         Extensions to OSPF for Advertising Optional Router Capabilities
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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. A new Router
   Information (RI) Link State Advertisement (LSA) is proposed for this
   purpose. In OSPFv2, the RI LSA will be implemented with a new opaque
   LSA type ID. In OSPFv3, the RI LSA will be implemented with a new
   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 including support for advertisement
   of multiple instances of the RI LSA and a TLV for functional
   capabilities.

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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 new optional capabilities cannot be
   advertised. This document proposes extensions to OSPF to advertise
   these optional capabilities via opaque LSAs in OSPFv2 and new LSAs in
   OSPFv3. For existing OSPF capabilities, backward-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 2.5 includes a new TLV for functional
       capabilities. This is constast to the existing TLV which is used
       to advertise capabilities for informational purposes only.

   3. Finally, references have been updated for drafts that have become
       RFCs and RFCs that have been obseleted since the publication of
       RFC 4970.

2. OSPF Router Information (RI) LSA

   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 and Opaque ID 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. RI Information LSAs subsequence to the first can
   be used for information which doesn't fit in the first instance.

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 Router Information LSA has an
   Opaque type of 4 and Opaque ID specifies the LSA instance ID with the
   first instance always having an Instance ID of 0.

```
     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              |     Options    | 9, 10, or 11 |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |       4        |        Opaque ID (Instance ID)               |
     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                      Advertising Router                       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                     LS sequence number                       |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |        LS checksum             |              length          |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                              |
    +-                           TLVs                            -+
    |                           ...                                |
```
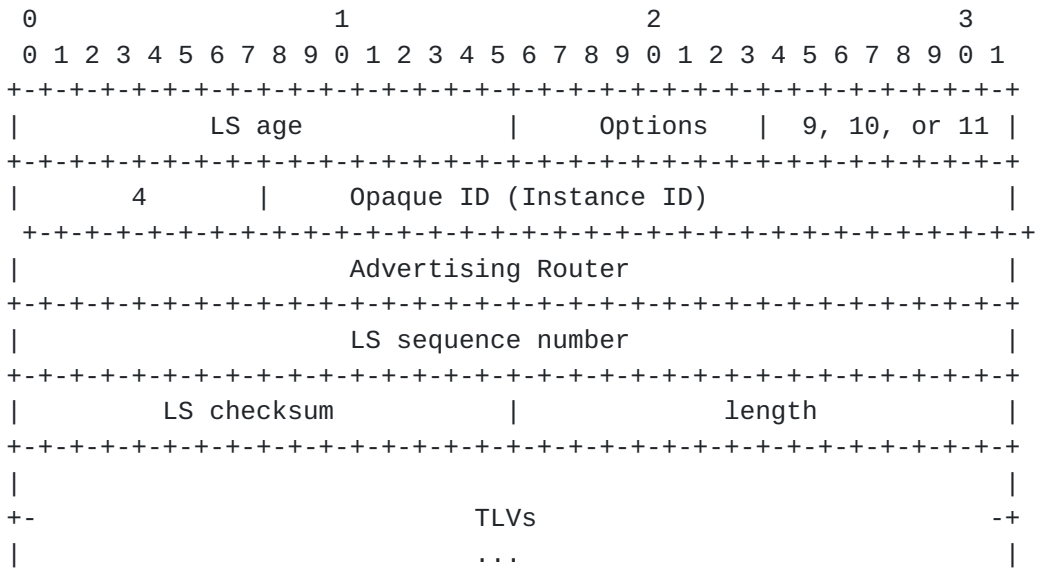
                    OSPFv2 Router Information Opaque LSA

   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:

```
 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 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 32-bit
aligned. For example, a 1-byte 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. Unrecognized types are ignored.

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 subsequence to the first can be used for information
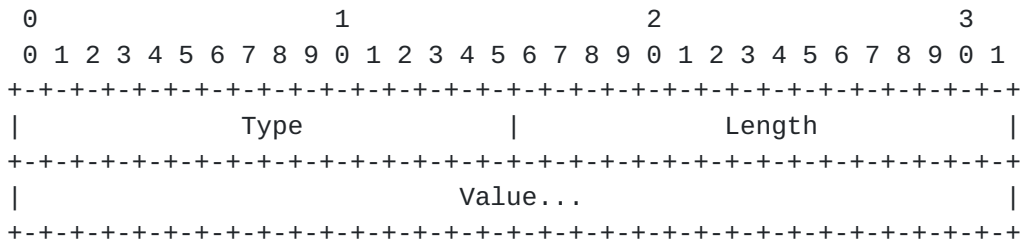which doesn't fit in the first instance. OSPFv3 routers MAY
advertise multiple RIs LSA per flooding scope.

