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OSPFv3 LSA Extendibility  
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## Abstract

OSPFv3 requires functional extension beyond what can be done with the fixed Link State Advertisement (LSA) format as described in [RFC 5340](#). This document extends the LSA format by allowing the optional inclusion of Type-Length-Value (TLV) tuples in the LSAs. It also covers all the aspects of backward compatibility.

## Status of this Memo

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## 1. Introduction

OSPFv3 requires functional extension beyond what can be done with the fixed Link State Advertisement (LSA) format as described in [RFC 5340 \[OSPFV3\]](#). This document extends the LSA format by allowing the optional inclusion of Type-Length-Value (TLV) tuples in the LSAs. Backward compatibility mechanisms are also described.

A similar extension was previously proposed in support of multi-topology routing. Additional requirements for OSPFv3 LSA extension include source/destination routing, route tagging, and others.

A final requirement is to limit the changes to OSPFv3 to those necessary for TLV-based LSAs. For the most part, the semantics of existing OSPFv3 LSA are retained for their TLV-based successor LSAs described herein. Additionally, encoding details, e.g., the representation of IPv6 prefixes as described in section A.4.1 in [RFC 5340 \[OSPFV3\]](#), have been retained. This requirement was incorporated to increase the expedience of IETF adoption and deployment.

The following aspects of OSPFv3 LSA extension are described:

1. Extended LSA Types
2. Extended LSA Formats
3. Backward Compatibility

### 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 [\[RFC-KEYWORDS\]](#).

### 1.2. Acknowledgments

OSPFv3 TLV-based LSAs were first proposed in "Multi-topology routing in OSPFv3 (MT-OSPFv3)" [[MT-OSPFV3](#)].

The RFC text was produced using Marshall Rose's xml2rfc tool.

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OSPFv3 LSA Extendibility

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## [2.](#) OSPFv3 Extended LSA Types

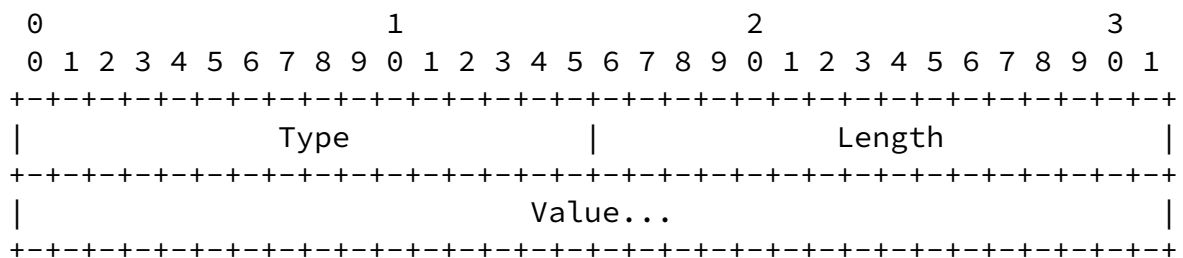
In order to provide backward compatibility, new LSA codes must be allocated. There are eight fixed format TLVs defined in [RFC 5340](#) [[OSPFV3](#)]. For ease of implementation and debugging, the LSA function codes are the same as the fixed-format LSAs only with an offset of 32. The alternative was to allocate a bit in the LSA Type indicating the new LSA format. However, this would use one half the LSA function codes space for the migration of the eight original fixed format LSAs.

LSA function code	LS Type	Description
-----		
33	0x2021	E-Router-LSA
34	0x2022	E-Network-LSA
35	0x2023	E-Inter-Area-Prefix-LSA
36	0x2024	E-Inter-Area-Router-LSA
37	0x4025	E-AS-External-LSA
38	N/A	Unused (Not to be allocated)
39	0x2027	E-Type-7-LSA
40	0x0028	E-Link-LSA
41	0x2029	E-Intra-Area-Prefix-LSA

OSPFv3 Extended LSA Types

### 3. OSPFv3 Extended LSA TLV

The format of the TLVs within the body of the extended LSAs is the same as the format used by the Traffic Engineering Extensions to OSPF [TE]. The variable TLV section consists of one or more nested Type/Length/Value (TLV) tuples. The format of each TLV is:



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 0). The TLV is padded to 4-octet alignment; padding is not included in the length

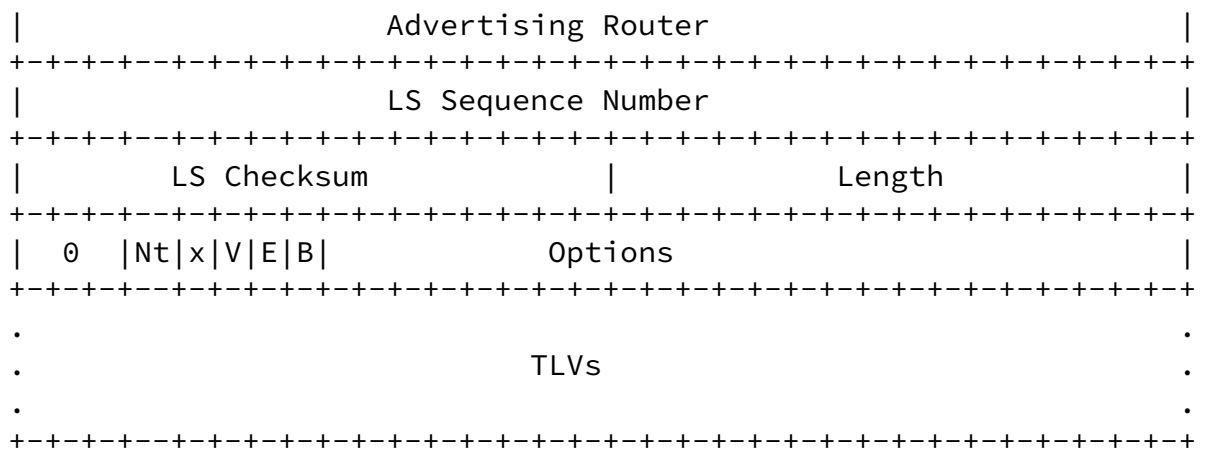
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#### 4. OSPFv3 E-Router-LSA

```

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
+-+-+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|               LS Age                |0|0|1|               0x21          |
+-+-+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|               Link State ID                |
+-+-+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

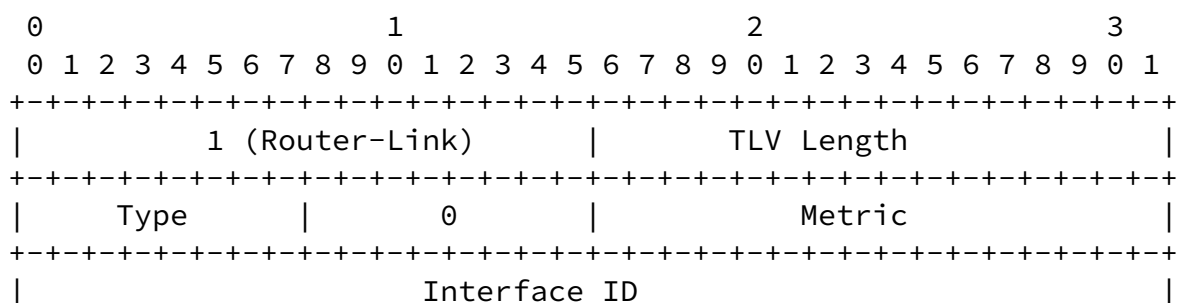
```



