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RFC 9587
YANG Data Model for OSPFv3 Extended Link State Advertisements (LSAs)

Abstract

This document defines a YANG data model augmenting the IETF OSPF YANG data model (RFC 9129) to provide support for OSPFv3 Link State Advertisement (LSA) Extensibility as defined in RFC 8362. OSPFv3 Extended LSAs provide extensible TLV-based LSAs for the base LSA types defined in RFC 5340.

Status of This Memo

This is an Internet Standards Track document.

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1. Overview

YANG [RFC7950] is a data definition language used to define the contents of a conceptual datastore that allows networked devices to be managed using NETCONF [RFC6241]. YANG is proving relevant beyond its initial confines as bindings to other interfaces (e.g., RESTCONF [RFC8040]) and encodings other than XML (e.g., JSON) are being defined. Furthermore, YANG data models can be used as the basis for implementation of other interfaces, such as Command-Line Interfaces (CLIs) and programmatic APIs.

This document defines a YANG data model augmenting the IETF OSPF YANG data model [RFC9129], which itself augments [RFC8349], to provide support for configuration and operational state for OSPFv3 Extended Link State Advertisements (LSAs) as defined in [RFC8362].

The YANG module specified in this document conforms to the Network Management Datastore Architecture (NMDA) [RFC8342].

2. Tree Diagrams

This document uses the graphical representation of data models defined in [RFC8340].

3. OSPFv3 Extended LSAs

This document defines a YANG data model for the OSPFv3 Extended LSA feature. It is an augmentation of the OSPF base model [RFC9129] to provide support for OSPFv3 LSA Extensibility [RFC8362]. OSPFv3 Extended LSAs provide extensible TLV-based LSAs for the base LSA types defined in [RFC5340].