```
    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              |1|S12|           12            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   Link State ID (Instance ID)                |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     Advertising Router                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                     LS sequence number                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |        LS checksum            |              Length           |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                                                              |
   +-                             TLVs                           -+
   |                             ...                              |
```
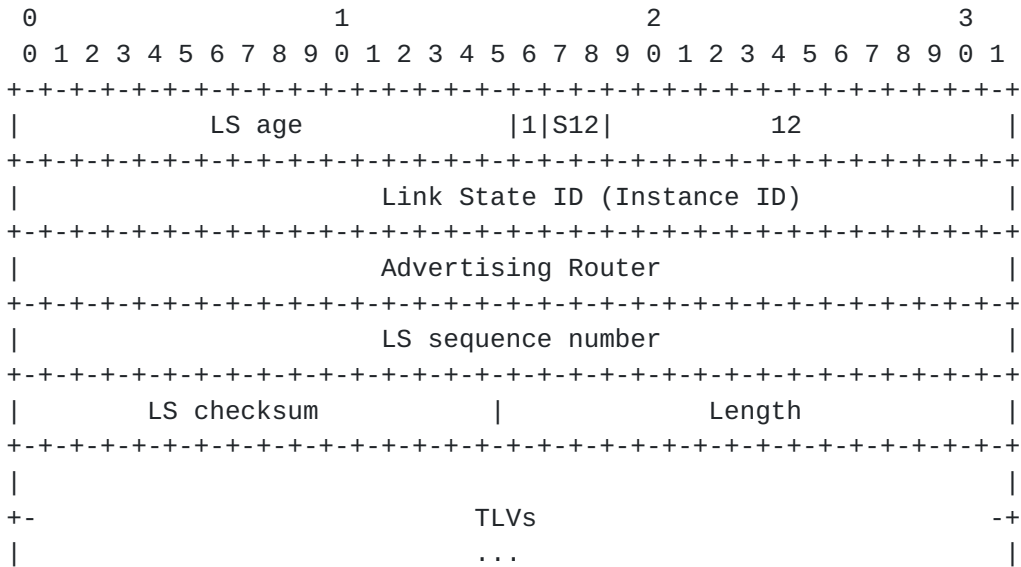
OSPFv3 Router Information LSA

The format of the TLVs within the body of an RI LSA is as defined in
Section 2.1

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.

2.3. OSPF Router Informational Capabilities TLV

The first defined TLV in the body of an RI LSA is the 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 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 the OSPF's
operation -- they are advertised purely for informational purposes.

The format of the Router Informational Capabilities TLV is as
follows:
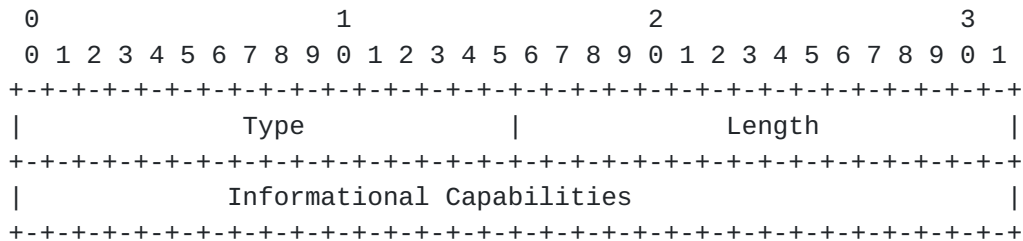
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Informational Capabilities                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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.

              OSPF Router Informational Capabilities TLV

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

2.4. **Assigned OSPF Router Informational Capability Bits**

   The following informational capability bits are 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 (Standards Action)

                 OSPF Router Informational Capabilities Bits

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

2.5. **OSPF Router Functional Capabilities TLV**

   This specification also defines the Router Functional Capabilities
   TLV for advertisement within 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 be used to
   reflect OSPF router functional capabilities. If the TLV is not
   included or the length doesn't include the assigned OSPF functional
   capability bit, the corresponding OSPF functional capabilty is
   implicitly advertised as not being support by the advertising OSPF
   router.

   The format of the Router Functional Capabilities TLV is as follows:
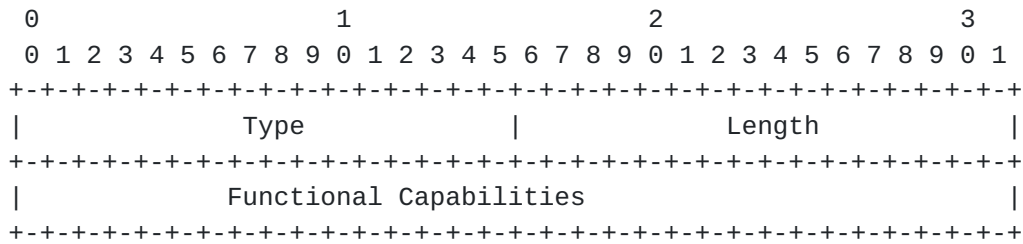
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Functional Capabilities                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

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.

                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
   Informatioal Capabilities TLV, the OSPF extensions advertised in this
   TLV MAY be used to by other OSPF routers to dicate protocol
   operation. The specifications for functional capabilities
   adveritised in this TLV MUST describe protocol behavior and address
   backward compatibility.

2.6. Flooding Scope of the Router Information LSA

   The flooding scope for a Router Information LSA is determined by the
   LSA type. For OSPFv2, type 9 (link-scoped), type 10 (area-scoped),
   or a 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 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 new Router
Information LSA TLVs.

3. Security Considerations

   This document describes both a generic mechanism for advertising
   router capabilities and a TLV for advertising informational and
   functional capability bits. 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].

[4](#). **IANA Considerations**

   The following IANA assignment was made from an existing registry:

      The OSPFv2 opaque LSA type 4 has been reserved for the OSPFv2 RI
      opaque LSA.

   The following registries have been defined for the following
   purposes:

   1. Registry for OSPFv3 LSA Function Codes - This new top-level
       registry will be comprised of the fields Value, LSA function code
       name, and Document Reference. The OSPFv3 LSA function code is
       defined in section A.4.2.1 of [OSPFV3]. The OSPFv3 LSA function
       code 12 has been reserved for the OSPFv3 Router Information (RI)
       LSA.

