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YANG Data Model for OSPF Protocol
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Abstract

This document defines a YANG data model that can be used to configure and manage OSPF. The model is based on YANG1.1 as defined in RFC 7950 and conforms to the Network Management Datastore Architecture (NMDA) as described in RFC 8342.

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1. Overview

YANG [RFC6020][RFC7950] is a data definition language used to define the contents of a conceptual data store that allows networked devices to be managed using NETCONF [RFC6241], RESTCONF [RFC8040], and other Network Management protocols. Furthermore, YANG data models can be used as the basis for implementation of other interfaces, such as CLI and programmatic APIs.

This document defines a YANG data model that can be used to configure and manage OSPF and it is an augmentation to the core routing data model. It fully conforms to the Network Management Datastore Architecture (NMDA) [RFC8342]. A core routing data model is defined in [RFC8349], and it provides the basis for the development of data models for routing protocols. The interface data model is defined in [RFC8343] and is used for referencing interfaces from the routing

protocol. The key-chain data model used for OSPF authentication is defined in [RFC8177] and provides both a reference to configured key-chains and an enumeration of cryptographic algorithms.

Both OSPFv2 [RFC2328] and OSPFv3 [RFC5340] are supported. In addition to the core OSPF protocol, features described in other OSPF RFCs are also supported. These includes demand circuit [RFC1793], traffic engineering [RFC3630], multiple address family [RFC5838], graceful restart [RFC3623] [RFC5187], NSSA [RFC3101], and OSPFv2 or OSPFv3 as a PE-CE Protocol [RFC4577], [RFC6565]. These non-core features are optional in the OSPF data model.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

1.2. Tree Diagrams

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

2. Design of Data Model

Although the basis of OSPF configuration elements like routers, areas, and interfaces remains the same, the detailed configuration model varies among router vendors. Differences are observed in terms of how the protocol instance is tied to the routing domain and how multiple protocol instances are be instantiated among others.

The goal of this document is to define a data model that provides a common user interface to the OSPFv2 and OSPFv3 protocols. There is very little information that is designated as "mandatory", providing freedom for vendors to adapt this data model to their respective product implementations.

2.1. OSPF Operational State

The OSPF operational state is included in the same tree as OSPF configuration consistent with the Network Management Datastore Architecture [RFC8342]. Consequently, only the routing container in the ietf-routing model [RFC8349] is augmented. The routing-state container is not augmented.

2.2. Overview

The OSPF YANG module defined in this document has all the common building blocks for the OSPF protocol.

The OSPF YANG module augments the /routing/control-plane-protocols/control-plane-protocol path defined in the ietf-routing module. The ietf-ospf model defines a single instance of OSPF which may be instantiated as an OSPFv2 or OSPFv3 instance. Multiple instances are instantiated as multiple control-plane protocols instances.

```

module: ietf-ospf
  augment /rt:routing/rt:control-plane-protocols/
    rt:control-plane-protocol:
      +--rw ospf
         .
         .
         +--rw af?                               identityref
            .
            .
            +--rw areas
               +--rw area* [area-id]
                  +--rw area-id                 area-id-type
                     .
                     .
                     +--rw virtual-links
                        +--rw virtual-link* [transit-area-id router-id]
                           .
                           .
                           +--rw sham-links {pe-ce-protocol}?
                              +--rw sham-link* [local-id remote-id]
                                 .
                                 .
                                 +--rw interfaces
                                    +--rw interface* [name]
                                       .
                                       .
            +--rw topologies {multi-topology}?
               +--rw topology* [name]
                  .
                  .

```

The ospf container includes one OSPF protocol instance. The instance includes OSPF router level configuration and operational state. Each OSPF instance maps to a control-plane-protcol instance as defined in [RFC8349].

The area and area/interface containers define the OSPF configuration and operational state for OSPF areas and interfaces respectively.

The topologies container defines the OSPF configuration and operational state for OSPF topologies when the multi-topology feature is supported.

2.3. OSPFv2 and OSPFv3

The data model defined herein supports both OSPFv2 and OSPFv3.

The field 'version' is used to indicate the OSPF version and is mandatory. Based on the configured version, the data model varies to accommodate the differences between OSPFv2 and OSPFv3.

2.4. Optional Features

Optional features are beyond the basic OSPF configuration and it is the responsibility of each vendor to decide whether to support a given feature on a particular device.

This model defines the following optional features:

1. multi-topology: Support Multi-Topology Routing (MTR) [RFC4915].
2. multi-area-adj: Support OSPF multi-area adjacency [RFC5185].
3. explicit-router-id: Support explicit per-instance Router-ID specification.
4. demand-circuit: Support OSPF demand circuits [RFC1793].
5. mtu-ignore: Support disabling OSPF Database Description packet MTU mismatch checking specified in section 10.6 of [RFC2328].
6. lls: Support OSPF link-local signaling (LLS) [RFC5613].
7. prefix-suppression: Support OSPF prefix advertisement suppression [RFC6860].
8. ttl-security: Support OSPF Time to Live (TTL) security check support [RFC5082].
9. nsr: Support OSPF Non-Stop Routing (NSR). The OSPF NSR feature allows a router with redundant control-plane capability (e.g., dual Route-Processor (RP) cards) to maintain its state and adjacencies during planned and unplanned control-plane processing restarts. It differs from graceful-restart or Non-

Stop Forwarding (NSF) in that no protocol signaling or assistance from adjacent OSPF neighbors is required to recover control-plane state.

10. graceful-restart: Support Graceful OSPF Restart [RFC3623], [RFC5187].
11. auto-cost: Support OSPF interface cost calculation according to reference bandwidth [RFC2328].
12. max-ecmp: Support configuration of the maximum number of Equal-Cost Multi-Path (ECMP) paths.
13. max-lsa: Support configuration of the maximum number of LSAs the OSPF instance will accept [RFC1765].
14. te-rid: Support configuration of the Traffic Engineering (TE) Router-ID, i.e., the Router Address described in Section 2.4.1 of [RFC3630] or the Router IPv6 Address TLV described in Section 3 of [RFC5329].
15. ldp-igp-sync: Support LDP IGP synchronization [RFC5443].
16. ospfv2-authentication-trailer: Support OSPFv2 Authentication trailer as specified in [RFC5709] or [RFC7474].
17. ospfv3-authentication-ipsec: Support IPsec for OSPFv3 authentication [RFC4552].
18. ospfv3-authentication-trailer: Support OSPFv3 Authentication trailer as specified in [RFC7166].
19. fast-reroute: Support IP Fast Reroute (IP-FRR) [RFC5714].
20. node-flag: Support node-flag for OSPF prefixes. [RFC7684].
21. node-tag: Support node admin tag for OSPF instances [RFC7777].
22. lfa: Support Loop-Free Alternates (LFAs) [RFC5286].
23. remote-lfa: Support Remote Loop-Free Alternates (R-LFA) [RFC7490].
24. stub-router: Support RFC 6987 OSPF Stub Router advertisement [RFC6987].
25. pe-ce-protocol: Support OSPF as a PE-CE protocol [RFC4577], [RFC6565].

26. ietf-spf-delay: Support IETF SPF delay algorithm [RFC8405].
27. bfd: Support BFD detection of OSPF neighbor reachability [RFC5880], [RFC5881], and [I-D.ietf-bfd-yang].
28. hybrid-interface: Support OSPF Hybrid Broadcast and Point-to-Point Interfaces [RFC6845].

It is expected that vendors will support additional features through vendor-specific augmentations.

2.5. OSPF Router Configuration/Operational State

The ospf container is the top-level container in this data model. It represents an OSPF protocol instance and contains the router level configuration and operational state. The operational state includes the instance statistics, IETF SPF delay statistics, AS-Scoped Link State Database, local RIB, SPF Log, and the LSA log.

```

module: ietf-ospf
  augment /rt:routing/rt:control-plane-protocols/
    rt:control-plane-protocol:
      +--rw ospf
      .
      .
      +--rw af iana-rt-types:address-family
      +--rw enable? boolean
      +--rw explicit-router-id? rt-types:router-id
      | {explicit-router-id}?
      +--rw preference
      | +--rw (scope)?
      | | +--:(single-value)
      | | | +--rw all? uint8
      | | +--:(multi-values)
      | | +--rw (granularity)?
      | | | +--:(detail)
      | | | | +--rw intra-area? uint8
      | | | | +--rw inter-area? uint8
      | | | +--:(coarse)
      | | | | +--rw internal? uint8
      | | | +--rw external? uint8
      +--rw nsr {nsr}?
      | +--rw enable? boolean
      +--rw graceful-restart {graceful-restart}?
      | +--rw enable? boolean
      | +--rw helper-enable? boolean
      | +--rw restart-interval? uint16
      | +--rw helper-strict-lsa-checking? boolean
  
```

```

+--rw auto-cost {auto-cost}?
|   +--rw enable?                boolean
|   +--rw reference-bandwidth?   uint32
+--rw spf-control
|   +--rw paths?                  uint16 {max-ecmp}?
|   +--rw ietf-spf-delay {ietf-spf-delay}?
|       +--rw initial-delay?     uint16
|       +--rw short-delay?       uint16
|       +--rw long-delay?        uint16
|       +--rw hold-down?         uint16
|       +--rw time-to-learn?     uint16
|       +--ro current-state?     enumeration
|       +--ro remaining-time-to-learn? uint16
|       +--ro remaining-hold-down? uint16
|       +--ro last-event-received? yang:timestamp
|       +--ro next-spf-time?     yang:timestamp
|       +--ro last-spf-time?     yang:timestamp
+--rw database-control
|   +--rw max-lsa?               uint32 {max-lsa}?
+--rw stub-router {stub-router}?
|   +--rw (trigger)?
|       +--:(always)
|           +--rw always!
+--rw mpls
|   +--rw te-rid {te-rid}?
|       |   +--rw ipv4-router-id?   inet:ipv4-address
|       |   +--rw ipv6-router-id?   inet:ipv6-address
|   +--rw ldp
|       +--rw igp-sync?           boolean {ldp-igp-sync}?
+--rw fast-reroute {fast-reroute}?
|   +--rw lfa {lfa}?
+--ro protected-routes
|   +--ro af-stats* [af prefix alternate]
|       +--ro af                    iana-rt-types:address-family
|       +--ro prefix                  string
|       +--ro alternate                string
|       +--ro alternate-type?         enumeration
|       +--ro best?                    boolean
|       +--ro non-best-reason?        string
|       +--ro protection-available?   bits
|       +--ro alternate-metric1?     uint32
|       +--ro alternate-metric2?     uint32
|       +--ro alternate-metric3?     uint32
+--ro unprotected-routes
|   +--ro af-stats* [af prefix]
|       +--ro af                    iana-rt-types:address-family
|       +--ro prefix                  string
+--ro protection-statistics* [frr-protection-method]

```

```

|   +--ro frr-protection-method string
|   +--ro af-stats* [af]
|       +--ro af                               iana-rt-types:address-family
|       +--ro total-routes?                    uint32
|       +--ro unprotected-routes?             uint32
|       +--ro protected-routes?               uint32
|       +--ro linkprotected-routes?           uint32
|       +--ro nodeprotected-routes?           uint32
+--rw node-tags {node-tag}?
|   +--rw node-tag* [tag]
|       +--rw tag                               uint32
+--ro router-id?
+--ro local-rib
|   +--ro route* [prefix]
|       +--ro prefix                          inet:ip-prefix
|       +--ro next-hops
|           +--ro next-hop* [next-hop]
|               +--ro outgoing-interface?     if:interface-ref
|               +--ro next-hop                 inet:ip-address
|       +--ro metric?                          uint32
|       +--ro route-type?                      route-type
|       +--ro route-tag?                      uint32
+--ro statistics
|   +--ro discontinuity-time                    yang:date-and-time
|   +--ro originate-new-lsa-count?            yang:counter32
|   +--ro rx-new-lsas-count?                  yang:counter32
|   +--ro as-scope-lsa-count?                 yang:gauge32
|   +--ro as-scope-lsa-chksum-sum?           uint32
|   +--ro database
|       +--ro as-scope-lsa-type*
|           +--ro lsa-type?                    uint16
|           +--ro lsa-count?                   yang:gauge32
|           +--ro lsa-cksum-sum?              int32
+--ro database
|   +--ro as-scope-lsa-type* [lsa-type]
|   +--ro as-scope-lsas
|       +--ro as-scope-lsa* [lsa-id adv-router]
|           +--ro lsa-id                       union
|           +--ro adv-router                   inet:ipv4-address
|           +--ro decoded-completed?          boolean
|           +--ro raw-data?                   yang:hex-string
|           +--ro (version)?
|               +--:(ospfv2)
|                   | +--ro ospfv2
|                   .
|                   .
|               +--:(ospfv3)
|                   +--ro ospfv3

```

```

.
.
+--ro spf-log
|   +--ro event* [id]
|   |   +--ro id                uint32
|   |   +--ro spf-type?         enumeration
|   |   +--ro schedule-timestamp? yang:timestamp
|   |   +--ro start-timestamp?  yang:timestamp
|   |   +--ro end-timestamp?    yang:timestamp
|   |   +--ro trigger-lsa*
|   |   |   +--ro area-id?      area-id-type
|   |   |   +--ro link-id?     union
|   |   |   +--ro type?        uint16
|   |   |   +--ro lsa-id?     yang:dotted-quad
|   |   |   +--ro adv-router?  yang:dotted-quad
|   |   |   +--ro seq-num?    uint32
+--ro lsa-log
|   +--ro event* [id]
|   |   +--ro id                uint32
|   |   +--ro lsa
|   |   |   +--ro area-id?      area-id-type
|   |   |   +--ro link-id?     union
|   |   |   +--ro type?        uint16
|   |   |   +--ro lsa-id?     yang:dotted-quad
|   |   |   +--ro adv-router?  yang:dotted-quad
|   |   |   +--ro seq-num?    uint32
|   |   +--ro received-timestamp? yang:timestamp
|   |   +--ro reason?          identityref
.
.