The OSPFv3 Extended LSA YANG module requires support for the OSPF base model, which defines basic OSPF configuration and state. The OSPF YANG data model augments the "ietf-routing" YANG data model defined in [RFC8349]. The augmentations defined in the "ietf-ospfv3-extended-lsa" YANG module provide global configuration, area configuration, and the addition of OSPFv3 Extended LSAs to the Link State Database (LSDB) operational state.

```
module: ietf-ospfv3-extended-lsa

  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/ospf:ospf:
    +--rw extended-lsa-support?   boolean
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/ospf:ospf/ospf:areas
            /ospf:area:
    +--rw extended-lsa-support?   boolean
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/ospf:ospf/ospf:areas/ospf:area
            /ospf:interfaces/ospf:interface/ospf:database
            /ospf:link-scope-lsa-type/ospf:link-scope-lsas
            /ospf:link-scope-lsa/ospf:version/ospf:ospfv3/ospf:ospfv3
            /ospf:body:
    +--ro e-link
       +--ro rtr-priority?   uint8
       +--ro lsa-options
       |  +--ro lsa-options*   identityref
       +--ro e-link-tlvs* []
          +--ro unknown-tlv
          |  +--ro type?     uint16
          |  +--ro length?   uint16
          |  +--ro value?    yang:hex-string
          +--ro intra-prefix-tlv
          |  +--ro metric?           ospf:ospf-metric
          |  +--ro prefix?           inet:ip-prefix
          |  +--ro prefix-options
          |  |  +--ro prefix-options*   identityref
          |  +--ro sub-tlvs* []
          |     +--ro unknown-sub-tlv
          |        +--ro type?     uint16
          |        +--ro length?   uint16
          |        +--ro value?    yang:hex-string
          +--ro ipv6-link-local-addr-tlv
          |  +--ro link-local-address?   inet:ipv6-address
          |  +--ro sub-tlvs* []
          |     +--ro unknown-sub-tlv
          |        +--ro type?     uint16
```

```
          |        +--ro length?   uint16
          |        +--ro value?    yang:hex-string
          +--ro ipv4-link-local-addr-tlv
             +--ro link-local-address?   inet:ipv4-address
             +--ro sub-tlvs* []
                +--ro unknown-sub-tlv
                   +--ro type?     uint16
                   +--ro length?   uint16
                   +--ro value?    yang:hex-string
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/ospf:ospf/ospf:areas/ospf:area
            /ospf:database/ospf:area-scope-lsa-type
            /ospf:area-scope-lsas/ospf:area-scope-lsa/ospf:version
            /ospf:ospfv3/ospf:ospfv3/ospf:body:
    +--ro e-router
    |  +--ro router-bits
    |  |  +--ro rtr-lsa-bits*   identityref
    |  +--ro lsa-options
    |  |  +--ro lsa-options*   identityref
    |  +--ro e-router-tlvs* []
    |     +--ro unknown-tlv
    |     |  +--ro type?     uint16
    |     |  +--ro length?   uint16
    |     |  +--ro value?    yang:hex-string
    |     +--ro link-tlv
    |        +--ro interface-id?            uint32
    |        +--ro neighbor-interface-id?   uint32
    |        +--ro neighbor-router-id?      rt-types:router-id
    |        +--ro type?                    ospf:router-link-type
    |        +--ro metric?                  ospf:ospf-link-metric
    |        +--ro sub-tlvs* []
    |           +--ro unknown-sub-tlv
    |              +--ro type?     uint16
    |              +--ro length?   uint16
    |              +--ro value?    yang:hex-string
    +--ro e-network
    |  +--ro lsa-options
    |  |  +--ro lsa-options*   identityref
    |  +--ro e-network-tlvs* []
    |     +--ro unknown-tlv
    |     |  +--ro type?     uint16
    |     |  +--ro length?   uint16
    |     |  +--ro value?    yang:hex-string
    |     +--ro attached-router-tlv
    |        +--ro adjacent-neighbor-router-id*   rt-types:router-id
    +--ro e-nssa
    |  +--ro e-external-tlvs* []
    |     +--ro unknown-tlv
    |     |  +--ro type?     uint16
    |     |  +--ro length?   uint16
    |     |  +--ro value?    yang:hex-string
    |     +--ro external-prefix-tlv
    |        +--ro flags
    |        |  +--ro ospfv3-e-external-prefix-bits*   identityref