```
+-----------+------------------------------------+
| Range     | Assignment Policy                  |
+-----------+------------------------------------+
| 0         | Reserved (not to be assigned)      |
|           |                                    |
| 1-9       | Already assigned                   |
|           |                                    |
| 10-11     | Unassigned (Standards Action)      |
|           |                                    |
| 12        | OSPFv3 RI LSA (Assigned herein)    |
|           |                                    |
| 13-255    | Unassigned (Standards Action)      |
|           |                                    |
| 256-8175  | Reserved (No assignments)          |
|           |                                    |
| 8176-8183 | Experimentation (No assignments)   |
|           |                                    |
| 8184-8191 | Vendor Private Use (No assignments) |
+-----------+------------------------------------+
```

                       OSPFv3 LSA Function Codes

       * OSPFv3 LSA function codes in the range 256-8175 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.

       * OSPFv3 LSA function codes in the range 8176-8181 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 8184-8191 MUST include the Vendor 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.

2. Registry for OSPF RI TLVs - This top-level registry will be
   comprised of the fields Value, TLV Name, and Document Reference.
   The value of 1 for the capabilities TLV is defined herein.

   +-------------+-----------------------------------+
   | Range | Assignment Policy |
   +-------------+-----------------------------------+
0	Reserved (not to be assigned)
1	Already assigned
2-32767	Unassigned (Standards Action)
32768-32777	Experimentation (No assignements)
32778-65535	Reserved (Not to be assigned)
   +----------+-----------------------------------+

                      OSPF RI TLVs

   * Types in the range 32768-32777 are for experimental use; these
     will not be registered with IANA and MUST NOT be mentioned by
     RFCs.

   * 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 covers the range being assigned.

3. Registry for OSPF Router Informational Capability Bits - This
   sub-registry of the OSPF RI TLV registry will be comprised of the
   fields Bit Number, Capability Name, and Document Reference. The
   values are defined in Section 2.4. All Router Informational
   Capability TLV additions are to be assigned through standards
   action.

4. Registry for OSPF Router Functional Capability Bits - This sub-
   registry of the OSPF RI TLV registry will be comprised of the
   fields Bit Number, Capability Name, and Document Reference.

Initially, the sub-registry will be empty but will be available
for future capabilities. All Router Functional Capability TLV
additions are to be assigned through standards action.

5. References

5.1. Normative References

[OPAQUE]   Berger, L., Bryskin, I., Zinin, A., and R. Coltun, "The
            OSPF Opaque LSA Option", RFC 5250, July 2008.

[OSPF]   Moy, J., "OSPF Version 2", STD 54, RFC 2328, April 1998.

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

[RFC-KEYWORDS]
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            Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC4970]   Lindem, A., Shen, N., Vasseur, J., Aggarwal, R., and S.
            Shaffer, "Extensions to OSPF for Advertising Optional
            Router Capabilities", RFC 4970, July 2007.

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

5.2. Informative References

[EXP-TE]   Srisuresh, P. and P. Joseph, "OSPF-xTE: Experimental
            Extension to OSPF for Traffic Engineering", RFC 4973,
            July 2007.

[GRACE]   Moy, J., Pillay-Esnault, P., and A. Lindem, "Graceful OSPF
            Restart", RFC 3623, November 2003.

[P2PLAN]   Shen, N. and A. Zinin, "Point-to-point operation over LAN
            in link-state routing protocols", RFC 5309, October 2008.

[STUB]   Retana, A., Nguyen, L., White, R., Zinin, A., and D.
            McPherson, "OSPF Stub Router Advertisement", RFC 6987,
            September 2013.

Appendix A. Acknowledgments

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