```

2.6. OSPF Area Configuration/Operational State

The area container contains OSPF area configuration and the list of interface containers representing all the OSPF interfaces in the area. The area operational state includes the area statistics and the Area Link State Database (LSDB).

```

module: ietf-ospf
  augment /rt:routing/rt:control-plane-protocols/
    rt:control-plane-protocol:
      +--rw ospf
      .
      .
      +--rw areas
      |   +--rw area* [area-id]
      |   |   +--rw area-id                area-id-type
      |   |   +--rw area-type?            identityref

```



```

+--rw virtual-link* [transit-area-id router-id]
  +--rw transit-area-id      -> ../../../../
                             area/area-id
  +--rw router-id            rt-types:router-id
  +--rw hello-interval?     uint16
  +--rw dead-interval?      uint32
  +--rw retransmit-interval? uint16
  +--rw transmit-delay?     uint16
  +--rw lls?                 boolean {lls}?
  +--rw ttl-security {ttl-security}?
  |   +--rw enable?         boolean
  |   +--rw hops?           uint8
  +--rw enable?              boolean
  +--rw authentication
  |   +--rw (auth-type-selection)?
  |   |   +--:(ospfv2-auth)
  |   |   |   +--rw ospfv2-auth-trailer-rfc?
  |   |   |   |   ospfv2-auth-trailer-rfc-version
  |   |   |   |   {ospfv2-authentication-trailer}?
  |   |   |   +--rw (ospfv2-auth-specification)?
  |   |   |   |   +--:(auth-key-chain) {key-chain}?
  |   |   |   |   |   +--rw ospfv2-key-chain?
  |   |   |   |   |   |   key-chain:key-chain-ref
  |   |   |   |   |   +--:(auth-key-explicit)
  |   |   |   |   |   |   +--rw ospfv2-key-id?         uint32
  |   |   |   |   |   |   +--rw ospfv2-key?           string
  |   |   |   |   |   |   +--rw ospfv2-crypto-algorithm?
  |   |   |   |   |   |   |   identityref
  |   |   |   +--:(ospfv3-auth-ipsec)
  |   |   |   |   {ospfv3-authentication-ipsec}?
  |   |   |   |   +--rw sa?                             string
  |   |   |   +--:(ospfv3-auth-trailer)
  |   |   |   |   {ospfv3-authentication-trailer}?
  |   |   |   +--rw (ospfv3-auth-specification)?
  |   |   |   |   +--:(auth-key-chain) {key-chain}?
  |   |   |   |   |   +--rw ospfv3-key-chain?
  |   |   |   |   |   |   key-chain:key-chain-ref
  |   |   |   |   |   +--:(auth-key-explicit)
  |   |   |   |   |   |   +--rw ospfv3-sa-id?           uint16
  |   |   |   |   |   |   +--rw ospfv3-key?           string
  |   |   |   |   |   |   +--rw ospfv3-crypto-algorithm?
  |   |   |   |   |   |   |   identityref
  +--ro cost?                uint16
  +--ro state?               if-state-type
  +--ro hello-timer?        rt-types:
  |                           rtimer-value-seconds16
  +--ro wait-timer?         rt-types:
  |                           rtimer-value-seconds16
  |

```

```

+--ro dr-router-id?          rt-types:router-id
+--ro dr-ip-addr?           inet:ip-address
+--ro bdr-router-id?       rt-types:router-id
+--ro bdr-ip-addr?         inet:ip-address
+--ro statistics
|   +--ro discontinuity-time  yang:date-and-time
|   +--ro if-event-count?    yang:counter32
|   +--ro link-scope-lsa-count? yang:gauge32
|   +--ro link-scope-lsa-cksum-sum?
|                                   uint32
|
|   +--ro database
|     +--ro link-scope-lsa-type*
|         +--ro lsa-type?      uint16
|         +--ro lsa-count?     yang:gauge32
|         +--ro lsa-cksum-sum? int32
+--ro neighbors
|   +--ro neighbor* [neighbor-router-id]
|       +--ro neighbor-router-id
|                                   rt-types:router-id
|       +--ro address?        inet:ip-address
|       +--ro dr-router-id?   rt-types:router-id
|       +--ro dr-ip-addr?     inet:ip-address
|       +--ro bdr-router-id?  rt-types:router-id
|       +--ro bdr-ip-addr?    inet:ip-address
|       +--ro state?          nbr-state-type
|       +--ro dead-timer?     rt-types:
|           |                   rtimer-value-seconds16
+--ro statistics
|   +--ro discontinuity-time
|                                   yang:date-and-time
|   +--ro nbr-event-count?
|                                   yang:counter32
|   +--ro nbr-retrans-qlen?
|                                   yang:gauge32
+--ro database
|   +--ro link-scope-lsa-type* [lsa-type]
|       +--ro lsa-type        uint16
|       +--ro link-scope-lsas
.
.
+--rw sham-links {pe-ce-protocol}?
|   +--rw sham-link* [local-id remote-id]
|       +--rw local-id        inet:ip-address
|       +--rw remote-id       inet:ip-address
|       +--rw hello-interval? uint16
|       +--rw dead-interval?  uint32
|       +--rw retransmit-interval? uint16
|       +--rw transmit-delay? uint16

```

```

+--rw lls?                               boolean {lls}?
+--rw ttl-security {ttl-security}?
|   +--rw enable?    boolean
|   +--rw hops?      uint8
+--rw enable?                boolean
+--rw authentication
|   +--rw (auth-type-selection)?
|   |   +--:(ospfv2-auth)
|   |   |   +--rw ospfv2-auth-trailer-rfc?
|   |   |   |   ospfv2-auth-trailer-rfc-version
|   |   |   |   {ospfv2-authentication-trailer}?
|   |   |   +--rw (ospfv2-auth-specification)?
|   |   |   |   +--:(auth-key-chain) {key-chain}?
|   |   |   |   |   +--rw ospfv2-key-chain?
|   |   |   |   |   |   key-chain:key-chain-ref
|   |   |   |   |   +--:(auth-key-explicit)
|   |   |   |   |   |   +--rw ospfv2-key-id?    uint32
|   |   |   |   |   |   +--rw ospfv2-key?      string
|   |   |   |   |   |   +--rw ospfv2-crypto-algorithm?
|   |   |   |   |   |   |   identityref
|   |   |   +--:(ospfv3-auth-ipsec)
|   |   |   |   {ospfv3-authentication-ipsec}?
|   |   |   |   +--rw sa?                        string
|   |   |   +--:(ospfv3-auth-trailer)
|   |   |   |   {ospfv3-authentication-trailer}?
|   |   |   +--rw (ospfv3-auth-specification)?
|   |   |   |   +--:(auth-key-chain) {key-chain}?
|   |   |   |   |   +--rw ospfv3-key-chain?
|   |   |   |   |   |   key-chain:key-chain-ref
|   |   |   |   |   +--:(auth-key-explicit)
|   |   |   |   |   |   +--rw ospfv3-sa-id?    uint16
|   |   |   |   |   |   +--rw ospfv3-key?      string
|   |   |   |   |   |   +--rw ospfv3-crypto-algorithm?
|   |   |   |   |   |   |   identityref
|   |   +--rw cost?                uint16
|   +--rw mtu-ignore?              boolean
|   |   {mtu-ignore}?
+--rw prefix-suppression? boolean
|   {prefix-suppression}?
+--ro state?                       if-state-type
+--ro hello-timer?                 rt-types:
|   rtimer-value-seconds16
+--ro wait-timer?                 rt-types:
|   rtimer-value-seconds16
+--ro dr-router-id?               rt-types:router-id
+--ro dr-ip-addr?                 inet:ip-address
+--ro bdr-router-id?             rt-types:router-id
+--ro bdr-ip-addr?               inet:ip-address

```

```

+--ro statistics
  +--ro discontinuity-time      yang:date-and-time
  +--ro if-event-count?        yang:counter32
  +--ro link-scope-lsa-count?  yang:gauge32
  +--ro link-scope-lsa-cksum-sum?
                                uint32
  +--ro database
    +--ro link-scope-lsa-type*
      +--ro lsa-type?          uint16
      +--ro lsa-count?         yang:gauge32
      +--ro lsa-cksum-sum?     int32
+--ro neighbors
  +--ro neighbor* [neighbor-router-id]
    +--ro neighbor-router-id
                                rt-types:router-id
  +--ro address?               inet:ip-address
  +--ro dr-router-id?          rt-types:router-id
  +--ro dr-ip-addr?            inet:ip-address
  +--ro bdr-router-id?         rt-types:router-id
  +--ro bdr-ip-addr?           inet:ip-address
  +--ro state?                  nbr-state-type
  +--ro cost?                   uint32
  +--ro dead-timer?            rt-types:
    |                           rtimer-value-seconds16
  +--ro statistics
    +--ro nbr-event-count?      yang:counter32
    +--ro nbr-retrans-qlen?    yang:gauge32
+--ro database
  +--ro link-scope-lsa-type* [lsa-type]
    +--ro lsa-type              uint16
  +--ro link-scope-lsas
:
:
:
:

```

2.7. OSPF Interface Configuration/Operational State

The interface container contains OSPF interface configuration and operational state. The interface operational state includes the statistics, list of neighbors, and Link-Local Link State Database (LSDB).

```

module: ietf-ospf
  augment /rt:routing/rt:control-plane-protocols/
    rt:control-plane-protocol:
      +--rw ospf
      .

```

```

.
+--rw areas
  +--rw area* [area-id]
    .
    .
    +--rw interfaces
      +--rw interface* [name]
        +--rw name                               if:interface-ref
        +--rw interface-type?                   enumeration
        +--rw passive?                          boolean
        +--rw demand-circuit?                  boolean
        +--rw priority?                         uint8
        +--rw multi-areas {multi-area-adj}?
          +--rw multi-area* [multi-area-id]
            +--rw multi-area-id                 area-id-type
            +--rw cost?                         uint16
        +--rw static-neighbors
          +--rw neighbor* [identifier]
            +--rw identifier                    inet:ip-address
            +--rw cost?                        uint16
            +--rw poll-interval?              uint16
            +--rw priority?                   uint8
        +--rw node-flag?                       boolean
        +--rw bfd {bfd}?
          +--rw enable?                       boolean
        +--rw fast-reroute {fast-reroute}?
          +--rw lfa {lfa}?
            +--rw candidate-enable?          boolean
            +--rw enable?                    boolean
            +--rw remote-lfa {remote-lfa}?
              +--rw enable?                  boolean
        +--rw hello-interval?                  uint16
        +--rw dead-interval?                   uint32
        +--rw retransmit-interval?            uint16
        +--rw transmit-delay?                 uint16
        +--rw lls?                             boolean {lls}?
        +--rw ttl-security {ttl-security}?
          +--rw enable?                       boolean
          +--rw hops?                         uint8
        +--rw enable?                         boolean
        +--rw authentication
          +--rw (auth-type-selection)?
            +--:(ospfv2-auth)
              +--rw ospfv2-auth-trailer-rfc?
                ospfv2-auth-trailer-rfc-version
                {ospfv2-authentication-trailer}?

```

```

    +--rw (ospfv2-auth-specification)?
      +--:(auth-key-chain) {key-chain}?
        |   +--rw ospfv2-key-chain?
        |       key-chain:key-chain-ref
        +--:(auth-key-explicit)
          +--rw ospfv2-key-id?      uint32
          +--rw ospfv2-key?        string
          +--rw ospfv2-crypto-algorithm?
              identityref
+--:(ospfv3-auth-ipsec)
  |   {ospfv3-authentication-ipsec}?
  |   +--rw sa?                    string
+--:(ospfv3-auth-trailer)
  |   {ospfv3-authentication-trailer}?
  +--rw (ospfv3-auth-specification)?
    +--:(auth-key-chain) {key-chain}?
      |   +--rw ospfv3-key-chain?
      |       key-chain:key-chain-ref
    +--:(auth-key-explicit)
      +--rw ospfv3-sa-id?          uint16
      +--rw ospfv3-key?            string
      +--rw ospfv3-crypto-algorithm?
          identityref
+--rw cost?                        uint16
+--rw mtu-ignore?                  boolean
  |   {mtu-ignore}?
+--rw prefix-suppression?         boolean
  |   {prefix-suppression}?
+--ro state?                       if-state-type
+--ro hello-timer?                rt-types:
  |   rtimer-value-seconds16
+--ro wait-timer?                 rt-types:
  |   rtimer-value-seconds16
+--ro dr-router-id?               rt-types:router-id
+--ro dr-ip-addr?                 inet:ip-address
+--ro bdr-router-id?              rt-types:router-id
+--ro bdr-ip-addr?                inet:ip-address
+--ro statistics
  |   +--ro if-event-count?         yang:counter32
  |   +--ro link-scope-lsa-count?  yang:gauge32
  |   +--ro link-scope-lsa-cksum-sum?
  |       uint32
  +--ro database
    +--ro link-scope-lsa-type*
      +--ro lsa-type?              uint16
      +--ro lsa-count?            yang:gauge32
      +--ro lsa-cksum-sum?        int32
+--ro neighbors

```

```

+--ro neighbor* [neighbor-router-id]
  +--ro neighbor-router-id
    rt-types:router-id
  +--ro address?      inet:ip-address
  +--ro dr-router-id? rt-types:router-id
  +--ro dr-ip-addr?   inet:ip-address
  +--ro bdr-router-id? rt-types:router-id
  +--ro bdr-ip-addr?  inet:ip-address
  +--ro state?        nbr-state-type
  +--ro dead-timer?   rt-types:
  |                   rtimer-value-seconds16
+--ro statistics
  +--ro nbr-event-count?
  |                   yang:counter32
  +--ro nbr-retrans-qlen?
  |                   yang:gauge32
+--ro database
  . +--ro link-scope-lsa-type* [lsa-type]
  .   +--ro lsa-type      uint16
  .   +--ro link-scope-lsas
  .
  .
+--rw topologies {ospf:multi-topology}?
  +--rw topology* [name]
  |   +--rw name -> ../../../../../../../../../../
  |   |                   ../../../../../../rt:ribs/rib/name
  |   +--rw cost? uint32
+--rw instance-id?      uint8

```

2.8. OSPF Notifications

This YANG model defines a list of notifications that inform YANG clients of important events detected during protocol operation. The defined notifications cover the common set of traps from the OSPFv2 MIB [RFC4750] and OSPFv3 MIB [RFC5643].

```

notifications:
  +---n if-state-change
  |   +--ro routing-protocol-name?
  |   +   -> /rt:routing/control-plane-protocols/
  |   +   control-plane-protocol/name
  |   +--ro af?
  |   +   -> /rt:routing/control-plane-protocols/
  |   +   control-plane-protocol
  |   +   [rt:name=current()/../routing-protocol-name]/
  |   +   ospf:ospf/af