### Extended Router-LSA

All LSA Header fields are the same as defined for the Router-LSA.  
The following top-level TLVs are defined:

- o 0 - Reserved
- o 1 - Router-Link TLV



```

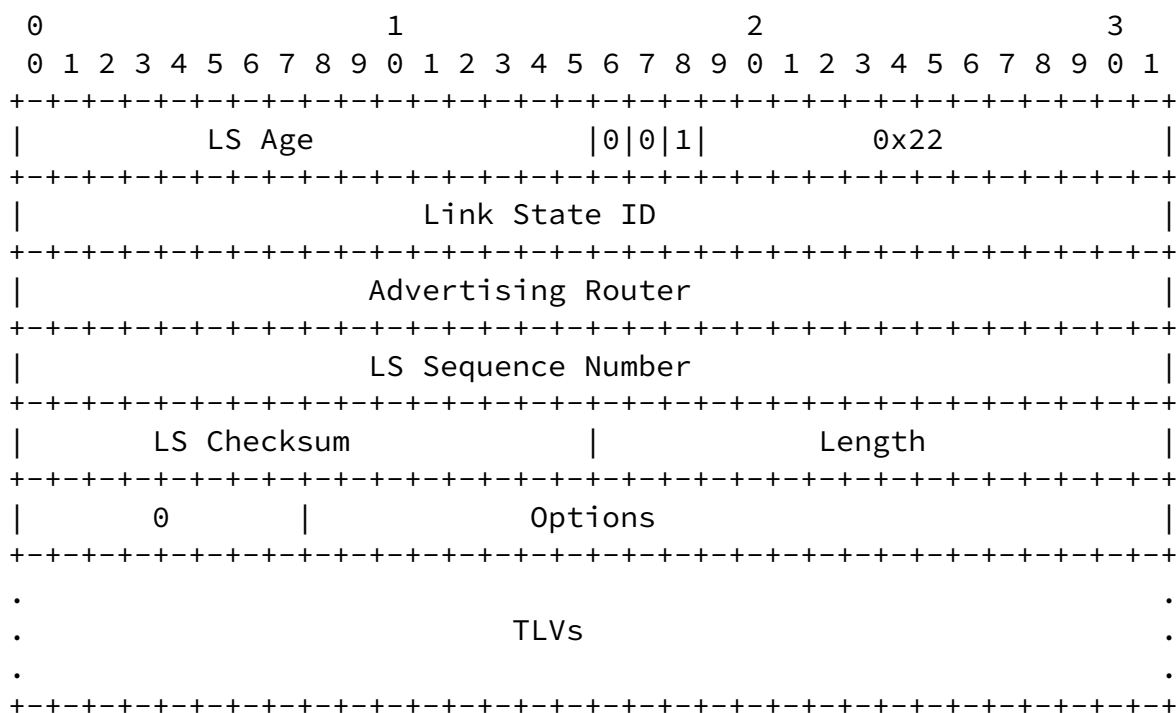
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Neighbor Interface ID                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|                               Neighbor Router ID                           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
.                                                                           .
.                               sub-TLVs                                    .
.                                                                           .
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

### Router-Link TLV

Like the existing Router-LSA, the LSA length is used to determine the end of the LSA including TLVs. The Router-Link TLV is only applicable to the E-Router-LSA. Inclusion in other Extended LSAs MUST be ignored.

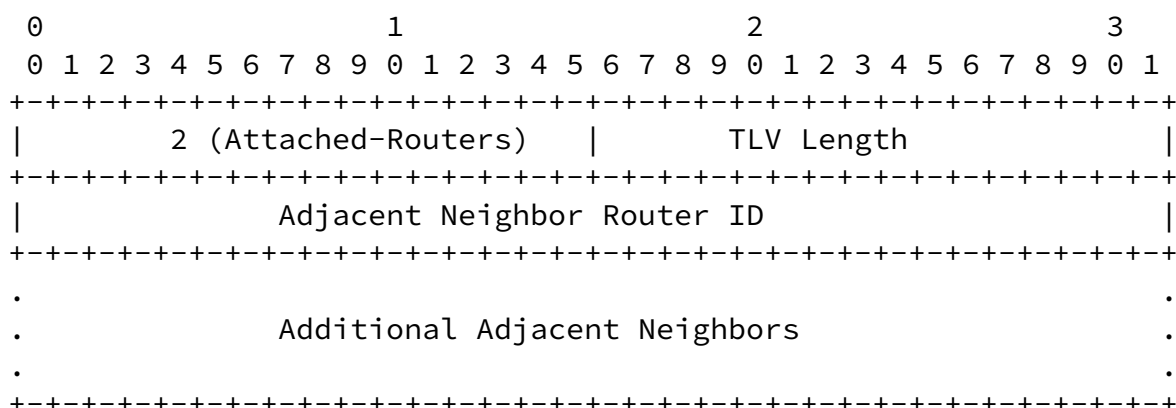
The E-Network-LSA has an LS Type of 0x2022 and will initially have the same content as the Network-LSA, section 4.4.3.3 in [OSPFV3], only fully extendable and represented as TLVs.