    |        +--ro metric?           ospf:ospf-metric
    |        +--ro prefix?           inet:ip-prefix
    |        +--ro prefix-options
    |        |  +--ro prefix-options*   identityref
```

```
     |        +--ro sub-tlvs* []
     |           +--ro ipv6-fwd-addr-sub-tlv
     |           |  +--ro forwarding-address?   inet:ipv6-address
     |           +--ro ipv4-fwd-addr-sub-tlv
     |           |  +--ro forwarding-address?   inet:ipv4-address
     |           +--ro route-tag-sub-tlv
     |           |  +--ro route-tag?   uint32
     |           +--ro unknown-sub-tlv
     |              +--ro type?     uint16
     |              +--ro length?   uint16
     |              +--ro value?    yang:hex-string
     +--ro e-inter-area-prefix
     |  +--ro e-inter-prefix-tlvs* []
     |     +--ro unknown-tlv
     |     |  +--ro type?     uint16
     |     |  +--ro length?   uint16
     |     |  +--ro value?    yang:hex-string
     |     +--ro inter-prefix-tlv
     |        +--ro metric?           ospf:ospf-metric
     |        +--ro prefix?           inet:ip-prefix
     |        +--ro prefix-options
     |        |  +--ro prefix-options*   identityref
     |        +--ro sub-tlvs* []
     |           +--ro unknown-sub-tlv
     |              +--ro type?     uint16
     |              +--ro length?   uint16
     |              +--ro value?    yang:hex-string
     +--ro e-inter-area-router
     |  +--ro e-inter-router-tlvs* []
     |     +--ro unknown-tlv
     |     |  +--ro type?     uint16
     |     |  +--ro length?   uint16
     |     |  +--ro value?    yang:hex-string
     |     +--ro inter-router-tlv
     |        +--ro lsa-options
     |        |  +--ro lsa-options*   identityref
     |        +--ro metric?                  ospf:ospf-metric
     |        +--ro destination-router-id?   rt-types:router-id
     |        +--ro sub-tlvs* []
     |           +--ro unknown-sub-tlv
     |              +--ro type?     uint16
     |              +--ro length?   uint16
     |              +--ro value?    yang:hex-string
     +--ro e-intra-area-prefix
        +--ro referenced-ls-type?         uint16
        +--ro referenced-link-state-id?   uint32
        +--ro referenced-adv-router?      rt-types:router-id
        +--ro e-intra-prefix-tlvs* []
           +--ro unknown-tlv
           |  +--ro type?     uint16
           |  +--ro length?   uint16
           |  +--ro value?    yang:hex-string
           +--ro intra-prefix-tlv
              +--ro metric?           ospf:ospf-metric
              +--ro prefix?           inet:ip-prefix
              +--ro prefix-options
              |  +--ro prefix-options*   identityref
              +--ro sub-tlvs* []
```

```
               +--ro unknown-sub-tlv
                  +--ro type?     uint16
                  +--ro length?   uint16
                  +--ro value?    yang:hex-string
  augment /rt:routing/rt:control-plane-protocols
            /rt:control-plane-protocol/ospf:ospf/ospf:database
            /ospf:as-scope-lsa-type/ospf:as-scope-lsas
            /ospf:as-scope-lsa/ospf:version/ospf:ospfv3/ospf:ospfv3
            /ospf:body:
    +--ro e-as-external
       +--ro e-external-tlvs* []
          +--ro unknown-tlv
          |  +--ro type?     uint16
          |  +--ro length?   uint16
          |  +--ro value?    yang:hex-string
          +--ro external-prefix-tlv
             +--ro flags
             |  +--ro ospfv3-e-external-prefix-bits*   identityref
             +--ro metric?           ospf:ospf-metric
             +--ro prefix?           inet:ip-prefix
             +--ro prefix-options
             |  +--ro prefix-options*   identityref
             +--ro sub-tlvs* []
                +--ro ipv6-fwd-addr-sub-tlv
                |  +--ro forwarding-address?   inet:ipv6-address
                +--ro ipv4-fwd-addr-sub-tlv
                |  +--ro forwarding-address?   inet:ipv4-address
                +--ro route-tag-sub-tlv
                |  +--ro route-tag?   uint32
                +--ro unknown-sub-tlv
                   +--ro type?     uint16
                   +--ro length?   uint16
                   +--ro value?    yang:hex-string
```