```

```

+--ro (if-link-type-selection)?
  +--:(interface)
  |   +--ro interface
  |       +--ro interface?   if:interface-ref
  +--:(virtual-link)
  |   +--ro virtual-link
  |       +--ro transit-area-id?   area-id-type
  |       +--ro neighbor-router-id?   rt-types:router-id
  +--:(sham-link)
  |   +--ro sham-link
  |       +--ro area-id?   area-id-type
  |       +--ro local-ip-addr?   inet:ip-address
  |       +--ro remote-ip-addr?   inet:ip-address
+--ro state?   if-state-type
+---n if-config-error
+--ro routing-protocol-name?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol/name
+--ro af?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol
+   [rt:name=current()/../routing-protocol-name]/
+   ospf:ospf/af
+--ro (if-link-type-selection)?
  +--:(interface)
  |   +--ro interface
  |       +--ro interface?   if:interface-ref
  +--:(virtual-link)
  |   +--ro virtual-link
  |       +--ro transit-area-id?   area-id-type
  |       +--ro neighbor-router-id?   rt-types:router-id
  +--:(sham-link)
  |   +--ro sham-link
  |       +--ro area-id?   area-id-type
  |       +--ro local-ip-addr?   inet:ip-address
  |       +--ro remote-ip-addr?   inet:ip-address
+--ro packet-source?   yang:dotted-quad
+--ro packet-type?   packet-type
+--ro error?   enumeration
+---n nbr-state-change
+--ro routing-protocol-name?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol/name
+--ro af?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol
+   [rt:name=current()/../routing-protocol-name]/
+   ospf:ospf/af

```

```

+--ro (if-link-type-selection)?
  +--:(interface)
  |   +--ro interface
  |       +--ro interface?   if:interface-ref
  +--:(virtual-link)
  |   +--ro virtual-link
  |       +--ro transit-area-id?   area-id-type
  |       +--ro neighbor-router-id?   rt-types:router-id
  +--:(sham-link)
  |   +--ro sham-link
  |       +--ro area-id?   area-id-type
  |       +--ro local-ip-addr?   inet:ip-address
  |       +--ro remote-ip-addr?   inet:ip-address
+--ro neighbor-router-id?   rt-types:router-id
+--ro neighbor-ip-addr?   yang:dotted-quad
+--ro state?   nbr-state-type
+---n nbr-restart-helper-status-change
+--ro routing-protocol-name?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol/name
+--ro af?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol
+   [rt:name=current()/../routing-protocol-name]/
+   ospf:ospf/af
+--ro (if-link-type-selection)?
  +--:(interface)
  |   +--ro interface
  |       +--ro interface?   if:interface-ref
  +--:(virtual-link)
  |   +--ro virtual-link
  |       +--ro transit-area-id?   area-id-type
  |       +--ro neighbor-router-id?   rt-types:router-id
  +--:(sham-link)
  |   +--ro sham-link
  |       +--ro area-id?   area-id-type
  |       +--ro local-ip-addr?   inet:ip-address
  |       +--ro remote-ip-addr?   inet:ip-address
+--ro neighbor-router-id?   rt-types:router-id
+--ro neighbor-ip-addr?   yang:dotted-quad
+--ro status?   restart-helper-status-type
+--ro age?   uint32
+--ro exit-reason?   restart-exit-reason-type
+---n if-rx-bad-packet
+--ro routing-protocol-name?
+   -> /rt:routing/control-plane-protocols/
+   control-plane-protocol/name
+--ro af?

```

```

+     -> /rt:routing/control-plane-protocols/
+     control-plane-protocol
+     [rt:name=current()/../routing-protocol-name]/
+     ospf:ospf/af
+---ro (if-link-type-selection)?
|   +---:(interface)
|   |   +---ro interface
|   |   |   +---ro interface?    if:interface-ref
|   |   +---:(virtual-link)
|   |   |   +---ro virtual-link
|   |   |   |   +---ro transit-area-id?    area-id-type
|   |   |   |   +---ro neighbor-router-id?  rt-types:router-id
|   |   +---:(sham-link)
|   |   |   +---ro sham-link
|   |   |   |   +---ro area-id?            area-id-type
|   |   |   |   +---ro local-ip-addr?     inet:ip-address
|   |   |   |   +---ro remote-ip-addr?    inet:ip-address
|   +---ro packet-source?                yang:dotted-quad
|   +---ro packet-type?                  packet-type
+---n lsdb-approaching-overflow
|   +---ro routing-protocol-name?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol/name
|   +---ro af?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol
|   +     [rt:name=current()/../routing-protocol-name]/
|   +     ospf:ospf/af
|   +---ro ext-lsdb-limit?                uint32
+---n lsdb-overflow
|   +---ro routing-protocol-name?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol/name
|   +---ro af?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol
|   +     [rt:name=current()/../routing-protocol-name]/
|   +     ospf:ospf/af
|   +---ro ext-lsdb-limit?                uint32
+---n nssa-translator-status-change
|   +---ro routing-protocol-name?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol/name
|   +---ro af?
|   +     -> /rt:routing/control-plane-protocols/
|   +     control-plane-protocol
|   +     [rt:name=current()/../routing-protocol-name]/
|   +     ospf:ospf/af

```

```

|   +--ro area-id?                area-id-type
|   +--ro status?                 nssa-translator-state-type
+---n restart-status-change
|   +--ro routing-protocol-name?
|   +   -> /rt:routing/control-plane-protocols/
|   +   control-plane-protocol/name
|   +--ro af?
|   +   -> /rt:routing/control-plane-protocols/
|   +   control-plane-protocol
|   +   [rt:name=current()/../routing-protocol-name]/
|   +   ospf:ospf/af
+---ro status?                   restart-status-type
+---ro restart-interval?        uint16
+---ro exit-reason?             restart-exit-reason-type

```

2.9. OSPF RPC Operations

The "ietf-ospf" module defines two RPC operations:

- o clear-database: reset the content of a particular OSPF Link State Database.
- o clear-neighbor: Reset a particular OSPF neighbor or group of neighbors associated with an OSPF interface.

```

rpcs:
+---x clear-neighbor
|   +---w input
|   |   +---w routing-protocol-name
|   |   +   -> /rt:routing/control-plane-protocols/
|   |   +   control-plane-protocol/name
|   |   +---w interface?           if:interface-ref
+---x clear-database
|   +---w input
|   |   +---w routing-protocol-name
|   |   -> /rt:routing/control-plane-protocols/
|   |   control-plane-protocol/name

```

3. OSPF YANG Module

The following RFCs and drafts are not referenced in the document text but are referenced in the ietf-ospf.yang module: [RFC0905], [RFC4576], [RFC4973], [RFC5250], [RFC5309], [RFC5642], [RFC5881], [RFC6991], [RFC7770], [RFC7884], [RFC8294], and [RFC8476].

```

<CODE BEGINS> file "ietf-ospf@2019-10-17.yang"
module ietf-ospf {
  yang-version 1.1;

```

```
namespace "urn:ietf:params:xml:ns:yang:ietf-ospf";

prefix ospf;

import ietf-inet-types {
  prefix "inet";
  reference "RFC 6991: Common YANG Data Types";
}

import ietf-yang-types {
  prefix "yang";
  reference "RFC 6991: Common YANG Data Types";
}

import ietf-interfaces {
  prefix "if";
  reference "RFC 8343: A YANG Data Model for Interface
            Management (NMDA Version)";
}

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

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

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

import ietf-key-chain {
  prefix "key-chain";
  reference "RFC 8177: YANG Data Model for Key Chains";
}

import ietf-bfd-types {
  prefix "bfd-types";
  reference "RFC YYYY: YANG Data Model for Bidirectional
            Forwarding Detection (BFD). Please replace YYYY with
            published RFC number for draft-ietf-bfd-yang.";
```

```
}  
  
organization  
  "IETF LSR - Link State Routing Working Group";  
  
contact  
  "WG Web: <https://datatracker.ietf.org/group/lsr/>  
  WG List: <mailto:lsr@ietf.org>  
  
  Editor: Derek Yeung  
         <mailto:derek@arrcus.com>  
  Author: Acee Lindem  
         <mailto:acee@cisco.com>  
  Author: Yingzhen Qu  
         <mailto:yingzhen.qu@futurewei.com>  
  Author: Salih K A  
         <mailto:salih@juniper.net>  
  Author: Ing-Wher Chen  
         <mailto:ingwherchen@mitre.org>";  
  
description  
  "This YANG module defines the generic configuration and  
  operational state for the OSPF protocol common to all  
  vendor implementations. It is intended that the module  
  will be extended by vendors to define vendor-specific  
  OSPF configuration parameters and policies,  
  for example, route maps or route policies.  
  
  This YANG model conforms to the Network Management  
  Datastore Architecture (NMDA) as described in RFC 8242.  
  
  Copyright (c) 2018 IETF Trust and the persons identified as  
  authors of the code. All rights reserved.  
  
  Redistribution and use in source and binary forms, with or  
  without modification, is permitted pursuant to, and subject to  
  the license terms contained in, the Simplified BSD License set  
  forth in Section 4.c of the IETF Trust's Legal Provisions  
  Relating to IETF Documents  
  (https://trustee.ietf.org/license-info).  
  
  This version of this YANG module is part of RFC XXXX  
  (https://www.rfc-editor.org/info/rfcXXXX); see the RFC itself  
  for full legal notices.  
  
  The key words 'MUST', 'MUST NOT', 'REQUIRED', 'SHALL', 'SHALL  
  NOT', 'SHOULD', 'SHOULD NOT', 'RECOMMENDED', 'NOT RECOMMENDED',  
  'MAY', and 'OPTIONAL' in this document are to be interpreted as
```

described in BCP 14 (RFC 2119) (RFC 8174) when, and only when, they appear in all capitals, as shown here.