## E-Network-LSA

All LSA Header fields are the same as defined for the Network-LSA. The following top-level TLVs are defined:

- o 2 - Attached-Routers TLV



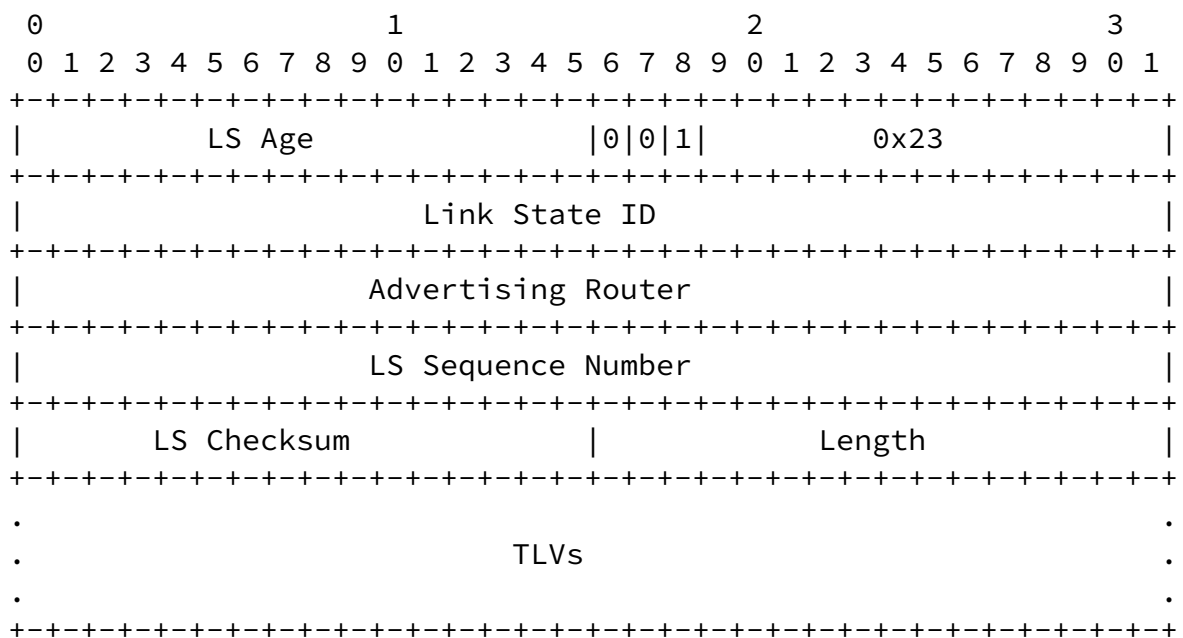
### Attached-Routers TLV

There are two reasons for not having a separate TLV or sub-TLV for each adjacent neighbor. The first is to discourage using the E-Network-LSA for more than its current role of solely advertising the routers attached to a multi-access network. Metric as well other attributes of individual attached routers should be advertised in their respective E-Router-LSAs. The second reason is that there is only a single E-Network-LSA per multi-access link with the Link State ID set to the Designated Router's Interface ID and, consequently, compact encoding has been chosen since to decrease the likelihood of the size of the E-Network-LSA requiring IPv6 fragmentation advertised in an OSPFv3 Link State Update packet.

Like the existing Network-LSA, the LSA length is used to determine the end of the LSA including TLVs. The Attached-Routers TLV is only applicable to the E-Network-LSA. Inclusion in other Extended LSAs MUST be ignored.

## 6. OSPFv3 E-Inter-Area-Prefix-LSA

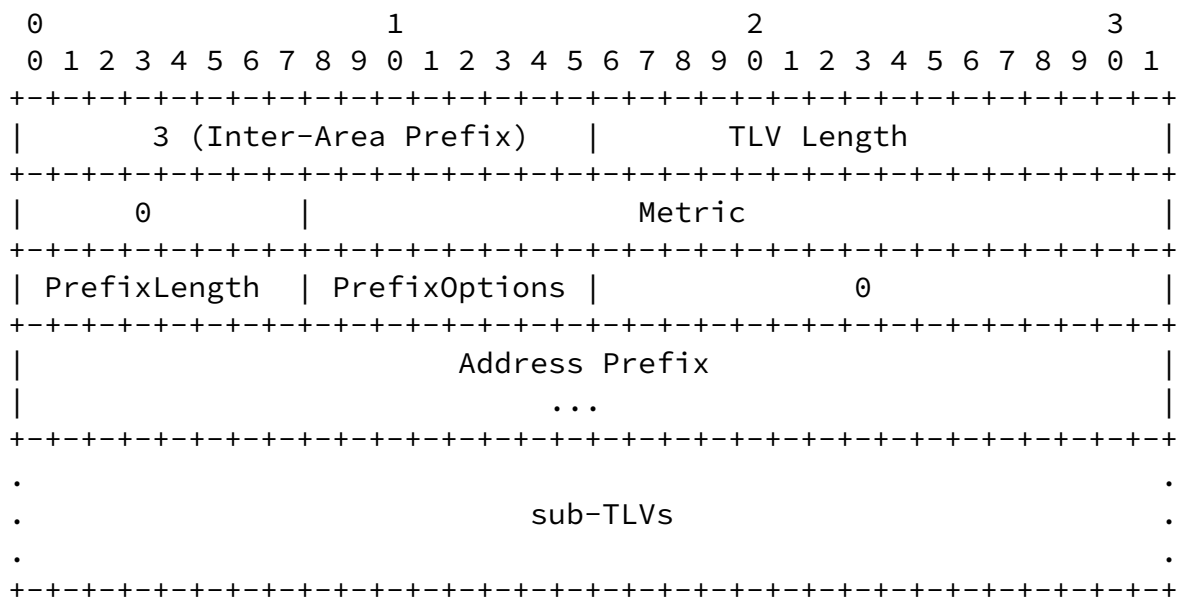
