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Extensions to OSPF for Advertising Optional Router Capabilities

Abstract

It is useful for routers in an OSPFv2 or OSPFv3 routing domain to know the capabilities of their neighbors and other routers in the routing domain. This document proposes extensions to OSPFv2 and OSPFv3 for advertising optional router capabilities. The Router Information (RI) Link State Advertisement (LSA) is defined for this purpose. In OSPFv2, the RI LSA will be implemented with an Opaque LSA type ID. In OSPFv3, the RI LSA will be implemented with a unique LSA type function code. In both protocols, the RI LSA can be advertised at any of the defined flooding scopes (link, area, or autonomous system (AS)). This document obsoletes RFC 4970 by providing a revised specification that includes support for advertisement of multiple instances of the RI LSA and a TLV for functional capabilities.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7770.

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1. Introduction

It is useful for routers in an OSPFv2 [OSPF] or OSPFv3 [OSPFv3] routing domain to know the capabilities of their neighbors and other routers in the routing domain. This can be useful for both the advertisement and discovery of OSPFv2 and OSPFv3 capabilities. Throughout this document, OSPF will be used when the specification is applicable to both OSPFv2 and OSPFv3. Similarly, OSPFv2 or OSPFv3 will be used when the text is protocol specific.

OSPF uses the options field in LSAs and hello packets to advertise optional router capabilities. In the case of OSPFv2, all the bits in this field have been allocated so additional optional capabilities cannot be advertised. This document describes extensions to OSPF to advertise these optional capabilities via Opaque LSAs in OSPFv2 and LSAs with a unique type in OSPFv3. For existing OSPF capabilities, backwards compatibility issues dictate that this advertisement is used primarily for informational purposes. For future OSPF extensions, this advertisement MAY be used as the sole mechanism for advertisement and discovery.

This document obsoletes RFC 4970 by providing a revised specification including support for advertisement of multiple instances of the RI LSA and a TLV for functional capabilities.

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. Summary of Changes from RFC 4970

This document includes the following changes from RFC 4970 [RFC4970]:

1. The main change is that an OSPF router will be able to advertise multiple instances of the OSPF Router Information LSA. This change permeates through much of the document.

2. Additionally, Section 2.6 includes an additional TLV for functional capabilities. This is in contrast to the existing TLV that is used to advertise capabilities for informational purposes only.

3. The IANA allocation policy has been changed from "Standards Action" to "IETF Review" [IANA-GUIDE] for the following registries:

   - OSPFv3 LSA Function Codes
   - OSPF Router Information (RI) TLVs
   - OSPF Router Informational Capability Bits
   - OSPF Router Functional Capability Bits

4. Finally, references have been updated for documents that have become RFCs and RFCs that have been obsoleted since the publication of RFC 4970.

2. OSPF Router Information (RI) LSA

2.1. OSPFv2 Router Information (RI) Opaque LSA

OSPFv2 routers will advertise a link scoped, area-scoped, or AS-scoped Opaque LSA [OPAQUE]. The OSPFv2 RI LSA has an Opaque type of 4 and the Opaque ID is the RI LSA Instance ID. The first Opaque ID, i.e., 0, SHOULD always contain the Router Informational Capabilities TLV and, if advertised, the Router Functional Capabilities TLV. RI LSA instances subsequent to the first can be used for information that doesn't fit in the first instance.

OSPFv2 routers will advertise a link-scoped, area-scoped, or AS-scoped Opaque LSA [OPAQUE]. The OSPFv2 Router Information LSA has an Opaque type of 4. The Opaque ID specifies the LSA Instance ID with the first instance always having an Instance ID of 0.