4. OSPFv3 Extended LSA YANG Module

The following RFCs are not referenced in the document text but are referenced in the "ietf-ospfv3-extended-lsa.yang" module: [RFC6991] and [RFC8294].

```
<CODE BEGINS> file "ietf-ospfv3-extended-lsa@2024-05-16.yang"

module ietf-ospfv3-extended-lsa {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-ospfv3-extended-lsa";
  prefix ospfv3-e-lsa;

  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-inet-types {
    prefix inet;
    reference
      "RFC 6991: Common YANG Data Types";
```

```
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing
       Management (NMDA Version)";
  }
  import ietf-ospf {
    prefix ospf;
    reference
      "RFC 9129: YANG Data Model for the OSPF Protocol";
  }

  organization
    "IETF LSR - Link State Routing Working Group";
  contact
    "WG Web:   <https://datatracker.ietf.org/wg/lsr/>
     WG List:  <mailto:lsr@ietf.org>

     Author:   Acee Lindem
               <mailto:acee.ietf@gmail.com>
     Author:   Sharmila Palani
               <mailto:sharmila.palani@microsoft.com>
     Author:   Yingzhen Qu
               <mailto:yingzhen.ietf@gmail.com>";
  description
    "This YANG module defines the configuration and operational
     state for OSPFv3 Extended LSAs, which is common across all
     vendor implementations.  The semantics and encodings for
     OSPFv3 Extended LSAs are described in RFC 8362.  OSPFv3
     Extended LSAs provide extensible TLV-based LSAs for the base
     LSA types defined in RFC 5340.

     This YANG data model conforms to the Network Management
     Datastore Architecture (NMDA) as described in RFC 8342.

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     Relating to IETF Documents
     (https://trustee.ietf.org/license-info).

     This version of this YANG module is part of RFC 9587; see the
     RFC itself for full legal notices.";

  reference
    "RFC 9587: YANG Data Model for OSPFv3 Extended Link State
     Advertisements (LSAs)";

  revision 2024-05-16 {
    description
      "Initial revision.";
    reference
      "RFC 9587: YANG Data Model for OSPFv3 Extended Link State
```

```
      Advertisements (LSAs)";
  }

  /*
   * OSPFv3 Extended LSA Type Identities
   */

  identity ospfv3-e-router-lsa {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 E-Router-LSA - Type 0xA021.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.1";
  }

  identity ospfv3-e-network-lsa {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 E-Network-LSA - Type 0xA022.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.2";
  }

  identity ospfv3-e-summary-lsa-type {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 Extended Summary LSA types:
       E-Inter-Area-Prefix-LSA and E-Inter-Area-Router-LSA.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Sections 4.3 and 4.4";
  }

  identity ospfv3-e-inter-area-prefix-lsa {
    base ospfv3-e-summary-lsa-type;
    description
      "OSPFv3 E-Inter-Area-Prefix-LSA - Type 0xA023.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.3";
  }

  identity ospfv3-e-inter-area-router-lsa {
    base ospfv3-e-summary-lsa-type;
    description
      "OSPFv3 E-Inter-Area-Router-LSA - Type 0xA024.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.4";
  }

  identity ospfv3-e-external-lsa-type {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 Extended External LSA types:
       E-AS-External-LSA and E-NSSA-LSA, where
```

```
       NSSA expands to Not-So-Stubby-Area.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Sections 4.5 and 4.6";
  }

  identity ospfv3-e-as-external-lsa {
    base ospfv3-e-external-lsa-type;
    description
      "OSPFv3 E-AS-External-LSA - Type 0xC025.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.5";
  }

  identity ospfv3-e-nssa-lsa {
    base ospfv3-e-external-lsa-type;
    description
      "OSPFv3 E-NSSA-LSA - Type 0xA027.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.6";
  }

  identity ospfv3-e-link-lsa {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 E-Link-LSA - Type 0x8028.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.7";
  }

  identity ospfv3-e-intra-area-prefix-lsa {
    base ospf:ospfv3-lsa-type;
    description
      "OSPFv3 E-Intra-Area-Prefix-LSA - Type 0xA029.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4.8";
  }

  identity ospfv3-e-prefix-option {
    description
      "Base identity for OSPFv3 prefix options.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1";
  }

  identity nu-bit {
    base ospfv3-e-prefix-option;
    description
      "When set, the prefix should be excluded
       from IPv6 unicast calculations.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1
```

```
       RFC 5340: OSPF for IPv6, Appendix A.4.1.1";
  }

  identity la-bit {
    base ospfv3-e-prefix-option;
    description
      "When set, the prefix is actually an IPv6 interface
       address of the advertising router.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1
       RFC 5340: OSPF for IPv6, Appendix A.4.1.1";
  }

  identity p-bit {
    base ospfv3-e-prefix-option;
    description
      "When set, the NSSA prefix should be translated to an
       E-AS-External-LSA and advertised by the translating
       NSSA Border Router.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1
       RFC 5340: OSPF for IPv6, Appendix A.4.1.1";
  }

  identity dn-bit {
    base ospfv3-e-prefix-option;
    description
      "When set, the E-Inter-Area-Prefix-LSA or
       E-AS-External-LSA prefix has been advertised as an
       L3VPN prefix.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1
       RFC 5340: OSPF for IPv6, Appendix A.4.1.1";
  }

  identity n-bit {
    base ospfv3-e-prefix-option;
    description
      "When set, the prefix is a host address that identifies
       the advertising router.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.1