The E-Inter-Area-Prefix-LSA has an LS Type of 0x2023 and will initially have the same content as the Inter-Area-Prefix-LSA, [section 4.4.3.4](#) in [\[OSPFV3\]](#), only fully extendable and represented as TLVs.



### E-Inter-Area-Prefix-LSA

All LSA Header fields are the same as defined for the Network-LSA. The following top-level TLVs are defined:

- o 3 - Inter-Area Prefix TLV



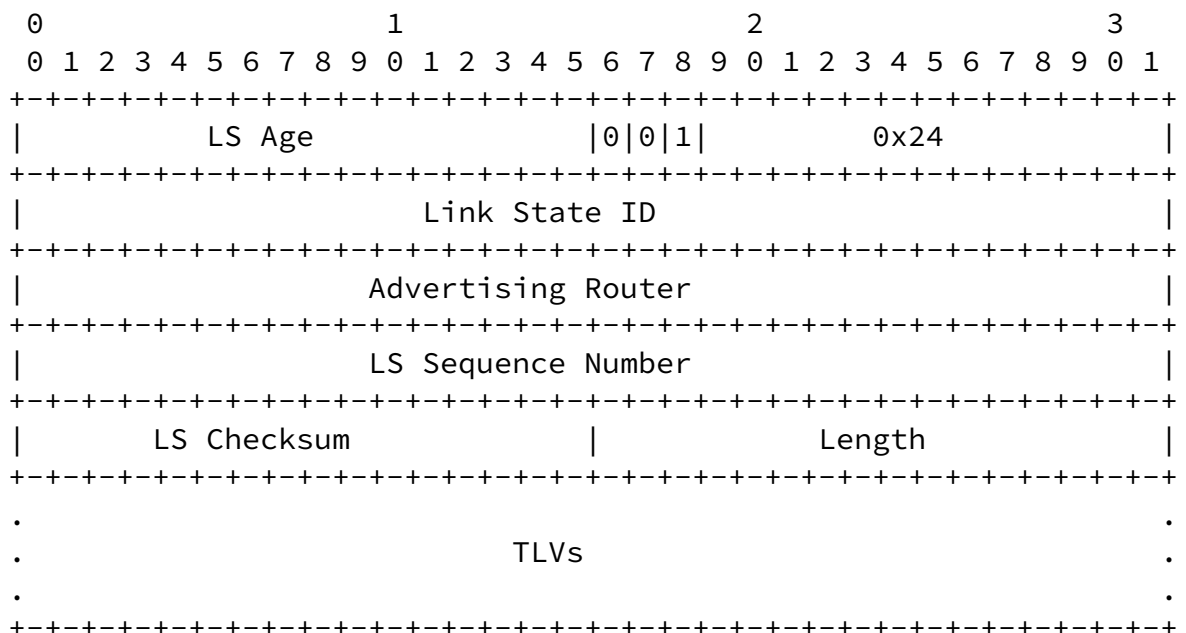
#### Inter-Area Prefix TLV

In order to retain compatibility and semantics with the current OSPFv3 specification, each LSA will contain a single Inter-Area Prefix TLV. This will facilitate migration and avoid changes to functions such as incremental SPF computation.

Like the existing Inter-Area-Prefix-LSA, the LSA length is used to determine the end of the LSA including TLV. The Inter-Area-Prefix TLV is only applicable to the E-Inter-Area-Prefix-LSA. Inclusion in other Extended LSAs MUST be ignored.

## 7. OSPFv3 E-Inter-Area-Router-LSA

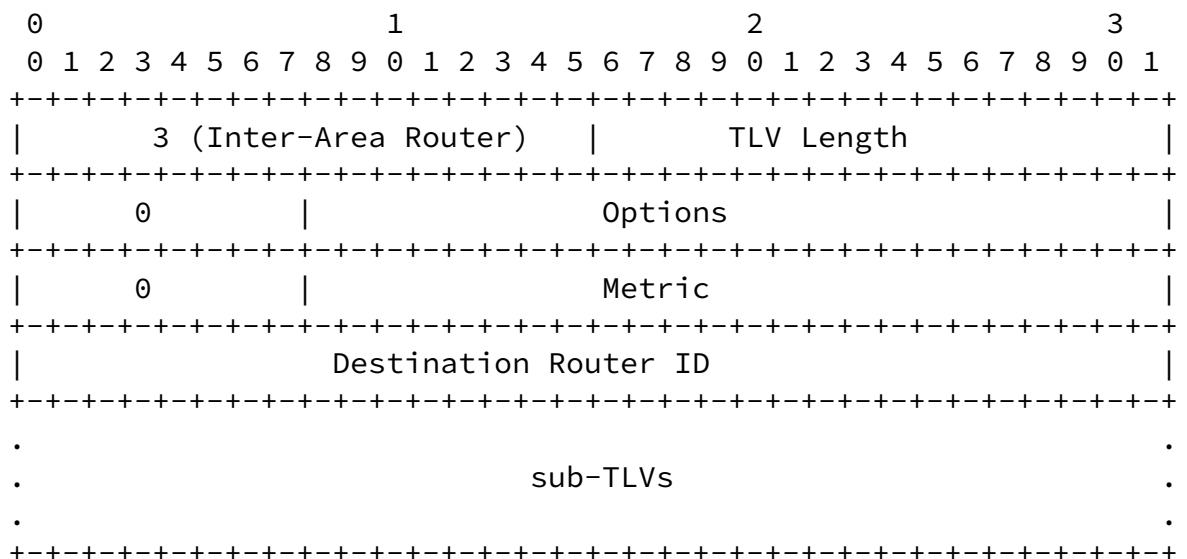
The E-Inter-Area-Router-LSA has an LS Type of 0x2024 and will initially have the same content as the Inter-Area-Router-LSA, [section 4.4.3.5](#) in [\[OSPFV3\]](#), only fully extendable and represented as TLVs.