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

```
revision 2019-10-17 {
  description
    "Initial revision.";
  reference
    "RFC XXXX: A YANG Data Model for OSPF.";
}

feature multi-topology {
  description
    "Support Multiple-Topology Routing (MTR).";
  reference "RFC 4915: Multi-Topology Routing";
}

feature multi-area-adj {
  description
    "OSPF multi-area adjacency support as in RFC 5185.";
  reference "RFC 5185: Multi-Area Adjacency";
}

feature explicit-router-id {
  description
    "Set Router-ID per instance explicitly.";
}

feature demand-circuit {
  description
    "OSPF demand circuit support as in RFC 1793.";
  reference "RFC 1793: OSPF Demand Circuits";
}

feature mtu-ignore {
  description
    "Disable OSPF Database Description packet MTU
     mismatch checking specified in the OSPF
     protocol specification.";
  reference "RFC 2328: OSPF Version 2, section 10.6";
}

feature lls {
  description
    "OSPF link-local signaling (LLS) as in RFC 5613.";
  reference "RFC 5613: OSPF Link-Local Signaling";
}
```

```
feature prefix-suppression {
  description
    "OSPF prefix suppression support as in RFC 6860.";
  reference "RFC 6860: Hide Transit-Only Networks in OSPF";
}

feature ttl-security {
  description
    "OSPF Time to Live (TTL) security check support.";
  reference "RFC 5082: The Generalized TTL Security
            Mechanism (GTSM)";
}

feature nsr {
  description
    "Non-Stop-Routing (NSR) support. The OSPF NSR feature
     allows a router with redundant control-plane capability
     (e.g., dual Route-Processor (RP) cards) to maintain its
     state and adjacencies during planned and unplanned
     OSPF instance restarts. It differs from graceful-restart
     or Non-Stop Forwarding (NSF) in that no protocol signaling
     or assistance from adjacent OSPF neighbors is required to
     recover control-plane state.";
}

feature graceful-restart {
  description
    "Graceful OSPF Restart as defined in RFC 3623 and
     RFC 5187.";
  reference "RFC 3623: Graceful OSPF Restart
            RFC 5187: OSPFv3 Graceful Restart";
}

feature auto-cost {
  description
    "Calculate OSPF interface cost according to
     reference bandwidth.";
  reference "RFC 2328: OSPF Version 2";
}

feature max-ecmp {
  description
    "Setting maximum number of ECMP paths.";
}

feature max-lsa {
  description
    "Setting the maximum number of LSAs the OSPF instance
```

```
        will accept.";
        reference "RFC 1765: OSPF Database Overload";
    }

    feature te-rid {
        description
            "Support configuration of the Traffic Engineering (TE)
            Router-ID, i.e., the Router Address described in Section
            2.4.1 of RFC3630 or the Router IPv6 Address TLV described
            in Section 3 of RFC5329.";
        reference "RFC 3630: Traffic Engineering (TE) Extensions
            to OSPF Version 2
            RFC 5329: Traffic Engineering (TE) Extensions
            to OSPF Version 3";
    }

    feature ldp-igp-sync {
        description
            "LDP IGP synchronization.";
        reference "RFC 5443: LDP IGP Synchronization";
    }

    feature ospfv2-authentication-trailer {
        description
            "Support OSPFv2 authentication trailer for OSPFv2
            authentication.";
        reference "RFC 5709: Supporting Authentication
            Trailer for OSPFv2
            RFC 7474: Security Extension for OSPFv2 When
            Using Manual Key Management";
    }

    feature ospfv3-authentication-ipsec {
        description
            "Support IPsec for OSPFv3 authentication.";
        reference "RFC 4552: Authentication/Confidentiality
            for OSPFv3";
    }

    feature ospfv3-authentication-trailer {
        description
            "Support OSPFv3 authentication trailer for OSPFv3
            authentication.";
        reference "RFC 7166: Supporting Authentication
            Trailer for OSPFv3";
    }

    feature fast-reroute {
```

```
description
  "Support for IP Fast Reroute (IP-FRR).";
reference "RFC 5714: IP Fast Reroute Framework";
}

feature key-chain {
  description
    "Support of keychain for authentication.";
reference "RFC8177: YANG Data Model for Key Chains";
}

feature node-flag {
  description
    "Support for node-flag for OSPF prefixes.";
reference "RFC 7684: OSPFv2 Prefix/Link Advertisement";
}

feature node-tag {
  description
    "Support for node admin tag for OSPF routing instances.";
reference "RFC 7777: Advertising Node Administrative
          Tags in OSPF";
}

feature lfa {
  description
    "Support for Loop-Free Alternates (LFAs).";
reference "RFC 5286: Basic Specification for IP Fast
          Reroute: Loop-Free Alternates";
}

feature remote-lfa {
  description
    "Support for Remote Loop-Free Alternates (R-LFA).";
reference "RFC 7490: Remote Loop-Free Alternate (LFA)
          Fast Reroute (FRR)";
}

feature stub-router {
  description
    "Support for RFC 6987 OSPF Stub Router Advertisement.";
reference "RFC 6987: OSPF Stub Router Advertisement";
}

feature pe-ce-protocol {
  description
    "Support for OSPF as a PE-CE protocol";
reference "RFC 4577: OSPF as the Provider/Customer Edge
```

```
        Protocol for BGP/MPLS IP Virtual Private
        Networks (VPNs)
        RFC 6565: OSPFv3 as a Provider Edge to Customer
        Edge (PE-CE) Routing Protocol";
    }

    feature ietf-spf-delay {
        description
            "Support for IETF SPF delay algorithm.";
        reference "RFC 8405: SPF Back-off algorithm for link
            state IGP";
    }

    feature bfd {
        description
            "Support for BFD detection of OSPF neighbor reachability.";
        reference "RFC 5880: Bidirectional Forwarding Detection (BFD)
            RFC 5881: Bidirectional Forwarding Detection
            (BFD) for IPv4 and IPv6 (Single Hop)";
    }

    feature hybrid-interface {
        description
            "Support for OSPF Hybrid interface type.";
        reference "RFC 6845: OSPF Hybrid Broadcast and
            Point-to-Multipoint Interface Type";
    }

    identity ospf {
        base "rt:routing-protocol";
        description "Any OSPF protocol version";
    }

    identity ospfv2 {
        base "ospf";
        description "OSPFv2 protocol";
    }

    identity ospfv3 {
        base "ospf";
        description "OSPFv3 protocol";
    }

    identity area-type {
        description "Base identity for OSPF area type.";
    }

    identity normal-area {
```

```
    base area-type;
    description "OSPF normal area.";
}

identity stub-nssa-area {
    base area-type;
    description "OSPF stub or NSSA area.";
}

identity stub-area {
    base stub-nssa-area;
    description "OSPF stub area.";
}

identity nssa-area {
    base stub-nssa-area;
    description "OSPF Not-So-Stubby Area (NSSA).";
    reference "RFC 3101: The OSPF Not-So-Stubby Area
              (NSSA) Option";
}

identity ospf-lsa-type {
    description
        "Base identity for OSPFv2 and OSPFv3
         Link State Advertisement (LSA) types";
}

identity ospfv2-lsa-type {
    base ospf-lsa-type;
    description
        "OSPFv2 LSA types";
}

identity ospfv2-router-lsa {
    base ospfv2-lsa-type;
    description
        "OSPFv2 Router LSA - Type 1";
}

identity ospfv2-network-lsa {
    base ospfv2-lsa-type;
    description
        "OSPFv2 Network LSA - Type 2";
}

identity ospfv2-summary-lsa-type {
    base ospfv2-lsa-type;
    description
```

```
    "OSPFv2 Summary LSA types";
}

identity ospfv2-network-summary-lsa {
  base ospfv2-summary-lsa-type;
  description
    "OSPFv2 Network Summary LSA - Type 3";
}

identity ospfv2-asbr-summary-lsa {
  base ospfv2-summary-lsa-type;
  description
    "OSPFv2 AS Boundary Router (ASBR) Summary LSA - Type 4";
}

identity ospfv2-external-lsa-type {
  base ospfv2-lsa-type;
  description
    "OSPFv2 External LSA types";
}

identity ospfv2-as-external-lsa {
  base ospfv2-external-lsa-type;
  description
    "OSPFv2 AS External LSA - Type 5";
}

identity ospfv2-nssa-lsa {
  base ospfv2-external-lsa-type;
  description
    "OSPFv2 Not-So-Stubby-Area (NSSA) LSA - Type 7";
}

identity ospfv2-opaque-lsa-type {
  base ospfv2-lsa-type;
  description
    "OSPFv2 Opaque LSA types";
}

identity ospfv2-link-scope-opaque-lsa {
  base ospfv2-opaque-lsa-type;
  description
    "OSPFv2 Link-Scoped Opaque LSA - Type 9";
}

identity ospfv2-area-scope-opaque-lsa {
  base ospfv2-opaque-lsa-type;
  description
```

```
        "OSPFv2 Area-Scoped Opaque LSA - Type 10";
    }

    identity ospfv2-as-scope-opaque-lsa {
        base ospfv2-opaque-lsa-type;
        description
            "OSPFv2 AS-Scoped Opaque LSA - Type 11";
    }

    identity ospfv2-unknown-lsa-type {
        base ospfv2-lsa-type;
        description
            "OSPFv2 Unknown LSA type";
    }

    identity ospfv3-lsa-type {
        base ospf-lsa-type;
        description
            "OSPFv3 LSA types.";
    }

    identity ospfv3-router-lsa {
        base ospfv3-lsa-type;
        description
            "OSPFv3 Router LSA - Type 0x2001";
    }

    identity ospfv3-network-lsa {
        base ospfv3-lsa-type;
        description
            "OSPFv3 Network LSA - Type 0x2002";
    }

    identity ospfv3-summary-lsa-type {
        base ospfv3-lsa-type;
        description
            "OSPFv3 Summary LSA types";
    }

    identity ospfv3-inter-area-prefix-lsa {
        base ospfv3-summary-lsa-type;
        description
            "OSPFv3 Inter-area Prefix LSA - Type 0x2003";
    }

    identity ospfv3-inter-area-router-lsa {
        base ospfv3-summary-lsa-type;
        description
```

```
    "OSPFv3 Inter-area Router LSA - Type 0x2004";
}

identity ospfv3-external-lsa-type {
  base ospfv3-lsa-type;
  description
    "OSPFv3 External LSA types";
}

identity ospfv3-as-external-lsa {
  base ospfv3-external-lsa-type;
  description
    "OSPFv3 AS-External LSA - Type 0x4005";
}

identity ospfv3-nssa-lsa {
  base ospfv3-external-lsa-type;
  description
    "OSPFv3 Not-So-Stubby-Area (NSSA) LSA - Type 0x2007";
}

identity ospfv3-link-lsa {
  base ospfv3-lsa-type;
  description
    "OSPFv3 Link LSA - Type 0x0008";
}

identity ospfv3-intra-area-prefix-lsa {
  base ospfv3-lsa-type;
  description
    "OSPFv3 Intra-area Prefix LSA - Type 0x2009";
}

identity ospfv3-router-information-lsa {
  base ospfv3-lsa-type;
  description
    "OSPFv3 Router Information LSA - Types 0x800C,
    0xA00C, and 0xC00C";
}

identity ospfv3-unknown-lsa-type {
  base ospfv3-lsa-type;
  description
    "OSPFv3 Unknown LSA type";
}

identity lsa-log-reason {
  description
```

```
    "Base identity for an LSA log reason.";
}

identity lsa-refresh {
  base lsa-log-reason;
  description
    "Identity used when the LSA is logged
     as a result of receiving a refresh LSA.";
}

identity lsa-content-change {
  base lsa-log-reason;
  description
    "Identity used when the LSA is logged
     as a result of a change in the content
     of the LSA.";
}

identity lsa-purge {
  base lsa-log-reason;
  description
    "Identity used when the LSA is logged
     as a result of being purged.";
}

identity informational-capability {
  description
    "Base identity for router informational capabilities.";
}

identity graceful-restart {
  base informational-capability;
  description
    "When set, the router is capable of restarting
     gracefully.";
  reference "RFC 3623: Graceful OSPF Restart
            RFC 5187: OSPFv3 Graceful Restart";
}

identity graceful-restart-helper {
  base informational-capability;
  description
    "When set, the router is capable of acting as
     a graceful restart helper.";
  reference "RFC 3623: Graceful OSPF Restart
            RFC 5187: OSPFv3 Graceful Restart";
}
```

```
identity stub-router {
  base informational-capability;
  description
    "When set, the router is capable of acting as
    an OSPF Stub Router.";
  reference "RFC 6987: OSPF Stub Router Advertisement";
}

identity traffic-engineering {
  base informational-capability;
  description
    "When set, the router is capable of OSPF traffic
    engineering.";
  reference "RFC 3630: Traffic Engineering (TE) Extensions
    to OSPF Version 2
    RFC 5329: Traffic Engineering (TE) Extensions
    to OSPF Version 3";
}

identity p2p-over-lan {
  base informational-capability;
  description
    "When set, the router is capable of OSPF Point-to-Point
    over LAN.";
  reference "RFC 5309: Point-to-Point Operation over LAN
    in Link State Routing Protocols";
}

identity experimental-te {
  base informational-capability;
  description
    "When set, the router is capable of OSPF experimental
    traffic engineering.";
  reference
    "RFC 4973: OSPF-xTE OSPF Experimental Traffic
    Engineering";
}

identity router-lsa-bit {
  description
    "Base identity for Router-LSA bits.";
}

identity vlink-end-bit {
  base router-lsa-bit;
  description
    "V bit, when set, the router is an endpoint of one or
    more virtual links.";
```

```
    }

    identity asbr-bit {
      base router-lsa-bit;
      description
        "E bit, when set, the router is an AS Boundary
        Router (ASBR).";
    }

    identity abr-bit {
      base router-lsa-bit;
      description
        "B bit, when set, the router is an Area Border
        Router (ABR).";
    }

    identity nssa-bit {
      base router-lsa-bit;
      description
        "Nt bit, when set, the router is an NSSA border router
        that is unconditionally translating NSSA LSAs into
        AS-external LSAs.";
    }

    identity ospfv3-lsa-option {
      description
        "Base identity for OSPF LSA options flags.";
    }

    identity af-bit {
      base ospfv3-lsa-option;
      description
        "AF bit, when set, the router supports OSPFv3 Address
        Families as in RFC5838.";
    }

    identity dc-bit {
      base ospfv3-lsa-option;
      description
        "DC bit, when set, the router supports demand circuits.";
    }

    identity r-bit {
      base ospfv3-lsa-option;
      description
        "R bit, when set, the originator is an active router.";
    }
  }
}
```

```
identity n-bit {
  base ospfv3-lsa-option;
  description
    "N bit, when set, the router is attached to an NSSA";
}

identity e-bit {
  base ospfv3-lsa-option;
  description
    "E bit, this bit describes the way AS-external LSAs
    are flooded";
}

identity v6-bit {
  base ospfv3-lsa-option;
  description
    "V6 bit, if clear, the router/link should be excluded
    from IPv6 routing calculation";
}

identity ospfv3-prefix-option {
  description
    "Base identity for OSPFv3 Prefix Options.";
}

identity nu-bit {
  base ospfv3-prefix-option;
  description
    "NU Bit, when set, the prefix should be excluded
    from IPv6 unicast calculations.";
}

identity la-bit {
  base ospfv3-prefix-option;
  description
    "LA bit, when set, the prefix is actually an IPv6
    interface address of the Advertising Router.";
}

identity p-bit {
  base ospfv3-prefix-option;
  description
    "P bit, when set, the NSSA area prefix should be
    translated to an AS External LSA and advertised
    by the translating NSSA Border Router.";
}

identity dn-bit {
```

```
    base ospfv3-prefix-option;
    description
      "DN bit, when set, the inter-area-prefix LSA or
      AS-external LSA prefix has been advertised as an
      L3VPN prefix.";
  }

  identity ospfv2-lsa-option {
    description
      "Base identity for OSPFv2 LSA option flags.";
  }

  identity mt-bit {
    base ospfv2-lsa-option;
    description
      "MT bit, When set, the router supports multi-topology as
      in RFC 4915.";
  }

  identity v2-dc-bit {
    base ospfv2-lsa-option;
    description
      "DC bit, When set, the router supports demand circuits.";
  }

  identity v2-p-bit {
    base ospfv2-lsa-option;
    description
      "P bit, wnlly used in type-7 LSA. When set, an NSSA
      border router should translate the type-7 LSA
      to a type-5 LSA.";
  }

  identity mc-flag {
    base ospfv2-lsa-option;
    description
      "MC Bit, when set, the router supports MOSPF.";
  }

  identity v2-e-flag {
    base ospfv2-lsa-option;
    description
      "E Bit, this bit describes the way AS-external LSAs
      are flooded.";
  }

  identity o-bit {
    base ospfv2-lsa-option;
```

```
    description
      "O bit, when set, the router is opaque-capable as in
       RFC 5250.";
  }

  identity v2-dn-bit {
    base ospfv2-lsa-option;
    description
      "DN bit, when a type 3, 5 or 7 LSA is sent from a PE
       to a CE, the DN bit must be set. See RFC 4576.";
  }

  identity ospfv2-extended-prefix-flag {
    description
      "Base identity for extended prefix TLV flag.";
  }

  identity a-flag {
    base ospfv2-extended-prefix-flag;
    description
      "Attach flag, when set it indicates that the prefix
       corresponds and a route what is directly connected to
       the advertising router..";
  }

  identity node-flag {
    base ospfv2-extended-prefix-flag;
    description
      "Node flag, when set, it indicates that the prefix is
       used to represent the advertising node, e.g., a loopback
       address.";
  }

  typedef ospf-metric {
    type uint32 {
      range "0 .. 16777215";
    }
    description
      "OSPF Metric - 24-bit unsigned integer.";
  }

  typedef ospf-link-metric {
    type uint16 {
      range "0 .. 65535";
    }
    description
      "OSPF Link Metric - 16-bit unsigned integer.";
  }
}
```

```
typedef opaque-id {
  type uint32 {
    range "0 .. 16777215";
  }
  description
    "Opaque ID - 24-bit unsigned integer.";
}

typedef area-id-type {
  type yang:dotted-quad;
  description
    "Area ID type.";
}

typedef route-type {
  type enumeration {
    enum intra-area {
      description "OSPF intra-area route.";
    }
    enum inter-area {
      description "OSPF inter-area route.";
    }
    enum external-1 {
      description "OSPF type 1 external route.";
    }
    enum external-2 {
      description "OSPF type 2 external route.";
    }
    enum nssa-1 {
      description "OSPF type 1 NSSA route.";
    }
    enum nssa-2 {
      description "OSPF type 2 NSSA route.";
    }
  }
  description "OSPF route type.";
}

typedef if-state-type {
  type enumeration {
    enum down {
      value "1";
      description
        "Interface down state.";
    }
    enum loopback {
      value "2";
      description

```

```
        "Interface loopback state.";
    }
    enum waiting {
        value "3";
        description
            "Interface waiting state.";
    }
    enum point-to-point {
        value "4";
        description
            "Interface point-to-point state.";
    }
    enum dr {
        value "5";
        description
            "Interface Designated Router (DR) state.";
    }
    enum bdr {
        value "6";
        description
            "Interface Backup Designated Router (BDR) state.";
    }
    enum dr-other {
        value "7";
        description
            "Interface Other Designated Router state.";
    }
}
description
    "OSPF interface state type.";
}

typedef router-link-type {
    type enumeration {
        enum point-to-point-link {
            value "1";
            description
                "Point-to-Point link to Router";
        }
        enum transit-network-link {
            value "2";
            description
                "Link to transit network identified by
                Designated-Router (DR)";
        }
        enum stub-network-link {
            value "3";
            description

