           Extensions to OSPF for Advertising Optional Router Capabilities
                     draft-ietf-ospf-rfc4970bis-02.txt

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 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 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,
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 an additional TLV for
    functional capabilities. This is in contrast 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 obsoleted 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 (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 LSAs subsequence to the first can be
used for information that 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                           -+
    |                              ...                              |
```
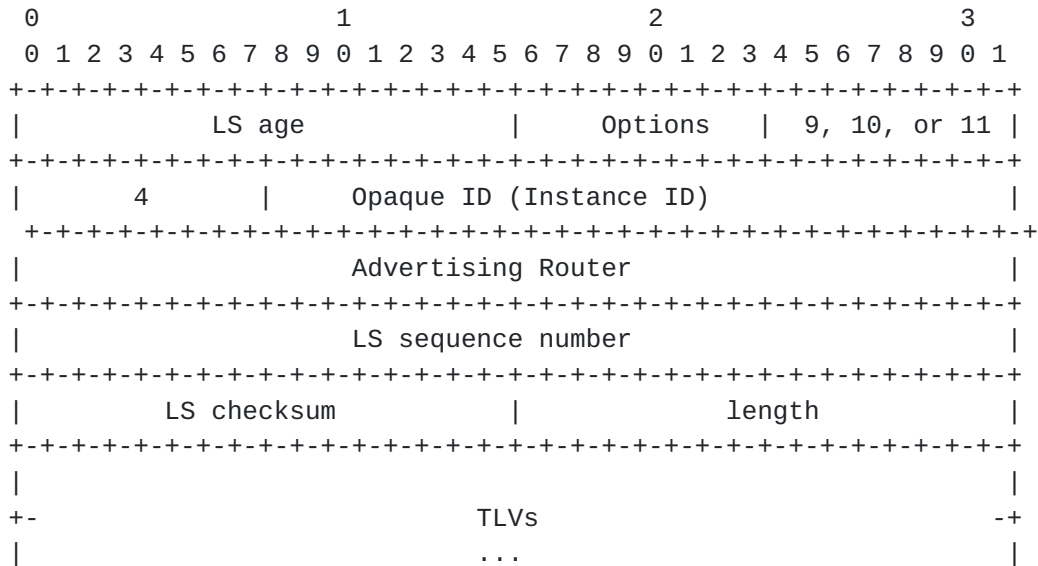
                OSPFv2 Router Information Opaque LSA

   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...                          |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
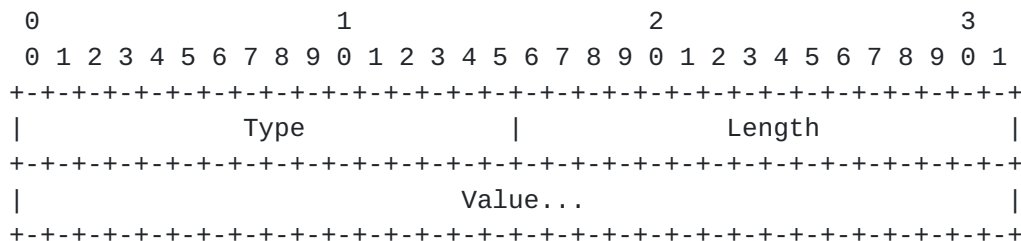
                          TLV Format

   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. The padding is composed of zeros. 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
that 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                           -+
    |                             ...                              |
```
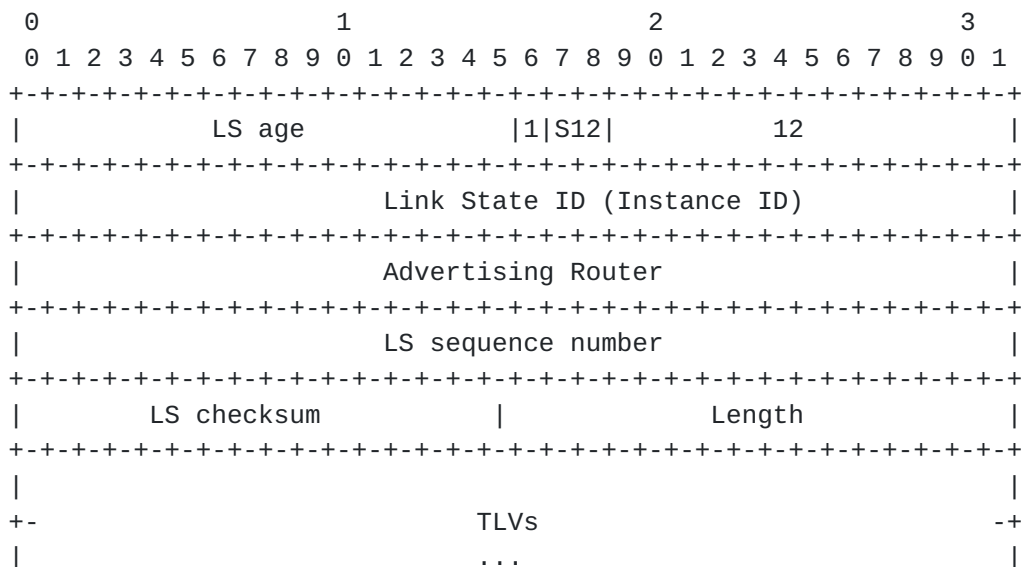
                   OSPFv3 Router Information LSA

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 capability is
   implicitly advertised as not being supported 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 IANA TBD.

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
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 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 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. 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 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 informational capabilities TLV is defined
   herein. The value IANA TBD for the functional capabilities TLV
   is also defined herein.

```
            +-------------+----------------------------------+
            | Range       | Assignment Policy                |
            +-------------+----------------------------------+
            | 0           | Reserved (not to be assigned)    |
            |             |                                  |
            | 1           | Informational Capabilities       |
            |             |                                  |
            | TBD         | Functional Capabilities          |
            |             |                                  |
            | 2-32767     | Unassigned (Standards Action)    |
            |             |                                  |
            | 32768-32777 | Experimentation (No assignments) |
            |             |                                  |
            | 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]
               Bradner, S., "Key words for use in RFC's to Indicate
               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

   The idea for this work grew out of a conversation with Andrew Partan
   and we would like to thank him for his contribution. The authors
   would like to thanks Peter Psenak for his review and helpful comments
   on early versions of the document.

   Comments from Abhay Roy, Vishwas Manral, Vivek Dubey, and Adrian
   Farrel have been incorporated into later versions.

   Thanks to Chris Bowers for review of the BIS version of the draft.

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

Authors' Addresses

   Acee Lindem (editor)
   Cisco Systems
   301 Midenhall Way
   Cary, NC 27513
   USA

   Email: acee@cisco.com

   Naiming Shen
   Cisco Systems
   225 West Tasman Drive
   San Jose, CA 95134
   USA

   Email: naiming@cisco.com

   Jean-Philippe Vasseur
   Cisco Systems
   1414 Massachusetts Avenue
   Boxborough, MA 01719
   USA

   Email: jpv@cisco.com

   Rahul Aggarwal
   Arktan

   Email: raggarwa_1@yahoo.com

   Scott Shaffer
   Akamai
   8 Cambridge Center
   Cambridge, MA 02142
   USA

   Email: sshaffer@akamai.com