## E-Inter-Area-Router-LSA

All LSA Header fields are the same as defined for the Inter-Area-Router-LSA. The following top-level TLVs are defined:

- o 4 - Inter-Area Router TLV



Inter-Area Router TLV

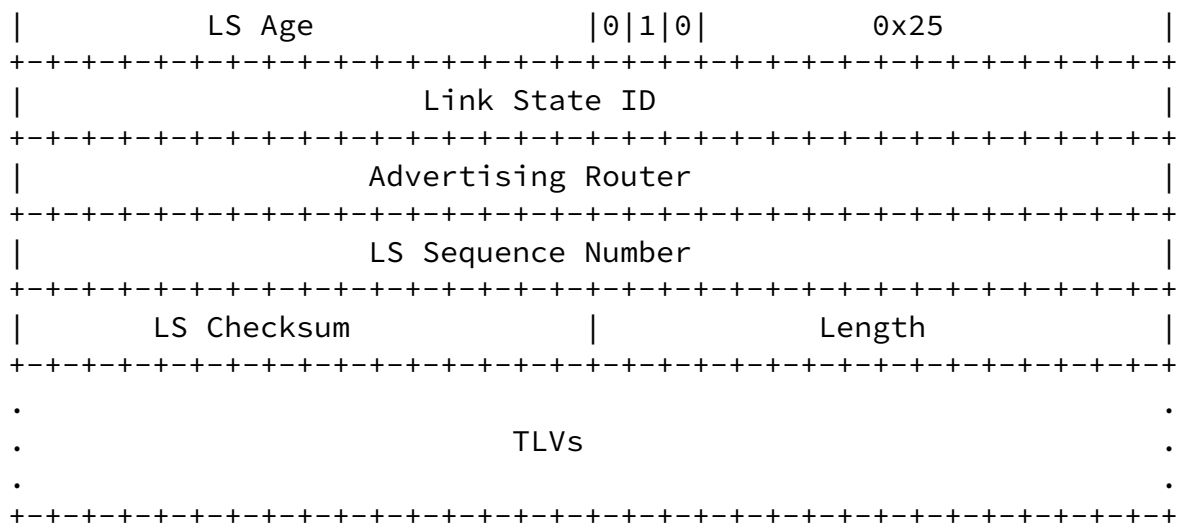
In order to retain compatibility and semantics with the current OSPFv3 specification, each LSA will contain a single Inter-Area Router TLV. This will facilitate migration and avoid changes to functions such as incremental SPF computation.

Like the existing Inter-Area-Router-LSA, the LSA length is used to determine the end of the LSA including sub-TLVs. The Inter-Area-Router TLV is only applicable to the E-Inter-Area-Router-LSA. Inclusion in other Extended LSAs MUST be ignored.

## 8. OSPFv3 E-AS-External-LSA

The E-AS-External-LSA has an LS Type of 0x4025 and will initially have the same content as the AS-External-LSA, section 4.4.3.6 in [OSPFV3], only fully extendable and represented as TLVs.

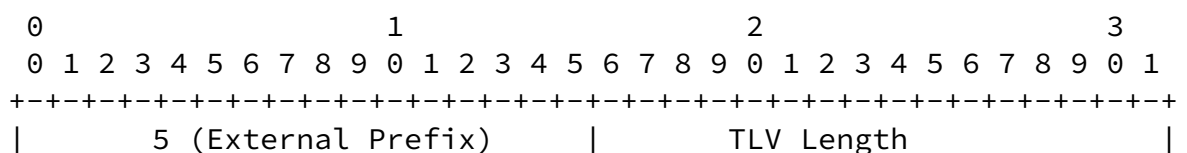
0										1										2										3									
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9
+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-



### E-AS-External-LSA

All LSA Header fields are the same as defined for the AS-External-LSA. The following top-level TLVs are defined:

- o 5 - External Prefix TLV