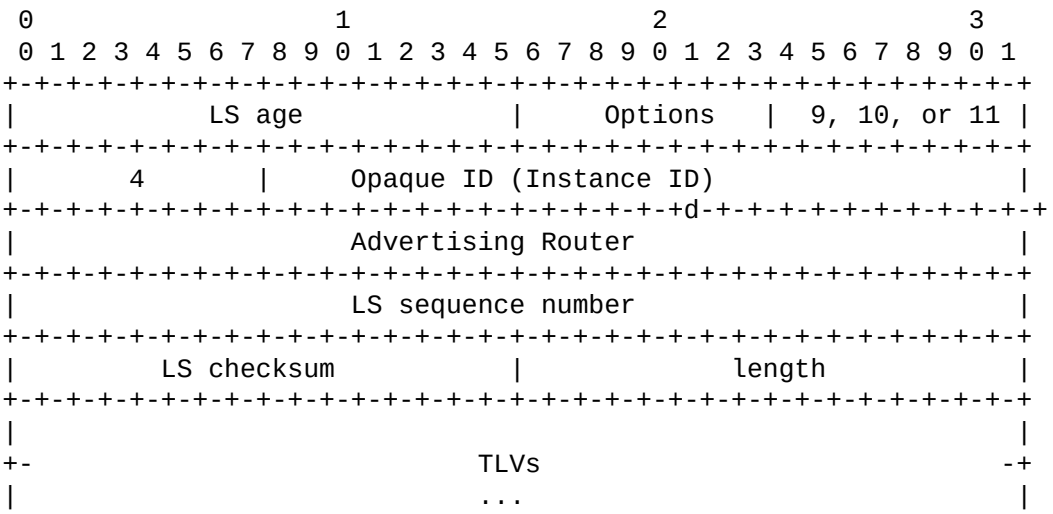


Figure 1. OSPFv2 Router Information Opaque LSA

The format of the TLVs within the body of an RI LSA is as defined in Section 2.3.

2.2. OSPFv3 Router Information (RI) Opaque LSA

The OSPFv3 Router Information LSA has a function code of 12 while the S1/S2 bits are dependent on the desired flooding scope for the LSA. The U bit will be set indicating that the OSPFv3 RI LSA should be flooded even if it is not understood. The Link State ID (LSID) value for this LSA is the Instance ID. The first Instance ID, i.e., 0, SHOULD always contain the Router Informational Capabilities TLV and, if advertised, the Router Functional Capabilities TLV. OSPFv3 Router Information LSAs subsequent to the first can be used for information that doesn't fit in the first instance. OSPFv3 routers MAY advertise multiple RI LSAs per flooding scope.

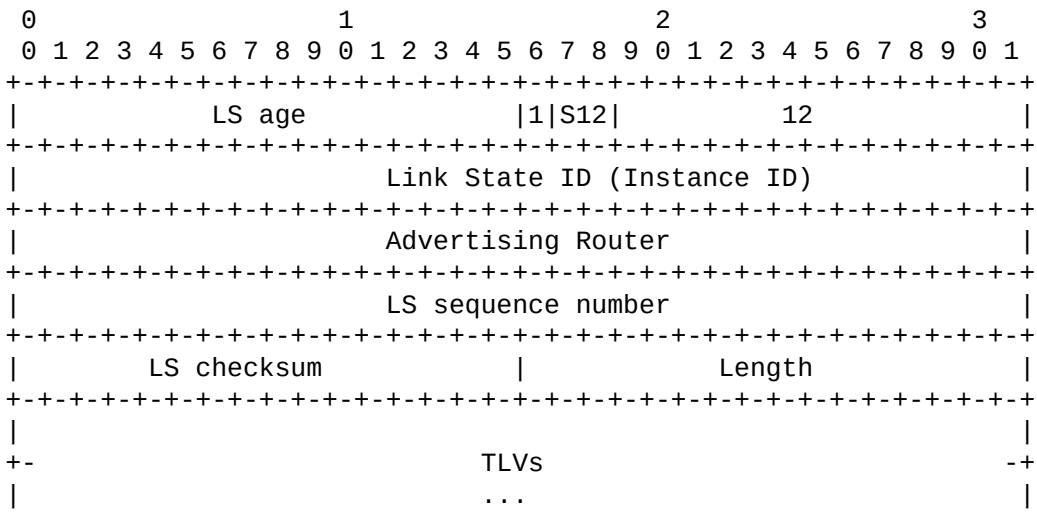


Figure 2. OSPFv3 Router Information LSA

The format of the TLVs within the body of an RI LSA is as defined in Section 2.3

2.3. OSPF Router Information LSA TLV Format

The format of the TLVs within the body of an RI 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:

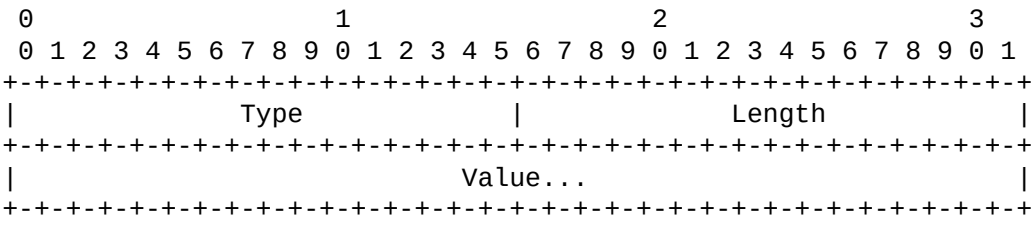


Figure 3. TLV Format

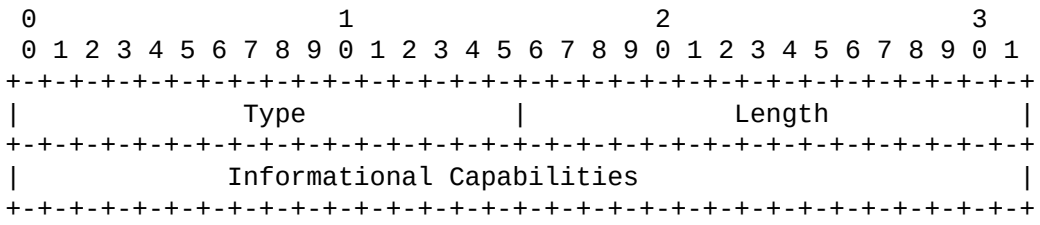
The Length field defines the length of the value portion in octets (thus a TLV with no value portion would have a length of 0). The TLV is padded to 4-octet alignment; padding is not included in the length field (so a 3-octet value would have a length of 3, but the total size of the TLV would be 8 octets). Nested TLVs are also 4-octet aligned. For example, a 1-octet value would have the length field set to 1, and 3 octets of padding would be added to the end of the value portion of the TLV. The padding is composed of undefined bits. Unrecognized types are ignored.

When a new Router Information LSA TLV is defined, the specification MUST explicitly state whether the TLV is applicable to OSPFv2 only, OSPFv3 only, or both OSPFv2 and OSPFv3.

2.4. OSPF Router Informational Capabilities TLV

An OSPF router advertising an OSPF RI LSA MAY include the Router Informational Capabilities TLV. If included, it MUST be the first TLV in the first instance, i.e., Instance 0, of the OSPF RI LSA. Additionally, the TLV MUST accurately reflect the OSPF router's capabilities in the scope advertised. However, the informational capabilities advertised have no impact on OSPF protocol operation; they are advertised purely for informational purposes.

The format of the Router Informational Capabilities TLV is as follows:



Type A 16-bit field set to 1.

Length A 16-bit field that indicates the length of the value portion in octets and will be a multiple of 4 octets dependent on the number of capabilities advertised. Initially, the length will be 4, denoting 4 octets of informational capability bits.

Value A variable-length sequence of capability bits rounded to a multiple of 4 octets padded with undefined bits. Initially, there are 4 octets of capability bits. Bits are numbered left to right starting with the most significant bit being bit 0.

Figure 4. OSPF Router Informational Capabilities TLV

The Router Informational Capabilities TLV MAY be followed by optional TLVs that further specify a capability.

2.5. Assigned OSPF Router Informational Capability Bits

The following informational capability bits have been assigned:

Bit	Capabilities
0	OSPF graceful restart capable [GRACE]
1	OSPF graceful restart helper [GRACE]
2	OSPF Stub Router support [STUB]
3	OSPF Traffic Engineering support [TE]
4	OSPF point-to-point over LAN [P2PLAN]
5	OSPF Experimental TE [EXP-TE]
6-31	Unassigned (IETF Review)

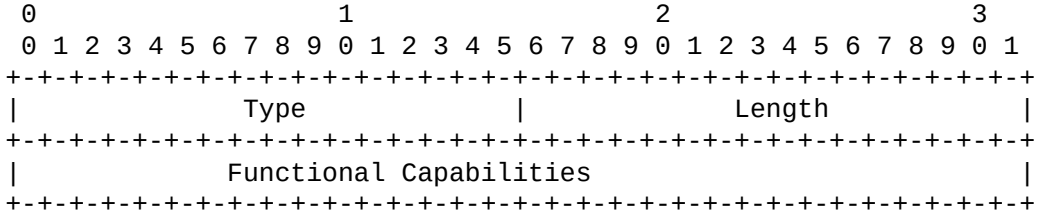
Figure 5. OSPF Router Informational Capabilities Bits

References for [GRACE], [STUB], [TE], [P2PLAN], and [EXP-TE] are included herein.