```

```
        "Link to stub network identified by subnet";
    }
    enum virtual-link {
        value "4";
        description
            "Virtual link across transit area";
    }
}
description
    "OSPF Router Link Type.";
}

typedef nbr-state-type {
    type enumeration {
        enum down {
            value "1";
            description
                "Neighbor down state.";
        }
        enum attempt {
            value "2";
            description
                "Neighbor attempt state.";
        }
        enum init {
            value "3";
            description
                "Neighbor init state.";
        }
        enum 2-way {
            value "4";
            description
                "Neighbor 2-Way state.";
        }
        enum exstart {
            value "5";
            description
                "Neighbor exchange start state.";
        }
        enum exchange {
            value "6";
            description
                "Neighbor exchange state.";
        }
        enum loading {
            value "7";
            description
                "Neighbor loading state.";
        }
    }
}
```

```
    }
    enum full {
      value "8";
      description
        "Neighbor full state.";
    }
  }
  description
    "OSPF neighbor state type.";
}

typedef restart-helper-status-type {
  type enumeration {
    enum not-helping {
      value "1";
      description
        "Restart helper status not helping.";
    }
    enum helping {
      value "2";
      description
        "Restart helper status helping.";
    }
  }
  description
    "Restart helper status type.";
}

typedef restart-exit-reason-type {
  type enumeration {
    enum none {
      value "1";
      description
        "Restart not attempted.";
    }
    enum in-progress {
      value "2";
      description
        "Restart in progress.";
    }
    enum completed {
      value "3";
      description
        "Restart successfully completed.";
    }
    enum timed-out {
      value "4";
      description

```

```
        "Restart timed out.";
    }
    enum topology-changed {
        value "5";
        description
            "Restart aborted due to topology change.";
    }
}
description
    "Describes the outcome of the last attempt at a
    graceful restart, either by itself or acting
    as a helper.";
}

typedef packet-type {
    type enumeration {
        enum hello {
            value "1";
            description
                "OSPF Hello packet.";
        }
        enum database-description {
            value "2";
            description
                "OSPF Database Description packet.";
        }
        enum link-state-request {
            value "3";
            description
                "OSPF Link State Request packet.";
        }
        enum link-state-update {
            value "4";
            description
                "OSPF Link State Update packet.";
        }
        enum link-state-ack {
            value "5";
            description
                "OSPF Link State Acknowledgement packet.";
        }
    }
    description
        "OSPF packet type.";
}

typedef nssa-translator-state-type {
    type enumeration {
```

```
    enum enabled {
      value "1";
      description
        "NSSA translator enabled state.";
    }
    enum elected {
      value "2";
      description
        "NSSA translator elected state.";
    }
    enum disabled {
      value "3";
      description
        "NSSA translator disabled state.";
    }
  }
  description
    "OSPF NSSA translator state type.";
}

typedef restart-status-type {
  type enumeration {
    enum not-restarting {
      value "1";
      description
        "Router is not restarting.";
    }
    enum planned-restart {
      value "2";
      description
        "Router is going through planned restart.";
    }
    enum unplanned-restart {
      value "3";
      description
        "Router is going through unplanned restart.";
    }
  }
  description
    "OSPF graceful restart status type.";
}

typedef fletcher-checksum16-type {
  type string {
    pattern '(0x)?[0-9a-fA-F]{4}';
  }
  description
    "Fletcher 16-bit checksum in hex-string format 0xXXXX.";
```

```
        reference "RFC 905: ISO Transport Protocol specification
                  ISO DP 8073";
    }

typedef ospfv2-auth-trailer-rfc-version {
    type enumeration {
        enum rfc5709 {
            description
                "Support OSPF Authentication Trailer as
                 described in RFC 5709";
            reference "RFC 5709: OSPFv2 HMAC-SHA Cryptographic
                    Authentication";
        }

        enum rfc7474 {
            description
                "Support OSPF Authentication Trailer as
                 described in RFC 7474";
            reference
                "RFC 7474: Security Extension for OSPFv2
                 When Using Manual Key Management Authentication";
        }
    }
    description
        "OSPFv2 Authentication Trailer Support";
}

grouping tlv {
    description
        "Type-Length-Value (TLV)";
    leaf type {
        type uint16;
        description "TLV type.";
    }
    leaf length {
        type uint16;
        description "TLV length (octets).";
    }
    leaf value {
        type yang:hex-string;
        description "TLV value.";
    }
}

grouping unknown-tlvs {
    description
        "Unknown TLVs grouping - Used for unknown TLVs or
```

```
        unknown sub-TLVs.";
    container unknown-tlvs {
        description "All unknown TLVs.";
        list unknown-tlv {
            description "Unknown TLV.";
            uses tlv;
        }
    }
}

grouping node-tag-tlv {
    description "OSPF Node Admin Tag TLV grouping.";
    list node-tag {
        leaf tag {
            type uint32;
            description
                "Node admin tag value.";
        }
        description
            "List of tags.";
    }
}

grouping router-capabilities-tlv {
    description "OSPF Router Capabilities TLV grouping.";
    reference "RFC 7770: OSPF Router Capabilities";
    container router-informational-capabilities {
        leaf-list informational-capabilities {
            type identityref {
                base informational-capability;
            }
            description
                "Informational capability list. This list will
                contains the identities for the informational
                capabilities supported by router.";
        }
        description
            "OSPF Router Informational Flag Definitions.";
    }
    list informational-capabilities-flags {
        leaf informational-flag {
            type uint32;
            description
                "Individual informational capability flag.";
        }
        description
            "List of informational capability flags. This will
            return all the 32-bit informational flags irrespective
```

```
        of whether or not they are known to the device.";
    }
    list functional-capabilities {
        leaf functional-flag {
            type uint32;
            description
                "Individual functional capability flag.";
        }
        description
            "List of functional capability flags. This will
            return all the 32-bit functional flags irrespective
            of whether or not they are known to the device.";
    }
}

grouping dynamic-hostname-tlv {
    description "Dynamic Hostname TLV";
    reference "RFC 5642: Dynamic Hostnames for OSPF";
    leaf hostname {
        type string {
            length "1..255";
        }
        description "Dynamic Hostname";
    }
}

grouping sbfd-discriminator-tlv {
    description "Seamless BFD Discriminator TLV";
    reference "RFC 7884: S-BFD Discriminators in OSPF";
    list sbfd-discriminators {
        leaf sbfd-discriminator {
            type uint32;
            description "Individual S-BFD Discriminator.";
        }
        description
            "List of S-BFD Discriminators";
    }
}

grouping maximum-sid-depth-tlv {
    description "Maximum SID Depth (MSD) TLV";
    reference
        "RFC 8476: Signaling Maximum Segment Depth (MSD)
        using OSPF";
    list msd-type {
        leaf msd-type {
            type uint8;
            description "Maximum Segment Depth (MSD) type";
        }
    }
}
```

```
    }
    leaf msd-value {
      type uint8;
      description
        "Maximum Segment Depth (MSD) value for the type";
    }
  }
  description
    "List of Maximum Segment Depth (MSD) tuples";
}

grouping ospf-router-lsa-bits {
  container router-bits {
    leaf-list rtr-lsa-bits {
      type identityref {
        base router-lsa-bit;
      }
      description
        "Router LSA bits list. This list will contain
        identities for the bits which are set in the
        Router-LSA bits.";
    }
    description "Router LSA Bits.";
  }
  description
    "Router LSA Bits - Currently common for OSPFv2 and
    OSPFv3 but it may diverge with future augmentations.";
}

grouping ospfv2-router-link {
  description "OSPFv2 router link.";
  leaf link-id {
    type union {
      type inet:ipv4-address;
      type yang:dotted-quad;
    }
    description "Router-LSA Link ID";
  }
  leaf link-data {
    type union {
      type inet:ipv4-address;
      type uint32;
    }
    description "Router-LSA Link data.";
  }
  leaf type {
    type router-link-type;
    description "Router-LSA Link type.";
  }
}
```

```
    }
  }

  grouping ospfv2-lsa-body {
    description "OSPFv2 LSA body.";
    container router {
      when "derived-from-or-self(..../header/type, "
        + "'ospfv2-router-lsa')" {
        description
          "Only applies to Router-LSAs.";
      }
      description
        "Router LSA.";
      uses ospf-router-lsa-bits;
      leaf num-of-links {
        type uint16;
        description "Number of links in Router LSA.";
      }
      container links {
        description "All router Links.";
        list link {
          description "Router LSA link.";
          uses ospfv2-router-link;
          container topologies {
            description "All topologies for the link.";
            list topology {
              description
                "Topology specific information.";
              leaf mt-id {
                type uint8;
                description
                  "The MT-ID for the topology enabled on
                  the link.";
              }
              leaf metric {
                type uint16;
                description "Metric for the topology.";
              }
            }
          }
        }
      }
    }
  }
  container network {
    when "derived-from-or-self(..../header/type, "
      + "'ospfv2-network-lsa')" {
      description
        "Only applies to Network LSAs.";
    }
  }
}
```

```
    }
  description
    "Network LSA.";
  leaf network-mask {
    type yang:dotted-quad;
    description
      "The IP address mask for the network.";
  }
  container attached-routers {
    description "All attached routers.";
    leaf-list attached-router {
      type inet:ipv4-address;
      description
        "List of the routers attached to the network.";
    }
  }
}
container summary {
  when "derived-from(..../header/type, "
    + "'ospfv2-summary-lsa-type')" {
    description
      "Only applies to Summary LSAs.";
  }
  description
    "Summary LSA.";
  leaf network-mask {
    type inet:ipv4-address;
    description
      "The IP address mask for the network";
  }
  container topologies {
    description "All topologies for the summary LSA.";
    list topology {
      description
        "Topology specific information.";
      leaf mt-id {
        type uint8;
        description
          "The MT-ID for the topology enabled for
            the summary.";
      }
      leaf metric {
        type ospf-metric;
        description "Metric for the topology.";
      }
    }
  }
}
```

```
container external {
  when "derived-from ../../header/type, "
    + "'ospfv2-external-lsa-type'" {
    description
      "Only applies to AS-external LSAs and NSSA LSAs.";
  }
  description
    "External LSA.";
  leaf network-mask {
    type inet:ipv4-address;
    description
      "The IP address mask for the network";
  }
  container topologies {
    description "All topologies for the external.";
    list topology {
      description
        "Topology specific information.";
      leaf mt-id {
        type uint8;
        description
          "The MT-ID for the topology enabled for the
            external or NSSA prefix.";
      }
      leaf flags {
        type bits {
          bit E {
            description
              "When set, the metric specified is a Type 2
                external metric.";
          }
        }
        description "Flags.";
      }
      leaf metric {
        type ospf-metric;
        description "Metric for the topology.";
      }
      leaf forwarding-address {
        type inet:ipv4-address;
        description
          "Forwarding address.";
      }
      leaf external-route-tag {
        type uint32;
        description
          "Route tag for the topology.";
      }
    }
  }
}
```

```
    }
  }
}
container opaque {
  when "derived-from(..../header/type, "
    + "'ospfv2-opaque-lsa-type')" {
    description
      "Only applies to Opaque LSAs.";
  }
  description
    "Opaque LSA.";

  container ri-opaque {
    description "OSPF Router Information (RI) opaque LSA.";
    reference "RFC 7770: OSPF Router Capabilities";

    container router-capabilities-tlv {
      description
        "Informational and functional router capabilities";
      uses router-capabilities-tlv;
    }

    container node-tag-tlvs {
      description
        "All node tag TLVs.";
      list node-tag-tlv {
        description
          "Node tag TLV.";
        uses node-tag-tlv;
      }
    }

    container dynamic-hostname-tlv {
      description "OSPF Dynamic Hostname";
      uses dynamic-hostname-tlv;
    }

    container sbfd-discriminator-tlv {
      description "OSPF S-BFD Discriminators";
      uses sbfd-discriminator-tlv;
    }

    container maximum-sid-depth-tlv {
      description "OSPF Maximum SID Depth (MSD) values";
      uses maximum-sid-depth-tlv;
    }
  }
  uses unknown-tlvs;
}
```

```
container te-opaque {
  description "OSPFv2 Traffic Engineering (TE) opaque LSA.";
  reference "RFC 3630: Traffic Engineering (TE)
            Extensions to OSPFv2";

  container router-address-tlv {
    description
      "Router address TLV.";
    leaf router-address {
      type inet:ipv4-address;
      description
        "Router address.";
    }
  }
}

container link-tlv {
  description "Describes a single link, and it is constructed
of a set of Sub-TLVs.";
  leaf link-type {
    type router-link-type;
    mandatory true;
    description "Link type.";
  }
  leaf link-id {
    type union {
      type inet:ipv4-address;
      type yang:dotted-quad;
    }
    mandatory true;
    description "Link ID.";
  }
  container local-if-ipv4-addr {
    description "All local interface IPv4 addresses.";
    leaf-list local-if-ipv4-addr {
      type inet:ipv4-address;
      description
        "List of local interface IPv4 addresses.";
    }
  }
  container remote-if-ipv4-addr {
    description "All remote interface IPv4 addresses.";
    leaf-list remote-if-ipv4-addr {
      type inet:ipv4-address;
      description
        "List of remote interface IPv4 addresses.";
    }
  }
  leaf te-metric {
```

```
        type uint32;
        description "TE metric.";
    }
    leaf max-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        description "Maximum bandwidth.";
    }
    leaf max-reservable-bandwidth {
        type rt-types:bandwidth-ieee-float32;
        description "Maximum reservable bandwidth.";
    }
    container unreserved-bandwidths {
        description "All unreserved bandwidths.";
        list unreserved-bandwidth {
            leaf priority {
                type uint8 {
                    range "0 .. 7";
                }
                description "Priority from 0 to 7.";
            }
            leaf unreserved-bandwidth {
                type rt-types:bandwidth-ieee-float32;
                description "Unreserved bandwidth.";
            }
            description
                "List of unreserved bandwidths for different
                priorities.";
        }
    }
    leaf admin-group {
        type uint32;
        description
            "Administrative group/Resource Class/Color.";
    }
    uses unknown-tlvs;
}

container extended-prefix-opaque {
    description "All extended prefix TLVs in the LSA.";
    list extended-prefix-tlv {
        description "Extended prefix TLV.";
        leaf route-type {
            type enumeration {
                enum unspecified {
                    value "0";
                    description "Unspecified.";
                }
            }
        }
    }
}
```

```
    enum intra-area {
      value "1";
      description "OSPF intra-area route.";
    }
    enum inter-area {
      value "3";
      description "OSPF inter-area route.";
    }
    enum external {
      value "5";
      description "OSPF External route.";
    }
    enum nssa {
      value "7";
      description "OSPF NSSA external route.";
    }
  }
  description "Route type.";
}
container flags {
  leaf-list extended-prefix-flags {
    type identityref {
      base ospfv2-extended-prefix-flag;
    }
    description
      "Extended prefix TLV flags list. This list will
       contain identities for the prefix flags that
       are set in the extended prefix flags.";
  }
  description "Prefix Flags.";
}
leaf prefix {
  type inet:ip-prefix;
  description "Address prefix.";
}
uses unknown-tlvs;
}

container extended-link-opaque {
  description "All extended link TLVs in the LSA.";
  container extended-link-tlv {
    description "Extended link TLV.";
    uses ospfv2-router-link;
    container maximum-sid-depth-tlv {
      description "OSPF Maximum SID Depth (MSD) values";
      uses maximum-sid-depth-tlv;
    }
  }
}
```

```
        uses unknown-tlvs;
    }
}
}

grouping ospfv3-lsa-options {
    description "OSPFv3 LSA options";
    container lsa-options {
        leaf-list lsa-options {
            type identityref {
                base ospfv3-lsa-option;
            }
            description
                "OSPFv3 LSA Option flags list. This list will contain
                the identities for the OSPFv3 LSA options that are
                set for the LSA.";
        }
        description "OSPFv3 LSA options.";
    }
}

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-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.";
    }
}

grouping ospfv3-lsa-external {
    description
        "AS-External and NSSA LSA.";
```

```
leaf metric {
  type ospf-metric;
  description "Metric";
}
leaf flags {
  type bits {
    bit E {
      description
        "When set, the metric specified is a Type 2
        external metric.";
    }
    bit F {
      description
        "When set, a Forwarding Address is included
        in the LSA.";
    }
    bit T {
      description
        "When set, an External Route Tag is included
        in the LSA.";
    }
  }
  description "Flags.";
}

leaf referenced-ls-type {
  type identityref {
    base ospfv3-lsa-type;
  }
  description "Referenced Link State type.";
}
leaf unknown-referenced-ls-type {
  type uint16;
  description
    "Value for an unknown Referenced Link State type.";
}

uses ospfv3-lsa-prefix;

leaf forwarding-address {
  type inet:ipv6-address;
  description
    "Forwarding address.";
}

leaf external-route-tag {
  type uint32;
  description
```

```
        "Route tag.";
    }
    leaf referenced-link-state-id {
        type uint32;
        description
            "Referenced Link State ID.";
    }
}

grouping ospfv3-lsa-body {
    description "OSPFv3 LSA body.";
    container router {
        when "derived-from-or-self(..../header/type, "
            + "'ospfv3-router-lsa')" {
            description
                "Only applies to Router LSAs.";
        }
        description "Router LSA.";
        uses ospf-router-lsa-bits;
        uses ospfv3-lsa-options;

        container links {
            description "All router link.";
            list link {
                description "Router LSA link.";
                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 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 uint16;
                description "Link Metric.";
            }
        }
    }
}
```

```
    }
  }
}
container network {
  when "derived-from-or-self(..../header/type, "
    + "'ospfv3-network-lsa')" {
    description
      "Only applies to Network LSAs.";
  }
  description "Network LSA.";

  uses ospfv3-lsa-options;

  container attached-routers {
    description "All attached routers.";
    leaf-list attached-router {
      type rt-types:router-id;
      description
        "List of the routers attached to the network.";
    }
  }
}
container inter-area-prefix {
  when "derived-from-or-self(..../header/type, "
    + "'ospfv3-inter-area-prefix-lsa')" {
    description
      "Only applies to Inter-Area-Prefix LSAs.";
  }
  leaf metric {
    type ospf-metric;
    description "Inter-Area Prefix Metric";
  }
  uses ospfv3-lsa-prefix;
  description "Prefix LSA.";
}
container inter-area-router {
  when "derived-from-or-self(..../header/type, "
    + "'ospfv3-inter-area-router-lsa')" {
    description
      "Only applies to Inter-Area-Router LSAs.";
  }
  uses ospfv3-lsa-options;
  leaf metric {
    type ospf-metric;
    description "AS Boundary Router (ASBR) Metric.";
  }
  leaf destination-router-id {
    type rt-types:router-id;
  }
}
```

```
        description
            "The Router ID of the ASBR described by the LSA.";
    }
    description "Inter-Area-Router LSA.";
}
container as-external {
    when "derived-from-or-self(..../header/type, "
        + "'ospfv3-as-external-lsa')" {
        description
            "Only applies to AS-external LSAs.";
    }

    uses ospfv3-lsa-external;

    description "AS-External LSA.";
}
container nssa {
    when "derived-from-or-self(..../header/type, "
        + "'ospfv3-nssa-lsa')" {
        description
            "Only applies to NSSA LSAs.";
    }
    uses ospfv3-lsa-external;

    description "NSSA LSA.";
}
container link {
    when "derived-from-or-self(..../header/type, "
        + "'ospfv3-link-lsa')" {
        description
            "Only applies to Link LSAs.";
    }
}
leaf rtr-priority {
    type uint8;
    description
        "Router priority for DR election. A router with a
        higher priority will be preferred in the election
        and a value of 0 indicates the router is not
        eligible to become Designated Router or Backup
        Designated Router (BDR).";
}
uses ospfv3-lsa-options;

leaf link-local-interface-address {
    type inet:ipv6-address;
    description
        "The originating router's link-local
        interface address for the link.";
```

```
    }

    leaf num-of-prefixes {
      type uint32;
      description "Number of prefixes.";
    }

    container prefixes {
      description "All prefixes for the link.";
      list prefix {
        description
          "List of prefixes associated with the link.";
        uses ospfv3-lsa-prefix;
      }
    }
    description "Link LSA.";
  }
  container intra-area-prefix {
    when "derived-from-or-self(..../header/type, "
      + "'ospfv3-intra-area-prefix-lsa')"{
      description
        "Only applies to Intra-Area-Prefix LSAs.";
    }
    description "Intra-Area-Prefix LSA.";

    leaf referenced-ls-type {
      type identityref {
        base ospfv3-lsa-type;
      }
      description "Referenced Link State type.";
    }
    leaf unknown-referenced-ls-type {
      type uint16;
      description
        "Value for an unknown 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.";
    }
  }

  leaf num-of-prefixes {
```

```
        type uint16;
        description "Number of prefixes.";
    }
    container prefixes {
        description "All prefixes in this LSA.";
        list prefix {
            description "List of prefixes in this LSA.";
            uses ospfv3-lsa-prefix;
            leaf metric {
                type ospf-metric;
                description "Prefix Metric.";
            }
        }
    }
}
container router-information {
    when "derived-from-or-self(..../header/type, "
        + "'ospfv3-router-information-lsa')" {
        description
            "Only applies to Router Information LSAs (RFC7770).";
    }
    container router-capabilities-tlv {
        description
            "Informational and functional router capabilities";
        uses router-capabilities-tlv;
    }
    container node-tag-tlvs {
        description
            "All node tag tlvs.";
        list node-tag-tlv {
            description
                "Node tag tlv.";
            uses node-tag-tlv;
        }
    }
    container dynamic-hostname-tlv {
        description "OSPF Dynamic Hostname";
        uses dynamic-hostname-tlv;
    }
    container sbfd-discriminator-tlv {
        description "OSPF S-BFD Discriminators";
        uses sbfd-discriminator-tlv;
    }
    description "Router Information LSA.";
    reference "RFC 7770: Extensions for Advertising Router
        Capabilities";
}
}
```

```
grouping lsa-header {
  description
    "Common LSA for OSPFv2 and OSPFv3";
  leaf age {
    type uint16;
    mandatory true;
    description "LSA age.";
  }
  leaf type {
    type identityref {
      base ospf-lsa-type;
    }
    mandatory true;
    description "LSA type";
  }
  leaf adv-router {
    type rt-types:router-id;
    mandatory true;
    description "LSA advertising router.";
  }
  leaf seq-num {
    type uint32;
    mandatory true;
    description "LSA sequence number.";
  }
  leaf checksum {
    type fletcher-checksum16-type;
    mandatory true;
    description "LSA checksum.";
  }
  leaf length {
    type uint16;
    mandatory true;
    description "LSA length including the header.";
  }
}

grouping ospfv2-lsa {
  description
    "OSPFv2 LSA - LSAs are uniquely identified by
    the <LSA Type, Link-State ID, Advertising Router>
    tuple with the sequence number differentiating
    LSA instances.";
  container header {
    must "(derived-from(type, "
      + "'ospfv2-opaque-lsa-type') and "
      + "opaque-id and opaque-type) or "
      + "(not(derived-from(type, "
```

```

        + "'ospfv2-opaque-lsa-type') "
        + "and not(opaque-id) and not(opaque-type))" {
    description
        "Opaque type and ID only apply to Opaque LSAs.";
    }
    description
        "Decoded OSPFv2 LSA header data.";

    container lsa-options {
        leaf-list lsa-options {
            type identityref {
                base ospfv2-lsa-option;
            }
            description
                "LSA option flags list. This list will contain
                 the identities for the identities for the OSPFv2
                 LSA options that are set.";
        }
        description
            "LSA options.";
    }

    leaf lsa-id {
        type yang:dotted-quad;
        mandatory true;
        description "Link-State ID.";
    }

    leaf opaque-type {
        type uint8;
        description "Opaque type.";
    }

    leaf opaque-id {
        type opaque-id;
        description "Opaque ID.";
    }

    uses lsa-header;
    }
    container body {
        description
            "Decoded OSPFv2 LSA body data.";
        uses ospfv2-lsa-body;
    }
    }

    grouping ospfv3-lsa {