```

+-----+
|      |E|F|T|      Metric      |
+-----+
| PrefixLength | PrefixOptions |      0      |
+-----+
|      Address Prefix      |
|      ...      |
+-----+
|
+-
|
+-      Forwarding Address (Optional)      +-
|
+-
|
+-----+
|      External Route Tag (Optional)      |
+-----+
.
.      sub-TLVs      .
.
+-----+

```

#### External Prefix TLV

In order to retain compatibility and semantics with the current OSPFv3 specification, each LSA will contain a single External Prefix TLV. This will facilitate migration and avoid changes to functions such as incremental SPF computation. Given the Referenced LS type and Referenced Link State ID from the AS-External-LSA have never been used or even specified, they have been omitted from the External Prefix TLV. If there were ever a requirement for a referenced LSA, it could be satisfied with a sub-TLV.

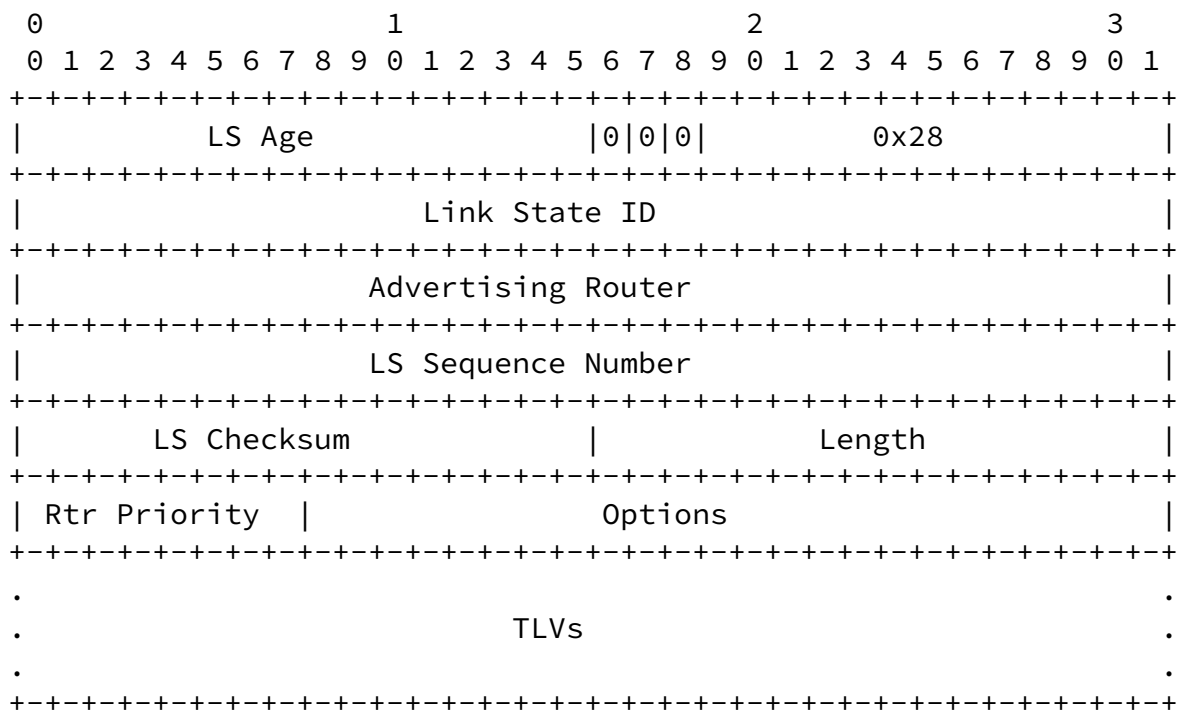
Like the existing AS-External-LSA, the LSA length is used to determine the end of the LSA including sub-TLVs. The External-Prefix TLV is only applicable to the E-AS-External-LSA and the E-NSSA-LSA. Inclusion in other Extended LSAs MUST be ignored.

## 9. OSPFv3 E-NSSA-LSA

The E-NSSA-LSA will have the same format and TLVs as the Extended AS-External-LSA [Section 8](#). This is the same relationship as exists between the NSSA-LSA, section 4.4.3.7 in [[OSPFV3](#)], and the AS-External-LSA. The NSSA-LSA will have type 0x2027 which implies area flooding scope. Future requirements may dictate that supported TLVs differ between the E-AS-External-LSA and the E-NSSA-TLV. However, future requirements are beyond the scope of this document.

10. OSPFv3 E-Link-LSA

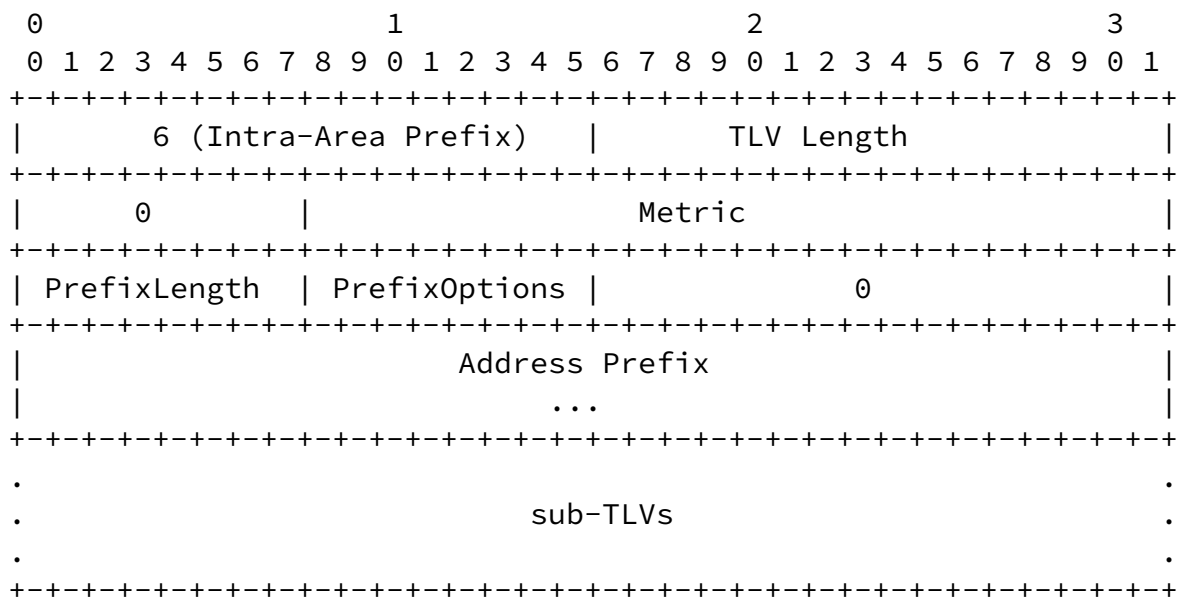
The E-Link-LSA has an LS Type of 0x0028 and will initially have the same content as the Link-LSA, section 4.4.3.8 in [[OSPFV3](#)], only fully extendable and represented as TLVs.



## E-Link-LSA

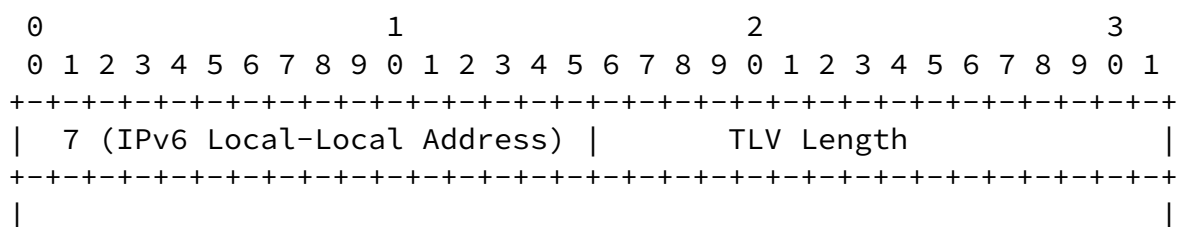
The following top-level TLVs are defined:

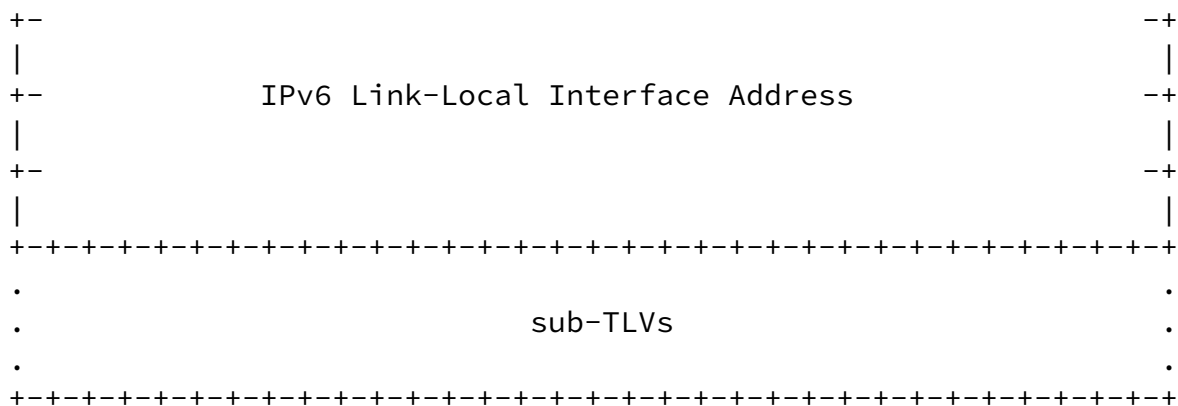
- o 6 - Intra-Area Prefix TLV
- o 7 - IPv6 Link-Local Address TLV
- o 8 - IPv4 Link-Local Address TLV



### Intra-Area Prefix TLV

Like the Link-LSA, the E-Link-LSA affords advertisement of multiple intra-area prefixes. Hence, multiple Intra-Area Prefix TLVs may be specified and the LSA length defines the end of the LSA including all TLVs. The Intra-Area-Prefix TLV is only applicable to the E-Link-LSA and the E-Intra-Area-Prefix-LSA. Inclusion in other Extended LSAs MUST be ignored.

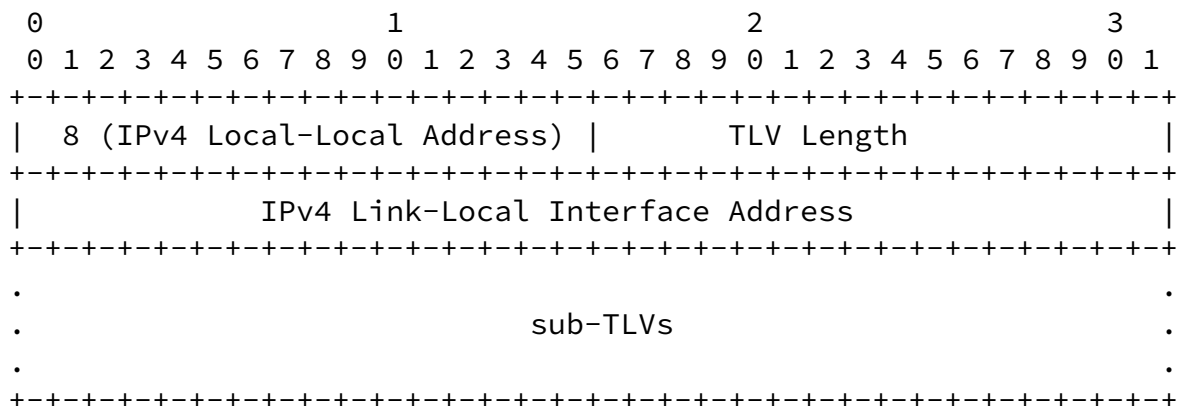




### IPv6 Link-Local Address TLV

The IPv6 Link-Local Address TLV is to be used with IPv6 address