       RFC 5340: OSPF for IPv6, Appendix A.4.1.1";
  }

  identity ospfv3-e-external-prefix-option {
    description
      "Base identity for OSPFv3 external prefix options.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.6";
  }

  identity e-bit {
```

```
    base ospfv3-e-external-prefix-option;
    description
      "When the E-bit is set, the metric specified is a Type 2
       external metric.  This means the metric is considered larger
       than any intra-AS path.  When the E-bit is clear, the
       specified metric is a Type 1 external metric.  This means
       that it is expressed in the same units as other LSAs (i.e.,
       the same units as the interface costs in Router-LSAs).";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.6";
  }

  grouping unknown-sub-tlv {
    description
      "Unknown TLV grouping.";
    container unknown-sub-tlv {
      uses ospf:tlv;
      description
        "Unknown External TLV sub-TLV.";
    }
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 6.3";
  }

  grouping ospfv3-lsa-prefix {
    description
      "OSPFv3 LSA prefix.";
    leaf prefix {
      type inet:ip-prefix;
      description
        "LSA prefix.";
    }
    container prefix-options {
      leaf-list prefix-options {
        type identityref {
          base ospfv3-e-prefix-option;
        }
        description
          "OSPFv3 prefix option flag list.  This list will
           contain the identities for the OSPFv3 options
           that are set for the OSPFv3 prefix.";
      }
      description
        "Prefix options.";
      reference
        "RFC 8362:  OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 3.1";
    }
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3";
  }

  grouping external-prefix-tlv {
    container external-prefix-tlv {
      description
```

```
          "External Prefix LSA TLV.";
        container flags {
          leaf-list ospfv3-e-external-prefix-bits {
            type identityref {
              base ospfv3-e-external-prefix-option;
            }
            description
              "OSPFv3 External-Prefix TLV bits list.";
          }
          description
            "External prefix flags.";
        }
        leaf metric {
          type ospf:ospf-metric;
          description
            "External prefix metric.";
        }
        uses ospfv3-lsa-prefix;
        list sub-tlvs {
          description
            "External-Prefix TLV sub-TLVs.";
          container ipv6-fwd-addr-sub-tlv {
            description
              "IPv6-Forwarding-Address sub-TLV for
               E-AS-External-LSAs and E-NSSA-LSAs for the IPv6
               address family.";
            leaf forwarding-address {
              type inet:ipv6-address;
              description
                "IPv6 forwarding address.";
            }
            reference
              "RFC 8362: OSPFv3 Link State Advertisement (LSA)
               Extensibility, Section 3.10";
          }
          container ipv4-fwd-addr-sub-tlv {
            description
              "IPv4-Forwarding-Address sub-TLV for
               E-AS-External-LSAs and E-NSSA-LSAs for the IPv4
               address family.";
            leaf forwarding-address {
              type inet:ipv4-address;
              description
                "IPv4 forwarding address.";
            }
            reference
              "RFC 8362: OSPFv3 Link State Advertisement (LSA)
               Extensibility, Section 3.11";
          }
          container route-tag-sub-tlv {
            description
              "Route-Tag sub-TLV.";
            leaf route-tag {
              type uint32;
              description
                "Route tag.";
            }
            reference
```

```
            "RFC 8362: OSPFv3 Link State Advertisement (LSA)
             Extensibility, Section 3.12";
        }
        uses unknown-sub-tlv;
      }
    }
    description
      "External-Prefix TLV grouping.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.6";
  }

  grouping intra-area-prefix-tlv {
    container intra-prefix-tlv {
      description
        "Intra-Area-Prefix-LSA TLV.";
      leaf metric {
        type ospf:ospf-metric;
        description
          "Intra-Area Prefix metric.";
      }
      uses ospfv3-lsa-prefix;
      list sub-tlvs {
        description
          "Intra-Area-Prefix TLV sub-TLVs.";
        uses unknown-sub-tlv;
      }
    }
    description
      "Intra-Area-Prefix TLV grouping.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.7";
  }

  grouping ipv6-link-local-addr-tlv {
    container ipv6-link-local-addr-tlv {
      description
        "IPv6 Link-Local Address LSA TLV.";
      leaf link-local-address {
        type inet:ipv6-address;
        description
          "IPv6 Link-Local address.";
      }
      list sub-tlvs {
        description
          "IPv6 Link-Local Address TLV sub-TLVs.";
        uses unknown-sub-tlv;
      }
    }
    description
      "IPv6 Link-Local Address TLV grouping.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.8";
  }
```

```
  grouping ipv4-link-local-addr-tlv {
    container ipv4-link-local-addr-tlv {
      description
        "IPv4 Link-Local Address LSA TLV.";
      leaf link-local-address {
        type inet:ipv4-address;
        description
          "IPv4 Link-Local address.";
      }
      list sub-tlvs {
        description
          "IPv4 Link-Local Address TLV sub-TLVs.";
        uses unknown-sub-tlv;
      }
    }
    description
      "IPv4 Link-Local Address TLV grouping.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 3.9";
  }

  /* Configuration */

  augment "/rt:routing/rt:control-plane-protocols"
        + "/rt:control-plane-protocol/ospf:ospf" {
    when "../rt:type = 'ospf:ospfv3'" {
      description
        "This augments the OSPFv3 routing protocol when used.";
    }
    description