2.6. OSPF Router Functional Capabilities TLV

This specification also defines the Router Functional Capabilities TLV for advertisement in the OSPF Router Information LSA. An OSPF router advertising an OSPF RI LSA MAY include the Router Functional Capabilities TLV. If included, it MUST be the included in the first instance of the LSA. Additionally, the TLV MUST reflect the advertising OSPF router's actual functional capabilities since the information will be used to dictate OSPF protocol operation in the flooding scope of the containing OSPF RI LSA. If the TLV is not included or the length doesn't include the assigned OSPF functional capability bit, the corresponding OSPF functional capability is implicitly advertised as not being supported by the advertising OSPF router.

The format of the Router Functional Capabilities TLV is as follows:



Type A 16-bit field set to 2.

Length A 16-bit field that indicates the length of the value portion in octets and will be a multiple of 4 octets dependent on the number of capabilities advertised. Initially, the length will be 4, denoting 4 octets of informational capability bits.

Value A variable-length sequence of capability bits rounded to a multiple of 4 octets padded with undefined bits. Initially, there are 4 octets of capability bits. Bits are numbered left to right starting with the most significant bit being bit 0.

Figure 6. OSPF Router Functional Capabilities TLV

The Router Functional Capabilities TLV MAY be followed by optional TLVs that further specify a capability. In contrast to the Router Informational Capabilities TLV, the OSPF extensions advertised in this TLV MAY be used by other OSPF routers to dictate protocol operation. The specifications for functional capabilities advertised in this TLV MUST describe protocol behavior and address backwards compatibility.

2.7. Flooding Scope of the Router Information LSA

The flooding scope for a Router Information LSA is determined by the LSA type. For OSPFv2, a type 9 (link-scoped), type 10 (area-scoped), or type 11 (AS-scoped) Opaque LSA may be flooded. For OSPFv3, the S1 and S2 bits in the LSA type determine the flooding scope. If AS-wide flooding scope is chosen, the originating router should also advertise area-scoped LSA(s) into any attached Not-So-Stubby Area (NSSA) area(s). An OSPF router MAY advertise different capabilities when both NSSA area-scoped LSA(s) and an AS-scoped LSA are advertised. This allows functional capabilities to be limited in scope. For example, a router may be an area border router but only support traffic engineering (TE) in a subset of its attached areas.

The choice of flooding scope is made by the advertising router and is a matter of local policy. The originating router MAY advertise multiple RI LSAs with the same Instance ID as long as the flooding scopes differ. TLV flooding-scope rules will be specified on a per-TLV basis and MUST be specified in the accompanying specifications for future Router Information LSA TLVs.

3. Backwards Compatibility

For backwards compatibility, previously advertised Router Information TLVs SHOULD continue to be advertised in the first instance, i.e., 0, of the Router Information LSA. If a Router Information TLV is advertised in multiple Router Information LSA instances and the multiple instance processing is not explicitly specified in the RFC defining that Router Information TLV, the Router Instance TLV in the Router Information LSA with the numerically smallest Instance ID will be used and subsequent instances will be ignored.

4. Security Considerations

This document describes both a generic mechanism for advertising router capabilities and TLVs for advertising informational and functional capabilities. The capability TLVs are less critical than the topology information currently advertised by the base OSPF protocol. The security considerations for the generic mechanism are dependent on the future application and, as such, should be described as additional capabilities are proposed for advertisement. Security considerations for the base OSPF protocol are covered in [OSPF] and [OSPFv3].

5. IANA Considerations

5.1. OSPFv2 Opaque LSA Type Assignment

[RFC4970] defined the Router Information Opaque LSA as type 4 in the "Opaque Link-State Advertisements (LSA) Option Types" registry. IANA has updated the reference for that entry to point to this RFC.

5.2. OSPFv3 LSA Function Code Assignment

[RFC4970] created the registry for "OSPFv3 LSA Function Codes". IANA has updated the reference for that registry to point to this RFC. References within that registry to [RFC4970] have been updated to point to this RFC; references to other RFCs are unchanged.

The definition and assignment policy has been updated as follows.

This registry is now comprised of the fields Value, LSA Function Code Name, and Reference. The OSPFv3 LSA function code is defined in Appendix A.4.2.1 of [OSPFv3]. Values 1-11 and 13-15 have already been assigned. The OSPFv3 LSA function code 12 has been assigned to the OSPFv3 Router Information (RI) LSA as defined herein.