families as defined in [[OSPFV3-AF](#)]. The IPv6 Link-Local Address TLV is only applicable to the E-Link-LSA. Inclusion in other Extended LSAs MUST be ignored. Only a single instance of the IPv6 Link-Local Address family SHOULD be included in the E-Link-LSA. Instances preceding the first MUST be ignored. For IPv4 address families as defined in [[OSPFV3-AF](#)], this TLV SHOULD be ignored. Future specifications may support advertisement of routing and topology for multiple address families. However, this is beyond the scope of this document.



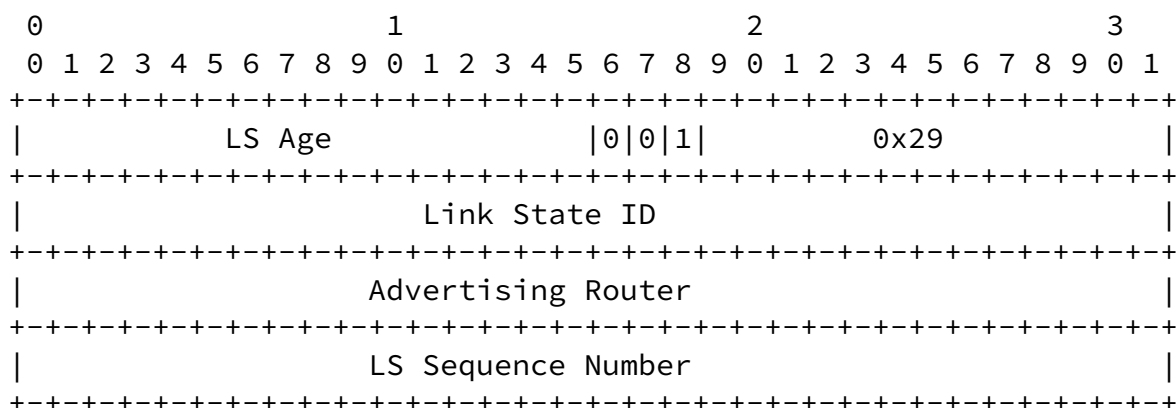
### IPv4 Link-Local Address TLV

The IPv4 Link-Local Address TLV is to be used with IPv4 address

families as defined in [OSPFV3-AF]. The IPv4 Link-Local Address TLV is only applicable to the E-Link-LSA. Inclusion in other Extended LSAs MUST be ignored. Only a single instance of the IPv4 Link-Local Address family SHOULD be included in the E-Link-LSA. Instances preceding the first MUST be ignored. For IPv6 address families as defined in [OSPFV3-AF]. Future specifications may support advertisement of routing and topology for multiple address families. However, this is beyond the scope of this document.

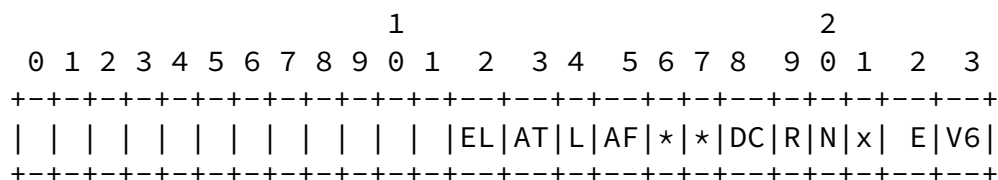
## 11. OSPFv3 E-Intra-Area-Prefix-LSA

The E-Intra-Area-Prefix-LSA has an LS Type of 0x2029 and will initially have the same content as the Intra-Area-Prefix-LSA, [section 4.4.3.9](#) in [OSPFV3], only fully extendable and represented as TLVs.





within a routing domain, mixed routing domains are not supported. Networks requiring concurrent support for both OSPFv3 routers utilizing TLV-based LSAs and OSPFv3 routers not supporting them will need to do so with separate OSPFv3 routing domains and multiple OSPFv3 instances. An OSPFv3 instance will be configured to use either the TLV-based or Non-TLV-based LSAs (Appendix A). In order to facilitate this separation, the OSPFv3 options field (as described in [Appendix A.2 of RFC 5340 \[OSPFV3\]](#)), will contain an additional options bits. The EL-bit will be used to indicate that the advertising OSPFv3 Router can receive, process, and originate TLV-based LSAs. A configured to support TLV-based LSAs WILL set its option field EL-bit in OSPFv3 Hello and Database Description packets and MUST NOT form adjacencies with OSPFv3 Routers sending OSPFv3 Hello and Database Description packets with the options field EL-bit clear. In this manner, OSPFv3 routing domains utilizing the new encoding will be completely isolated from those using the [RFC 5340](#) encodings.



## The Options field

EL-bit

This bit indicates whether or not the OSPFv3 router supports the Extended LSA format with the bit set condition indicating support.

## Options Field EL-bit

### 12.1. LSA TLV Processing Backward Compatibility

This section defines the general rules for processing LSA TLVs. To ensure compatibility of future TLV-based LSA extensions, all implementations **MUST** adhere to these rules:

1. Unrecognized TLVs and sub-TLVs are ignored when parsing or processing Extended-LSAs.