```

```
description
    "Decoded OSPFv3 LSA.";
container header {
    description
        "Decoded OSPFv3 LSA header data.";
    leaf lsa-id {
        type uint32;
        mandatory true;
        description "OSPFv3 LSA ID.";
    }
    uses lsa-header;
}
container body {
    description
        "Decoded OSPF LSA body data.";
    uses ospfv3-lsa-body;
}
}
grouping lsa-common {
    description
        "Common fields for OSPF LSA representation.";
    leaf decode-completed {
        type boolean;
        description
            "The OSPF LSA body was successfully decoded other than
            unknown TLVs. Unknown LSAs types and OSPFv2 unknown
            opaque LSA types are not decoded. Additionally,
            malformed LSAs are generally not accepted and will
            not be in the Link State Database.";
    }
    leaf raw-data {
        type yang:hex-string;
        description
            "The complete LSA in network byte
            order hexadecimal as received or originated.";
    }
}
}

grouping lsa {
    description
        "OSPF LSA.";
    uses lsa-common;
    choice version {
        description
            "OSPFv2 or OSPFv3 LSA body.";
        container ospfv2 {
            description "OSPFv2 LSA";
            uses ospfv2-lsa;
        }
    }
}
```

```
    }
    container ospfv3 {
      description "OSPFv3 LSA";
      uses ospfv3-lsa;
    }
  }
}

grouping lsa-key {
  description
    "OSPF LSA key - the database key for each LSA of a given
    type in the Link State DataBase (LSDB).";
  leaf lsa-id {
    type union {
      type yang:dotted-quad;
      type uint32;
    }
    description
      "Link-State ID.";
  }
  leaf adv-router {
    type rt-types:router-id;
    description
      "Advertising router.";
  }
}

grouping instance-stat {
  description "Per-instance statistics";
  leaf discontinuity-time {
    type yang:date-and-time;
    description
      "The time on the most recent occasion at which any one or
      more of this OSPF instance's counters suffered a
      discontinuity. If no such discontinuities have occurred
      since the OSPF instance was last re-initialized, then
      this node contains the time the OSPF instance was
      re-initialized which normally occurs when it was
      created.";
  }
  leaf originate-new-lsa-count {
    type yang:counter32;
    description
      "The number of new LSAs originated. Discontinuities in the
      value of this counter can occur when the OSPF instance is
      re-initialized.";
  }
  leaf rx-new-lsas-count {
```

```
    type yang:counter32;
    description
      "The number of new LSAs received. Discontinuities in the
       value of this counter can occur when the OSPF instance is
       re-initialized.";
  }
  leaf as-scope-lsa-count {
    type yang:gauge32;
    description "The number of AS-scope LSAs.";
  }
  leaf as-scope-lsa-chksum-sum {
    type uint32;
    description
      "The module 2**32 sum of the LSA checksums
       for AS-scope LSAs. The value should be treated as
       unsigned when comparing two sums of checksums. While
       differing checksums indicate a different combination
       of LSAs, equivalent checksums don't guarantee that the
       LSAs are the same given that multiple combinations of
       LSAs can result in the same checksum.";
  }
}
container database {
  description "Container for per AS-scope LSA statistics.";
  list as-scope-lsa-type {
    description "List of AS-scope LSA statistics";
    leaf lsa-type {
      type uint16;
      description "AS-Scope LSA type.";
    }
    leaf lsa-count {
      type yang:gauge32;
      description "The number of LSAs of the LSA type.";
    }
  }
  leaf lsa-cksum-sum {
    type uint32;
    description
      "The module 2**32 sum of the LSA checksums
       for the LSAs of this type. The value should be
       treated as unsigned when comparing two sums of
       checksums. While differing checksums indicate a
       different combination of LSAs, equivalent checksums
       don't guarantee that the LSAs are the same given that
       multiple combinations of LSAs can result in the same
       checksum.";
  }
}
}
}
uses instance-fast-reroute-state;
```

```
}

grouping area-stat {
  description "Per-area statistics.";
  leaf discontinuity-time {
    type yang:date-and-time;
    description
      "The time on the most recent occasion at which any one or
       more of this OSPF area's counters suffered a
       discontinuity.  If no such discontinuities have occurred
       since the OSPF area was last re-initialized, then
       this node contains the time the OSPF area was
       re-initialized which normally occurs when it was
       created.";
  }
  leaf spf-runs-count {
    type yang:counter32;
    description
      "The number of times the intra-area SPF has run.
       Discontinuities in the value of this counter can occur
       when the OSPF area is re-initialized.";
  }
  leaf abr-count {
    type yang:gauge32;
    description
      "The total number of Area Border Routers (ABRs)
       reachable within this area.";
  }
  leaf asbr-count {
    type yang:gauge32;
    description
      "The total number of AS Boundary Routers (ASBRs).";
  }
  leaf ar-nssa-translator-event-count {
    type yang:counter32;
    description
      "The number of NSSA translator-state changes.
       Discontinuities in the value of this counter can occur
       when the OSPF area is re-initialized.";
  }
  leaf area-scope-lsa-count {
    type yang:gauge32;
    description
      "The number of area-scope LSAs in the area.";
  }
  leaf area-scope-lsa-cksum-sum {
    type uint32;
    description
```

```
    "The module 2**32 sum of the LSA checksums
    for area-scope LSAs. The value should be treated as
    unsigned when comparing two sums of checksums. While
    differing checksums indicate a different combination
    of LSAs, equivalent checksums don't guarantee that the
    LSAs are the same given that multiple combinations of
    LSAs can result in the same checksum.";
  }
  container database {
    description "Container for area-scope LSA type statistics.";
    list area-scope-lsa-type {
      description "List of area-scope LSA statistics";
      leaf lsa-type {
        type uint16;
        description "Area-scope LSA type.";
      }
      leaf lsa-count {
        type yang:gauge32;
        description "The number of LSAs of the LSA type.";
      }
      leaf lsa-cksum-sum {
        type uint32;
        description
          "The module 2**32 sum of the LSA checksums
          for the LSAs of this type. The value should be
          treated as unsigned when comparing two sums of
          checksums. While differing checksums indicate a
          different combination of LSAs, equivalent checksums
          don't guarantee that the LSAs are the same given that
          multiple combinations of LSAs can result in the same
          checksum.";
      }
    }
  }
}

grouping interface-stat {
  description "Per-interface statistics";
  leaf discontinuity-time {
    type yang:date-and-time;
    description
      "The time on the most recent occasion at which any one or
      more of this OSPF interface's counters suffered a
      discontinuity. If no such discontinuities have occurred
      since the OSPF interface was last re-initialized, then
      this node contains the time the OSPF interface was
      re-initialized which normally occurs when it was
      created.";
  }
}
```

```
    }
    leaf if-event-count {
      type yang:counter32;
      description
        "The number of times this interface has changed its
         state or an error has occurred. Discontinuities in the
         value of this counter can occur when the OSPF interface
         is re-initialized.";
    }
    leaf link-scope-lsa-count {
      type yang:gauge32;
      description "The number of link-scope LSAs.";
    }
    leaf link-scope-lsa-cksum-sum {
      type uint32;
      description
        "The module 2**32 sum of the LSA checksums
         for link-scope LSAs. The value should be treated as
         unsigned when comparing two sums of checksums. While
         differing checksums indicate a different combination
         of LSAs, equivalent checksums don't guarantee that the
         LSAs are the same given that multiple combinations of
         LSAs can result in the same checksum.";
    }
  }
  container database {
    description "Container for link-scope LSA type statistics.";
    list link-scope-lsa-type {
      description "List of link-scope LSA statistics";
      leaf lsa-type {
        type uint16;
        description "Link scope LSA type.";
      }
      leaf lsa-count {
        type yang:gauge32;
        description "The number of LSAs of the LSA type.";
      }
    }
    leaf lsa-cksum-sum {
      type uint32;
      description
        "The module 2**32 sum of the LSA checksums
         for the LSAs of this type. The value should be
         treated as unsigned when comparing two sums of
         checksums. While differing checksums indicate a
         different combination of LSAs, equivalent checksums
         don't guarantee that the LSAs are the same given that
         multiple combinations of LSAs can result in the same
         checksum.";
    }
  }
}
```

```
    }
  }
}

grouping neighbor-stat {
  description "Per-neighbor statistics.";
  leaf discontinuity-time {
    type yang:date-and-time;
    description
      "The time on the most recent occasion at which any one or
      more of this OSPF neighbor's counters suffered a
      discontinuity. If no such discontinuities have occurred
      since the OSPF neighbor was last re-initialized, then
      this node contains the time the OSPF neighbor was
      re-initialized which normally occurs when the neighbor
      is dynamically discovered and created.";
  }
  leaf nbr-event-count {
    type yang:counter32;
    description
      "The number of times this neighbor has changed
      state or an error has occurred. Discontinuities in the
      value of this counter can occur when the OSPF neighbor
      is re-initialized.";
  }
  leaf nbr-retrans-qlen {
    type yang:gauge32;
    description
      "The current length of the retransmission queue.";
  }
}

grouping instance-fast-reroute-config {
  description
    "This group defines global configuration of IP
    Fast ReRoute (FRR).";
  container fast-reroute {
    if-feature fast-reroute;
    description
      "This container may be augmented with global
      parameters for IP-FRR.";
    container lfa {
      if-feature lfa;
      description
        "This container may be augmented with
        global parameters for Loop-Free Alternatives (LFA).
        Container creation has no effect on LFA activation.";
    }
  }
}
```

```
    }
  }

  grouping instance-fast-reroute-state {
    description "IP-FRR state data grouping";

    container protected-routes {
      if-feature fast-reroute;
      config false;
      description "Instance protection statistics";

      list address-family-stats {
        key "address-family prefix alternate";
        description
          "Per Address Family protected prefix information";

        leaf address-family {
          type iana-rt-types:address-family;
          description
            "Address-family";
        }
        leaf prefix {
          type inet:ip-prefix;
          description
            "Protected prefix.";
        }
        leaf alternate {
          type inet:ip-address;
          description
            "Alternate next hop for the prefix.";
        }
        leaf alternate-type {
          type enumeration {
            enum equal-cost {
              description
                "ECMP alternate.";
            }
            enum lfa {
              description
                "LFA alternate.";
            }
            enum remote-lfa {
              description
                "Remote LFA alternate.";
            }
            enum tunnel {
              description
                "Tunnel based alternate