      "This augments the OSPFv3 protocol instance-level
       configuration with Extended LSA support.  When enabled,
       OSPFv3 Extended LSAs will be advertised and OSPFv3 Legacy
       LSAs will not be advertised.  When disabled, OSPFv3 Legacy
       LSAs will be advertised.  However, OSPFv3 Extended LSAs
       could still be advertised in Extended LSA Sparse Mode to
       support incrementally deployed features as described in
       Section 6.2 of RFC 8362.";
    leaf extended-lsa-support {
      type boolean;
      default "false";
      description
        "Enable OSPFv3 Extended LSA support for the OSPFv3
         domain.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Appendix A - Global Configuration Support";
    }
  }

  augment "/rt:routing/rt:control-plane-protocols/"
        + "rt:control-plane-protocol/ospf:ospf/ospf:"
        + "areas/ospf:area" {
    when "../../../rt:type = 'ospf:ospfv3'" {
      description
        "This augments the OSPFv3 protocol area-level
         configuration when used.";
```

```
    }
    description
      "This augments the OSPFv3 protocol area-level
       configuration with Extended LSA support.";
    leaf extended-lsa-support {
      type boolean;
      must "derived-from(../ospf:area-type,'stub-nssa-area') or "
         + "(current() = 'true') or "
         + "(../../../extended-lsa-support = 'false')" {
        description
          "For regular areas, i.e., areas where AS-scoped LSAs
           are flooded, disabling AreaExtendedLSASupport at the
           area level is prohibited when ExtendedLSASupport is
           enabled at the instance level.  E-AS-External-LSAs
           are flooded into all OSPFv3 regular areas (i.e., not
           a stub or an NSSA), and disabling support at the
           area level is not possible.";
      }
      description
        "This augments the OSPFv3 protocol area-level
         configuration with Extended LSA support.  When enabled,
         OSPFv3 Extended LSAs will be advertised and OSPFv3 Legacy
         LSAs will not be advertised.  When disabled, OSPFv3
         Legacy LSAs will be advertised.  However, OSPFv3 Extended
         LSAs could still be advertised in Extended LSA Sparse
         Mode to support incrementally deployed features as
         described in Section 6.2 of RFC 8362.  If not specified,
         Extended LSA support status is inherited from the
         instance-level configuration.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Appendix B - Area Configuration Support";
    }
  }

  /*
   * Link State Database (LSDB) Augmentations
   */

  augment "/rt:routing/"
        + "rt:control-plane-protocols/rt:control-plane-protocol/"
        + "ospf:ospf/ospf:areas/ospf:area/"
        + "ospf:interfaces/ospf:interface/ospf:database/"
        + "ospf:link-scope-lsa-type/ospf:link-scope-lsas/"
        + "ospf:link-scope-lsa/ospf:version/ospf:ospfv3/"
        + "ospf:ospfv3/ospf:body" {
    when "../../../../../../../../../../../"
       + "rt:type = 'ospf:ospfv3'" {
      description
        "This augmentation is only valid for OSPFv3.";
    }
    description
      "This augmentation adds OSPFv3 Link-scoped Extended LSAs
       to the operational state for an interface Link State
       Database (LSDB).";
    container e-link {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-link-lsa'" {
```

```
        description
          "Only applies to E-Link-LSAs.";
      }
      description
        "E-Link-LSA.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.7";
      leaf rtr-priority {
        type uint8;
        description
          "Router priority for the interface.";
      }
      uses ospf:ospfv3-lsa-options;
      list e-link-tlvs {
        description
          "E-Link-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-Link TLV.";
        }
        uses intra-area-prefix-tlv;
        uses ipv6-link-local-addr-tlv;
        uses ipv4-link-local-addr-tlv;
      }
    }
  }

  augment "/rt:routing/"
        + "rt:control-plane-protocols/rt:control-plane-protocol/"
        + "ospf:ospf/ospf:areas/ospf:area/ospf:database/"
        + "ospf:area-scope-lsa-type/ospf:area-scope-lsas/"
        + "ospf:area-scope-lsa/ospf:version/ospf:ospfv3/"
        + "ospf:ospfv3/ospf:body" {
    when "../../../../../../../../../"
       + "rt:type = 'ospf:ospfv3'" {
      description
        "This augmentation is only valid for OSPFv3.";
    }
    description
      "This augmentation adds OSPFv3 Area-scoped Extended LSAs
       to the operational state for an area LSDB.";
    reference
      "RFC 8362: OSPFv3 Link State Advertisement (LSA)
       Extensibility, Section 4";
    container e-router {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-router-lsa'" {
        description
          "Only valid for OSPFv3 E-Router-LSAs.";
      }
      description
        "OSPFv3 E-Router-LSA contents.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.1";
      uses ospf:ospf-router-lsa-bits;
```

```
      uses ospf:ospfv3-lsa-options;
      list e-router-tlvs {
        description
          "E-Router-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-Router TLV.";
        }
        container link-tlv {
          description
            "E-Router-LSA TLV.";
          leaf interface-id {
            type uint32;
            description
              "Interface ID for link.";
          }
          leaf neighbor-interface-id {
            type uint32;
            description
              "Neighbor's Interface ID for link.";
          }
          leaf neighbor-router-id {
            type rt-types:router-id;
            description
              "Neighbor's Router ID for link.";
          }
          leaf type {
            type ospf:router-link-type;
            description
              "Link type: 1 - Point-to-Point Link
                          2 - Transit Network Link