Range	Assignment Policy
0	Reserved (not to be assigned)
16-255	Unassigned (IETF Review)
256-8175	Reserved (No assignments)
8176-8183	Experimentation (No assignments)
8184-8190	Vendor Private Use (No assignments)
8191	Reserved (not to be assigned)

Figure 7. OSPFv3 LSA Function Codes

- The assignment policy for OSPFv3 LSA function codes in the range 16-255 has changed and are now assigned subject to IETF Review. New values are assigned through RFCs that have been shepherded through the IESG as AD-Sponsored or IETF WG documents [IANA-GUIDE].

- OSPFv3 LSA function codes in the range 8176-8183 are for experimental use; these will not be registered with IANA and MUST NOT be mentioned by RFCs.

- OSPFv3 LSAs with an LSA Function Code in the Vendor Private Use range 8184-8190 MUST include the Enterprise Code [ENTERPRISE-CODE] as the first 4 octets following the 20 octets of LSA header.

- If a new LSA Function Code is documented, the documentation MUST include the valid combinations of the U, S2, and S1 bits for the LSA. It SHOULD also describe how the Link State ID is to be assigned.

5.3. OSPF RI LSA TLV Type Assignment

[RFC4970] created the registry for "OSPF Router Information (RI) TLVs". IANA has updated the reference for this registry to point to this RFC. References within that registry to [RFC4970] have been updated to point to this RFC; references to other RFCs are unchanged.

The definition and assignment policy has been updated as follows.

The registry is now comprised of the fields Value, TLV Name, and Reference. Values 3-9 have already been assigned. Value 1 has been assigned to the Router Informational Capabilities TLV and value 2 has been assigned to the Router Functional Capabilities TLV as defined herein.

Range	Assignment Policy
0	Reserved (not to be assigned)
10-32767	Unassigned (IETF Review)
32768-32777	Experimentation (No assignments)
32778-65535	Reserved (Not to be assigned)

Figure 8. OSPF RI TLVs

- Types in the range 10-32767 are to be assigned subject to IETF Review. New values are assigned through RFCs that have been shepherded through the IESG as AD-Sponsored or IETF WG documents [IANA-GUIDE].

- Types in the range 32778-65535 are reserved and are not to be assigned at this time. Before any assignments can be made in this range, there MUST be a Standards Track RFC that specifies IANA Considerations that cover the range being assigned.

5.4. Registry for OSPF Router Informational Capability Bits

[RFC4970] created the registry for "OSPF Router Informational Capability Bits". IANA has updated the reference for this registry to point to this RFC. The definition and assignment policy has been updated as follows.

- This registry is now comprised of the fields Bit Number, Capability Name, and Reference.

- The values are defined in Section 2.6. All Router Informational Capability TLV additions are to be assigned through IETF Review [IANA-GUIDE].

5.5. Registry for OSPF Router Functional Capability Bits

IANA has created a subregistry for "OSPF Router Functional Capability Bits" within the "Open Shortest Path First v2 (OSPFv2) Parameters" registry. This subregistry is comprised of the fields Bit Number, Capability Name, and Reference. Initially, the subregistry will be empty but will be available for future capabilities. All Router Functional Capability TLV additions are to be assigned through IETF Review [IANA-GUIDE].

6. References

6.1. Normative References

[OPAQUE] Berger, L., Bryskin, I., Zinin, A., and R. Coltun, "The OSPF Opaque LSA Option", RFC 5250, DOI 10.17487/RFC5250, July 2008, <http://www.rfc-editor.org/info/rfc5250>.

[OSPF] Moy, J., "OSPF Version 2", STD 54, RFC 2328, DOI 10.17487/RFC2328, April 1998, <http://www.rfc-editor.org/info/rfc2328>.

[OSPFv3] Coltun, R., Ferguson, D., Moy, J., and A. Lindem, "OSPF for IPv6", RFC 5340, DOI 10.17487/RFC5340, July 2008, <http://www.rfc-editor.org/info/rfc5340>.

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6.2. Informative References

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[IANA-GUIDE]
Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, DOI 10.17487/RFC5226, May 2008, <http://www.rfc-editor.org/info/rfc5226>.

[P2PLAN] Shen, N., Ed., and A. Zinin, Ed., "Point-to-Point Operation over LAN in Link State Routing Protocols", RFC 5309, DOI 10.17487/RFC5309, October 2008, <http://www.rfc-editor.org/info/rfc5309>.

[STUB] Retana, A., Nguyen, L., Zinin, A., White, R., and D. McPherson, "OSPF Stub Router Advertisement", RFC 6987, DOI 10.17487/RFC6987, September 2013, <http://www.rfc-editor.org/info/rfc6987>.

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