```

```
        (like RSVP-TE or GRE).";
    }
    enum ti-lfa {
        description
            "TI-LFA alternate.";
    }
    enum mrt {
        description
            "MRT alternate.";
    }
    enum other {
        description
            "Unknown alternate type.";
    }
}
description
    "Type of alternate.";
}
leaf best {
    type boolean;
    description
        "Indicates that this alternate is preferred.";
}
leaf non-best-reason {
    type string {
        length "1..255";
    }
    description
        "Information field to describe why the alternate
        is not best.";
}
leaf protection-available {
    type bits {
        bit node-protect {
            position 0;
            description
                "Node protection available.";
        }
        bit link-protect {
            position 1;
            description
                "Link protection available.";
        }
        bit srlg-protect {
            position 2;
            description
                "SRLG protection available.";
        }
    }
}
```

```
        bit downstream-protect {
            position 3;
            description
                "Downstream protection available.";
        }
        bit other {
            position 4;
            description
                "Other protection available.";
        }
    }
    description "Protection provided by the alternate.";
}
leaf alternate-metric1 {
    type uint32;
    description
        "Metric from Point of Local Repair (PLR) to
        destination through the alternate path.";
}
leaf alternate-metric2 {
    type uint32;
    description
        "Metric from PLR to the alternate node";
}
leaf alternate-metric3 {
    type uint32;
    description
        "Metric from alternate node to the destination";
}
}
}

container unprotected-routes {
    if-feature fast-reroute;
    config false;
    description "List of prefixes that are not protected";

    list address-family-stats {
        key "address-family prefix";
        description
            "Per Address Family (AF) unprotected prefix statistics.";

        leaf address-family {
            type iana-rt-types:address-family;
            description "Address-family";
        }
        leaf prefix {
            type inet:ip-prefix;
        }
    }
}
```

```
        description "Unprotected prefix.";
    }
}

list protection-statistics {
    key frr-protection-method;
    config false;
    description "List protection method statistics";

    leaf frr-protection-method {
        type string;
        description "Protection method used.";
    }
    list address-family-stats {
        key address-family;
        description "Per Address Family protection statistics.";

        leaf address-family {
            type iana-rt-types:address-family;
            description "Address-family";
        }
        leaf total-routes {
            type uint32;
            description "Total prefixes.";
        }
        leaf unprotected-routes {
            type uint32;
            description
                "Total prefixes that are not protected.";
        }
        leaf protected-routes {
            type uint32;
            description
                "Total prefixes that are protected.";
        }
        leaf linkprotected-routes {
            type uint32;
            description
                "Total prefixes that are link protected.";
        }
        leaf nodeprotected-routes {
            type uint32;
            description
                "Total prefixes that are node protected.";
        }
    }
}
}
```

```
    }

    grouping interface-fast-reroute-config {
      description
        "This group defines interface configuration of IP-FRR.";
      container fast-reroute {
        if-feature fast-reroute;
        container lfa {
          if-feature lfa;
          leaf candidate-enable {
            type boolean;
            default true;
            description
              "Enable the interface to be used as backup.";
          }
          leaf enable {
            type boolean;
            default false;
            description
              "Activates LFA - Per-prefix LFA computation
              is assumed.";
          }
          container remote-lfa {
            if-feature remote-lfa;
            leaf enable {
              type boolean;
              default false;
              description
                "Activates Remote LFA (R-LFA).";
            }
          }
          description
            "Remote LFA configuration.";
        }
        description
          "LFA configuration.";
      }
      description
        "Interface IP Fast-reroute configuration.";
    }
  }

  grouping interface-physical-link-config {
    description
      "Interface cost configuration that only applies to
      physical interfaces (non-virtual) and sham links.";
    leaf cost {
      type ospf-link-metric;
      description

```

```
        "Interface cost.";
    }
    leaf mtu-ignore {
        if-feature mtu-ignore;
        type boolean;
        description
            "Enable/Disable bypassing the MTU mismatch check in
            Database Description packets specified in RFC 2328,
            section 10.6.";
    }
    leaf prefix-suppression {
        if-feature prefix-suppression;
        type boolean;
        description
            "Suppress advertisement of the prefixes associated
            with the interface.";
    }
}

grouping interface-common-config {
    description
        "Common configuration for all types of interfaces,
        including virtual links and sham links.";

    leaf hello-interval {
        type uint16;
        units seconds;
        description
            "Interval between hello packets (seconds). It must
            be the same for all routers on the same network.
            Different networks, implementations, and deployments
            will use different hello-intervals. A sample value
            for a LAN network would be 10 seconds.";
        reference "RFC 2328: OSPF Version 2, Appendix C.3";
    }

    leaf dead-interval {
        type uint16;
        units seconds;
        must "../dead-interval > ../hello-interval" {
            error-message "The dead interval must be "
                + "larger than the hello interval";
        }
        description
            "The value must be greater than the 'hello-interval'.";
    }
    description
        "Interval after which a neighbor is declared down
        (seconds) if hello packets are not received. It is
```

```
        typically 3 or 4 times the hello-interval. A typical
        value for LAN networks is 40 seconds.";
        reference "RFC 2328: OSPF Version 2, Appendix C.3";
    }

    leaf retransmit-interval {
        type uint16 {
            range "1..3600";
        }
        units seconds;
        description
            "Interval between retransmitting unacknowledged Link
            State Advertisements (LSAs) (seconds). This should
            be well over the round-trip transmit delay for
            any two routers on the network. A sample value
            would be 5 seconds.";
        reference "RFC 2328: OSPF Version 2, Appendix C.3";
    }

    leaf transmit-delay {
        type uint16;
        units seconds;
        description
            "Estimated time needed to transmit Link State Update
            (LSU) packets on the interface (seconds). LSAs have
            their age incremented by this amount when advertised
            on the interface. A sample value would be 1 second.";
        reference "RFC 2328: OSPF Version 2, Appendix C.3";
    }

    leaf lls {
        if-feature lls;
        type boolean;
        description
            "Enable/Disable link-local signaling (LLS) support.";
    }

    container ttl-security {
        if-feature ttl-security;
        description "Time to Live (TTL) security check.";
        leaf enable {
            type boolean;
            description
                "Enable/Disable TTL security check.";
        }
        leaf hops {
            type uint8 {
                range "1..254";
            }
        }
    }
}
```

```
    }
    default 1;
    description
      "Maximum number of hops that an OSPF packet may
       have traversed before reception.";
  }
}
leaf enable {
  type boolean;
  default true;
  description
    "Enable/disable OSPF protocol on the interface.";
}

container authentication {
  description "Authentication configuration.";
  choice auth-type-selection {
    description
      "Options for OSPFv2/OSPFv3 authentication
       configuration.";
    case ospfv2-auth {
      when "derived-from-or-self(..../..../..../rt:type, "
        + "'ospfv2')" {
        description "Applied to OSPFv2 only.";
      }
      leaf ospfv2-auth-trailer-rfc {
        if-feature ospfv2-authentication-trailer;
        type ospfv2-auth-trailer-rfc-version;
        description
          "Version of OSFPv2 authentication trailer support -
           RFC 5709 or RFC 7474";
      }
    }
    choice ospfv2-auth-specification {
      description
        "Key chain or explicit key parameter specification";
      case auth-key-chain {
        if-feature key-chain;
        leaf ospfv2-key-chain {
          type key-chain:key-chain-ref;
          description
            "key-chain name.";
        }
      }
    }
    case auth-key-explicit {
      leaf ospfv2-key-id {
        type uint32;
        description
          "Key Identifier";
      }
    }
  }
}
```

```
    }
    leaf ospfv2-key {
      type string;
      description
        "OSPFv2 authentication key. The
         length of the key may be dependent on the
         cryptographic algorithm.";
    }
    leaf ospfv2-crypto-algorithm {
      type identityref {
        base key-chain:crypto-algorithm;
      }
      description
        "Cryptographic algorithm associated with key.";
    }
  }
}
}
case ospfv3-auth-ipsec {
  when "derived-from-or-self(..../..../..../..../rt:type, "
    + "'ospfv3')" {
    description "Applied to OSPFv3 only.";
  }
  if-feature ospfv3-authentication-ipsec;
  leaf sa {
    type string;
    description
      "Security Association (SA) name.";
  }
}
case ospfv3-auth-trailer {
  when "derived-from-or-self(..../..../..../..../rt:type, "
    + "'ospfv3')" {
    description "Applied to OSPFv3 only.";
  }
  if-feature ospfv3-authentication-trailer;
  choice ospfv3-auth-specification {
    description
      "Key chain or explicit key parameter specification";
    case auth-key-chain {
      if-feature key-chain;
      leaf ospfv3-key-chain {
        type key-chain:key-chain-ref;
        description
          "key-chain name.";
      }
    }
    case auth-key-explicit {
```

```
    leaf ospfv3-sa-id {
      type uint16;
      description
        "Security Association (SA) Identifier";
    }
    leaf ospfv3-key {
      type string;
      description
        "OSPFv3 authentication key. The
        length of the key may be dependent on the
        cryptographic algorithm.";
    }
    leaf ospfv3-crypto-algorithm {
      type identityref {
        base key-chain:crypto-algorithm;
      }
      description
        "Cryptographic algorithm associated with key.";
    }
  }
}
}
}
}
}
```

```
grouping interface-config {
  description "Configuration for real interfaces.";

  leaf interface-type {
    type enumeration {
      enum "broadcast" {
        description
          "Specify OSPF broadcast multi-access network.";
      }
      enum "non-broadcast" {
        description
          "Specify OSPF Non-Broadcast Multi-Access
          (NBMA) network.";
      }
      enum "point-to-multipoint" {
        description
          "Specify OSPF point-to-multipoint network.";
      }
      enum "point-to-point" {
        description
          "Specify OSPF point-to-point network.";
      }
    }
  }
}
```

```
    enum "hybrid" {
      if-feature hybrid-interface;
      description
        "Specify OSPF hybrid broadcast/P2MP network.";
    }
  }
  description
    "Interface type.";
}

leaf passive {
  type boolean;
  description
    "Enable/Disable passive interface - a passive interface's
    prefix will be advertised but no neighbor adjacencies
    will be formed on the interface.";
}

leaf demand-circuit {
  if-feature demand-circuit;
  type boolean;
  description
    "Enable/Disable demand circuit.";
}

leaf priority {
  type uint8;
  description
    "Configure OSPF router priority. On multi-access network
    this value is for Designated Router (DR) election. The
    priority is ignored on other interface types. A router
    with a higher priority will be preferred in the election
    and a value of 0 indicates the router is not eligible to
    become Designated Router or Backup Designated Router
    (BDR).";
}

container multi-areas {
  if-feature multi-area-adj;
  description "Container for multi-area config.";
  list multi-area {
    key multi-area-id;
    description
      "Configure OSPF multi-area adjacency.";
    leaf multi-area-id {
      type area-id-type;
      description
        "Multi-area adjacency area ID.";
    }
  }
}
```

```
    }
    leaf cost {
      type ospf-link-metric;
      description
        "Interface cost for multi-area adjacency.";
    }
  }
}

container static-neighbors {
  description "Statically configured neighbors.";

  list neighbor {
    key "identifier";
    description
      "Specify a static OSPF neighbor.";

    leaf identifier {
      type inet:ip-address;
      description
        "Neighbor Router ID, IPv4 address, or IPv6 address.";
    }

    leaf cost {
      type ospf-link-metric;
      description
        "Neighbor cost. Different implementations have different
        default costs with some defaulting to a cost inversely
        proportional to the interface speed. Others will
        default to 1 equating the cost to a hop count." ;
    }

    leaf poll-interval {
      type uint16;
      units seconds;
      description
        "Neighbor poll interval (seconds) for sending OSPF
        hello packets to discover the neighbor on NBMA
        networks. This interval dictates the granularity for
        discovery of new neighbors. A sample would be
        120 seconds (2 minutes) for a legacy Packet Data
        Network (PDN) X.25 network.";
      reference "RFC 2328: OSPF Version 2, Appendix C.5";
    }

    leaf priority {
      type uint8;
      description
        "Neighbor priority for DR election. A router with a
        higher priority will be preferred in the election