                          3 - Stub Network Link
                          4 - Virtual Link.";
          }
          leaf metric {
            type ospf:ospf-link-metric;
            description
              "Link metric.";
          }
          list sub-tlvs {
            description
              "Link TLV sub-TLVs.";
            uses unknown-sub-tlv;
          }
        }
      }
    }
    container e-network {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-network-lsa'" {
        description
          "Only applies to E-Network-LSAs.";
      }
      description
        "E-Network-LSA contents.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
```

```
          Extensibility, Section 4.2";
      uses ospf:ospfv3-lsa-options;
      list e-network-tlvs {
        description
          "E-Network-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-Network TLV.";
        }
        container attached-router-tlv {
          description
            "Attached-Routers TLV.";
          leaf-list adjacent-neighbor-router-id {
            type rt-types:router-id;
            description
              "Adjacent neighbor's Router ID.";
          }
        }
      }
    }
    container e-nssa {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-nssa-lsa'" {
        description
          "Only applies to E-NSSA-LSAs.";
      }
      list e-external-tlvs {
        description
          "E-NSSA-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-External TLV.";
        }
        uses external-prefix-tlv;
      }
      description
        "E-NSSA-LSA.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.6";
    }
    container e-inter-area-prefix {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-inter-area-prefix-lsa'" {
        description
          "Only applies to E-Inter-Area-Prefix-LSAs.";
      }
      description
        "E-Inter-Area-Prefix-LSA.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.3";
      list e-inter-prefix-tlvs {
        description
          "E-Inter-Area-Prefix-LSA TLVs.";
        container unknown-tlv {
```

```
          uses ospf:tlv;
          description
            "Unknown E-Inter-Area-Prefix TLV.";
        }
        container inter-prefix-tlv {
          description
            "Unknown E-Inter-Area-Prefix-LSA TLV.";
          leaf metric {
            type ospf:ospf-metric;
            description
              "Inter-Area Prefix metric.";
          }
          uses ospfv3-lsa-prefix;
          list sub-tlvs {
            description
              "Inter-Area-Prefix TLV sub-TLVs.";
            uses unknown-sub-tlv;
          }
        }
      }
    }
    container e-inter-area-router {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-inter-area-router-lsa'" {
        description
          "Only applies to E-Inter-Area-Router-LSAs.";
      }
      description
        "E-Inter-Area-Router-LSA contents.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.4";
      list e-inter-router-tlvs {
        description
          "E-Inter-Area-Router-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-Inter-Area-Router TLV.";
        }
        container inter-router-tlv {
          description
            "Unknown E-Inter-Area-Router-LSA TLV.";
          uses ospf:ospfv3-lsa-options;
          leaf metric {
            type ospf:ospf-metric;
            description
              "Inter-Area Router metric.";
          }
          leaf destination-router-id {
            type rt-types:router-id;
            description
              "Destination Router ID.";
          }
          list sub-tlvs {
            description
              "Inter-Area-Router TLV sub-TLVs.";
            uses unknown-sub-tlv;
```

```
          }
        }
      }
    }
    container e-intra-area-prefix {
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-intra-area-prefix-lsa'" {
        description
          "Only applies to E-Intra-Area-Prefix-LSAs.";
      }
      description
        "E-Intra-Area-Prefix-LSA.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.8";
      leaf referenced-ls-type {
        type uint16;
        description
          "Referenced Link State type.";
      }
      leaf referenced-link-state-id {
        type uint32;
        description
          "Referenced Link State ID.";
      }
      leaf referenced-adv-router {
        type rt-types:router-id;
        description
          "Referenced advertising router.";
      }
      list e-intra-prefix-tlvs {
        description
          "E-Intra-Area-Prefix-LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-Intra-Area-Prefix TLV.";
        }
        uses intra-area-prefix-tlv;
      }
    }
  }

  augment "/rt:routing/"
        + "rt:control-plane-protocols/rt:control-plane-protocol/"
        + "ospf:ospf/ospf:database/"
        + "ospf:as-scope-lsa-type/ospf:as-scope-lsas/"
        + "ospf:as-scope-lsa/ospf:version/ospf:ospfv3/"
        + "ospf:ospfv3/ospf:body" {
    when "../../../../../../../"
       + "rt:type = 'ospf:ospfv3'" {
      description
        "This augmentation is only valid for OSPFv3.";
    }
    description
      "This augmentation adds OSPFv3 AS-scoped Extended LSAs to
       the operational state for an AS instance-level LSDB.";
    container e-as-external {
```

```
      when "../../ospf:header/ospf:type = "
         + "'ospfv3-e-lsa:ospfv3-e-as-external-lsa'" {
        description
          "Only applies to E-AS-External-LSAs.";
      }
      list e-external-tlvs {
        description
          "E-External LSA TLVs.";
        container unknown-tlv {
          uses ospf:tlv;
          description
            "Unknown E-External TLV.";
        }
        uses external-prefix-tlv;
      }
      description
        "E-AS-External-LSA contents.";
      reference
        "RFC 8362: OSPFv3 Link State Advertisement (LSA)
         Extensibility, Section 4.5";
    }
  }
}

<CODE ENDS>
```

5. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in the "ietf-ospfv3-extended-lsa.yang" module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

/ospf:ospf/extended-lsa-support

/ospf:ospf/ospf:areas/ospf:area/extended-lsa-support

The ability to disable or enable OSPFv3 Extended LSA support can result in a Denial-of-Service (DoS) attack, since OSPFv3 routers will use solely OSPFv3 Extended LSAs or OSPFv3 Legacy LSAs for the OSPFv3 SPF computation. OSPFv3 routers using different types of LSAs will result in incomplete reachability and possible partitioning of the OSPFv3 routing domain. Refer to Section 6 of [RFC8362] for more information on OSPFv3 Extended LSA compatibility.

Some of the readable data nodes in the "ietf-ospfv3-extended-lsa.yang" module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes.

Exposing the Link State Database (LSDB) will in turn expose the detailed topology of the network. This includes topological information from other routers. This may be undesirable due to the fact that exposure may facilitate other attacks. Additionally, network operators may consider their topologies to be sensitive confidential data.

6. IANA Considerations

Per this document, IANA has registered the following URI in the "IETF XML Registry" [RFC3688]:

URI: urn:ietf:params:xml:ns:yang:ietf-ospfv3-extended-lsa
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.

Per this document, IANA has registered the following YANG module in the "YANG Module Names" registry [RFC6020]:

Name: ietf-ospfv3-extended-lsa
Maintained by IANA: N
Namespace: urn:ietf:params:xml:ns:yang:ietf-ospfv3-extended-lsa
Prefix: ospfv3-e-lsa
Reference: RFC 9587

7. References

7.1. Normative References

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

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

[RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/info/rfc6020>.

[RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/info/rfc6241>.

[RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <https://www.rfc-editor.org/info/rfc6242>.

[RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <https://www.rfc-editor.org/info/rfc6991>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/info/rfc7950>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[RFC8294] Liu, X., Qu, Y., Lindem, A., Hopps, C., and L. Berger, "Common YANG Data Types for the Routing Area", RFC 8294, DOI 10.17487/RFC8294, December 2017, <https://www.rfc-editor.org/info/rfc8294>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/info/rfc8342>.

[RFC8349] Lhotka, L., Lindem, A., and Y. Qu, "A YANG Data Model for Routing Management (NMDA Version)", RFC 8349, DOI 10.17487/RFC8349, March 2018, <https://www.rfc-editor.org/info/rfc8349>.

[RFC8362] Lindem, A., Roy, A., Goethals, D., Reddy Vallem, V., and F. Baker, "OSPFv3 Link State Advertisement (LSA) Extensibility", RFC 8362, DOI 10.17487/RFC8362, April 2018, <https://www.rfc-editor.org/info/rfc8362>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC9129] Yeung, D., Qu, Y., Zhang, Z., Chen, I., and A. Lindem, "YANG Data Model for the OSPF Protocol", RFC 9129, DOI 10.17487/RFC9129, October 2022, <https://www.rfc-editor.org/info/rfc9129>.

[W3C.REC-xml-20081126] Bray, T., Paoli, J., Sperberg-McQueen, C. M., Maler, E., and F. Yergeau, "Extensible Markup Language (XML) 1.0 (Fifth Edition)", W3C Recommendation REC-xml-20081126, November 2008, <https://www.w3.org/TR/xml/>.

7.2. Informative References

[RFC7951] Lhotka, L., "JSON Encoding of Data Modeled with YANG", RFC 7951, DOI 10.17487/RFC7951, August 2016, <https://www.rfc-editor.org/info/rfc7951>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

[RFC8792] Watsen, K., Auerswald, E., Farrel, A., and Q. Wu, "Handling Long Lines in Content of Internet-Drafts and RFCs", RFC 8792, DOI 10.17487/RFC8792, June 2020, <https://www.rfc-editor.org/info/rfc8792>.

Appendix A. Configuration Example

The following is an XML example (per [W3C.REC-xml-20081126]) using the YANG data model for OSPFv3 Extended LSAs. (Line breaks are used per [RFC8792] and are for display purposes only.)

```
Note: '\' line wrapping per RFC 8792.

<?xml version='1.0' encoding='UTF-8'?>
  <routing xmlns="urn:ietf:params:xml:ns:yang:ietf-routing">
    <router-id>192.0.2.1</router-id>
    <control-plane-protocols>
      <control-plane-protocol>
        <type xmlns:ospf="urn:ietf:params:xml:ns:yang:ietf-ospf">\
        ospf:ospfv3</type>
        <name>"OSPFv3"</name>
        <ospf xmlns="urn:ietf:params:xml:ns:yang:ietf-ospf">
          <extended-lsa-support xmlns="urn:ietf:params:xml:ns:yang:\
            ietf-ospfv3-extended-lsa">true</extended-lsa-support>
        </ospf>
      </control-plane-protocol>
    </control-plane-protocols>
  </routing>
```

The following is the same example using JSON format [RFC7951].

```
{
  "routing": {
    "router-id": "192.0.2.1",
    "control-plane-protocols": {
      "control-plane-protocol": {
        "type": "ospf:ospfv3",
        "name": "\"OSPFv3\"",
        "ospf": {
          "extended-lsa-support": true
        }
      }
    }
  }
}
```

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