6", RFC 2740, April 1998.

[RFC-KEYWORDS] Bradner, S., "Key words for use in RFC's to Indicate Requirement Levels", RFC 2119, March 1997.

[TE] Katz, D., Yeung, D., and K. Kompella, "Traffic Engineering Extensions to OSPF", RFC 3630, September 2003.

7.2. Informative References

[GMPLS] Kompella, K. and Y. Rekhter, "OSPF Extensions in Support of Generalized Multi-Protocol Switching (GMPLS)", RFC 4203, October 2005.

[OPAQUE] Coltun, R., "The OSPF Opaque LSA Option", RFC 2370, July 1998.

[TE-DIFF] Le Faucheur, F., Wu, L., Davie, B., Davari, S., Vaananen, P., Krishnan, R., Cheval, P., and J. Heinanen, "Multi-Protocol Label Switching (MPLS) Support of Differentiated Services", RFC 3270.

Appendix A. Acknowledgments

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