2. Whether or not partial deployment of a given TLV is supported MUST be specified.
3. If partial deployment is not supported, mechanisms to ensure the corresponding feature are not deployed MUST be specified in the document defining the new TLV or sub-TLV.
4. If partial deployment is supported, backward compatibility and partial deployment MUST be specified in the document defining the new TLV or sub-TLV.

### 13. Security Considerations

Extendible OSPFv3 LSAs do not introduce any new security concerns beyond those described in [RFC 5340](#) [[OSPFV3](#)].

#### 14. IANA Considerations

This specification defines nine OSPFv3 Extended LSA types as described in [Section 2](#).

This specification also creates two registries OSPFv3 Extended-LSAs TLVs and sub-TLVs. The TLV and Sub-TLV code-points in these registries are common to all Extended-LSAs and their respective definitions must define where they are applicable.

The OSPFv3 Extend-LSA TLV registry will define top-level TLVs for Extended-LSAs and should be placed in the existing OSPFv3 IANA registry. New values can be allocated via IETF Consensus or IESG Approval.

Nine initial values are allocated:

- o 0 - Reserved
- o 1 - Router-Link TLV
- o 2 - Attached-Routers TLV
- o 3 - Inter-Area Prefix TLV
- o 4 - Inter-Area Router TLV
- o 5 - External Prefix TLV
- o 6 - Intra-Area Prefix TLV
- o 7 - IPv6 Link-Local Address TLV
- o 8 - IPv4 Link-Local Address TLV

The OSPFv3 Extend-LSA sub-TLV registry will define sub-TLVs at any level of nesting for Extended-LSAs and should be placed in the existing OSPFv3 IANA registry. New values can be allocated via IETF Consensus or IESG Approval.

One initial value is allocated:

## [15.](#) References

### [15.1.](#) Normative References

[OSPFV3] Coltun, R., Ferguson, D., Moy, J., and A. Lindem, "OSPF for IPv6", [RFC 5340](#), July 2008.

[OSPFV3-AF] Lindem, A., Mirtorabi, S., Roy, A., Barnes, M., and R. Aggarwal, "Support of Address Families in OSPFv3", [RFC 5838](#), April 2010.

[RFC-KEYWORDS] Bradner, S., "Key words for use in RFCs 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.

### [15.2.](#) Informative References

[MT-OSPFV3] Mirtorabi, S. and A. Roy, "Multi-toplogy routing in OSPFv3 (MT-OSPFV3)", [draft-ietf-ospf-mt-ospfv3-04.txt](#) (work in progress).

## [Appendix A](#). Configurable Constants

An additional global configurable constant will be added to the OSPFv3 protocol.

### ExtendedLSASupport

This is a boolean value indicating whether or not the OSPFv3 instance supports the TLV format described herein for Extended LSAs. If this parameter is set, extended LSAs will be originated and utilized in the Shortest Path First (SPF) calculation. Non-extended LSAs will not be used in the SPF calculation and, if received, will result the network operator being alerted.

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