```

```
        and a value of 0 indicates the router is not
        eligible to become Designated Router or Backup
        Designated Router (BDR).";
    }
}

leaf node-flag {
    if-feature node-flag;
    type boolean;
    default false;
    description
        "Set prefix as identifying the advertising router.";
    reference "RFC 7684: OSPFv2 Prefix/Link Attribute
        Advertisement";
}

container bfd {
    if-feature bfd;
    description "BFD Client Configuration.";
    uses bfd-types:client-cfg-parms;
    reference "RFC YYYY: YANG Data Model for Bidirectional
        Forwarding Detection (BFD). Please replace YYYY with
        published RFC number for draft-ietf-bfd-yang.";
}

uses interface-fast-reroute-config;
uses interface-common-config;
uses interface-physical-link-config;
}

grouping neighbor-state {
    description
        "OSPF neighbor operational state.";

    leaf address {
        type inet:ip-address;
        config false;
        description
            "Neighbor address.";
    }

    leaf dr-router-id {
        type rt-types:router-id;
        config false;
        description "Neighbor's Designated Router (DR) Router ID.";
    }

    leaf dr-ip-addr {
```

```
    type inet:ip-address;
    config false;
    description "Neighbor's Designated Router (DR) IP address.";
  }

  leaf bdr-router-id {
    type rt-types:router-id;
    config false;
    description
      "Neighbor's Backup Designated Router (BDR) Router ID.";
  }

  leaf bdr-ip-addr {
    type inet:ip-address;
    config false;
    description
      "Neighbor's Backup Designated Router (BDR) IP Address.";
  }

  leaf state {
    type nbr-state-type;
    config false;
    description
      "OSPF neighbor state.";
  }

  leaf cost {
    type ospf-link-metric;
    config false;
    description "Cost to reach neighbor for Point-to-Multipoint
      and Hybrid networks";
  }

  leaf dead-timer {
    type rt-types:timer-value-seconds16;
    config false;
    description "This timer tracks the remaining time before
      the neighbor is declared dead.";
  }

  container statistics {
    config false;
    description "Per-neighbor statistics";
    uses neighbor-stat;
  }
}

grouping interface-common-state {
  description
    "OSPF interface common operational state.";
  reference "RFC2328 Section 9: OSPF Version2 -
    The Interface Data Structure";
}
```

```
leaf state {
  type if-state-type;
  config false;
  description "Interface state.";
}

leaf hello-timer {
  type rt-types:timer-value-seconds16;
  config false;
  description "This timer tracks the remaining time before
the next hello packet is sent on the
interface.";
}

leaf wait-timer {
  type rt-types:timer-value-seconds16;
  config false;
  description "This timer tracks the remaining time before
the interface exits the Waiting state.";
}

leaf dr-router-id {
  type rt-types:router-id;
  config false;
  description "Designated Router (DR) Router ID.";
}

leaf dr-ip-addr {
  type inet:ip-address;
  config false;
  description "Designated Router (DR) IP address.";
}

leaf bdr-router-id {
  type rt-types:router-id;
  config false;
  description "Backup Designated Router (BDR) Router ID.";
}

leaf bdr-ip-addr {
  type inet:ip-address;
  config false;
  description "Backup Designated Router (BDR) IP Address.";
}

container statistics {
  config false;
  description "Per-interface statistics";
}
```

```
    uses interface-stat;
  }

  container neighbors {
    config false;
    description "All neighbors for the interface.";
    list neighbor {
      key "neighbor-router-id";
      description
        "List of interface OSPF neighbors.";
      leaf neighbor-router-id {
        type rt-types:router-id;
        description
          "Neighbor Router ID.";
      }
      uses neighbor-state;
    }
  }

  container database {
    config false;
    description "Link-scope Link State Database.";
    list link-scope-lsa-type {
      key "lsa-type";
      description
        "List OSPF link-scope LSAs.";
      leaf lsa-type {
        type uint16;
        description "OSPF link-scope LSA type.";
      }
      container link-scope-lsas {
        description
          "All link-scope LSAs of this LSA type.";
        list link-scope-lsa {
          key "lsa-id adv-router";
          description "List of OSPF link-scope LSAs";
          uses lsa-key;
          uses lsa {
            refine "version/ospfv2/ospfv2" {
              must "derived-from-or-self( "
                + "../../../../../../../../../../../../../../../"
                + "rt:type, 'ospfv2')" {
                description "OSPFv2 LSA.";
              }
            }
            refine "version/ospfv3/ospfv3" {
              must "derived-from-or-self( "
                + "../../../../../../../../../../../../../../../"
                + "rt:type, 'ospfv3')" {
            }
          }
        }
      }
    }
  }
}
```

```
        description "OSPFv3 LSA.";
    }
}
}
}
}
}
}
}

grouping interface-state {
    description
        "OSPF interface operational state.";
    reference "RFC2328 Section 9: OSPF Version2 -
        The Interface Data Structure";

    uses interface-common-state;
}

grouping virtual-link-config {
    description
        "OSPF virtual link configuration state.";

    uses interface-common-config;
}

grouping virtual-link-state {
    description
        "OSPF virtual link operational state.";

    leaf cost {
        type ospf-link-metric;
        config false;
        description
            "Virtual link interface cost.";
    }
    uses interface-common-state;
}

grouping sham-link-config {
    description
        "OSPF sham link configuration state.";

    uses interface-common-config;
    uses interface-physical-link-config;
}

grouping sham-link-state {
```

```
description
  "OSPF sham link operational state.";
uses interface-common-state;
}

grouping address-family-area-config {
  description
    "OSPF address-family specific area config state.";

  container ranges {
    description "Container for summary ranges";

    list range {
      key "prefix";
      description
        "Summarize routes matching address/mask -
        Applicable to Area Border Routers (ABRs) only.";
      leaf prefix {
        type inet:ip-prefix;
        description
          "IPv4 or IPv6 prefix";
      }
      leaf advertise {
        type boolean;
        description
          "Advertise or hide.";
      }
      leaf cost {
        type ospf-metric;
        description
          "Advertised cost of summary route.";
      }
    }
  }
}

grouping area-common-config {
  description
    "OSPF area common configuration state.";

  leaf summary {
    when "derived-from(..../area-type,'stub-nssa-area')" {
      description
        "Summary advertisement into the stub/NSSA area.";
    }
    type boolean;
    description
      "Enable/Disable summary advertisement into the stub or
```

```
        NSSA area.";
    }
    leaf default-cost {
        when "derived-from(..../area-type,'stub-nssa-area')" {
            description
                "Cost for LSA default route advertised into the
                stub or NSSA area.";
        }
        type ospf-metric;
        description
            "Set the summary default route cost for a
            stub or NSSA area.";
    }
}

grouping area-config {
    description
        "OSPF area configuration state.";

    leaf area-type {
        type identityref {
            base area-type;
        }
        default normal-area;
        description
            "Area type.";
    }

    uses area-common-config;
    uses address-family-area-config;
}

grouping area-state {
    description
        "OSPF area operational state.";

    container statistics {
        config false;
        description "Per-area statistics";
        uses area-stat;
    }

    container database {
        config false;
        description "Area-scope Link State Database.";
        list area-scope-lsa-type {
            key "lsa-type";
            description "List OSPF area-scope LSAs.";
        }
    }
}
```



```
        description "Next hops for the route.";
        list next-hop {
            key "next-hop";
            description "List of next hops for the route";
            leaf outgoing-interface {
                type if:interface-ref;
                description
                    "Name of the outgoing interface.";
            }
            leaf next-hop {
                type inet:ip-address;
                description "Next hop address.";
            }
        }
    }
    leaf metric {
        type uint32;
        description "Metric for this route.";
    }
    leaf route-type {
        type route-type;
        description "Route type for this route.";
    }
    leaf route-tag {
        type uint32;
        description "Route tag for this route.";
    }
}
}
}

grouping ietf-spf-delay {
    leaf initial-delay {
        type uint32;
        units milliseconds;
        description
            "Delay used while in QUIET state (milliseconds).";
    }
    leaf short-delay {
        type uint32;
        units milliseconds;
        description
            "Delay used while in SHORT_WAIT state (milliseconds).";
    }
    leaf long-delay {
        type uint32;
        units milliseconds;
        description

```

```
        "Delay used while in LONG_WAIT state (milliseconds).";
    }
    leaf hold-down {
        type uint32;
        units milliseconds;
        description
            "Timer used to consider an IGP stability period
            (milliseconds).";
    }
    leaf time-to-learn {
        type uint32;
        units milliseconds;
        description
            "Duration used to learn all the IGP events
            related to a single component failure (milliseconds).";
    }
    leaf current-state {
        type enumeration {
            enum "quiet" {
                description "QUIET state";
            }
            enum "short-wait" {
                description "SHORT_WAIT state";
            }
            enum "long-wait" {
                description "LONG_WAIT state";
            }
        }
        config false;
        description
            "Current SPF back-off algorithm state.";
    }
    leaf remaining-time-to-learn {
        type rt-types:timer-value-milliseconds;
        config false;
        description
            "Remaining time until time-to-learn timer fires.";
    }
    leaf remaining-hold-down {
        type rt-types:timer-value-milliseconds;
        config false;
        description
            "Remaining time until hold-down timer fires.";
    }
    leaf last-event-received {
        type yang:timestamp;
        config false;
        description
```

```
        "Time of last SPF triggering event.";
    }
    leaf next-spf-time {
        type yang:timestamp;
        config false;
        description
            "Time when next SPF has been scheduled.";
    }
    leaf last-spf-time {
        type yang:timestamp;
        config false;
        description
            "Time of last SPF computation.";
    }
    description
        "Grouping for IETF SPF delay configuration and state";
}

grouping node-tag-config {
    description
        "OSPF node tag config state.";
    container node-tags {
        if-feature node-tag;
        list node-tag {
            key tag;
            leaf tag {
                type uint32;
                description
                    "Node tag value.";
            }
            description
                "List of tags.";
        }
        description
            "Container for node admin tags.";
    }
}

grouping instance-config {
    description
        "OSPF instance config state.";

    leaf enable {
        type boolean;
        default true;
        description
            "Enable/Disable the protocol.";
    }
}
```

```
leaf explicit-router-id {
  if-feature explicit-router-id;
  type rt-types:router-id;
  description
    "Defined in RFC 2328. A 32-bit number
     that uniquely identifies the router.";
}

container preference {
  description
    "Route preference configuration. In many
     implementations, preference is referred to as
     administrative distance.";
  reference
    "RFC 8349: A YANG Data Model for Routing Management
     (NMDA Version)";
  choice scope {
    description
      "Options for expressing preference
       as single or multiple values.";
    case single-value {
      leaf all {
        type uint8;
        description
          "Preference for intra-area, inter-area, and
           external routes.";
      }
    }
    case multi-values {
      choice granularity {
        description
          "Options for expressing preference
           for intra-area and inter-area routes.";
        case detail {
          leaf intra-area {
            type uint8;
            description
              "Preference for intra-area routes.";
          }
          leaf inter-area {
            type uint8;
            description
              "Preference for inter-area routes.";
          }
        }
        case coarse {
          leaf internal {
            type uint8;
          }
        }
      }
    }
  }
}
```

```
        description
            "Preference for both intra-area and
            inter-area routes.";
    }
}
leaf external {
    type uint8;
    description
        "Preference for AS external routes.";
}
}
}

container nsr {
    if-feature nsr;
    description
        "Non-Stop Routing (NSR) config state.";
    leaf enable {
        type boolean;
        description
            "Enable/Disable NSR.";
    }
}

container graceful-restart {
    if-feature graceful-restart;
    description
        "Graceful restart config state.";
    reference "RFC 3623: OSPF Graceful Restart
        RFC 5187: OSPFv3 Graceful Restart";
    leaf enable {
        type boolean;
        description
            "Enable/Disable graceful restart as defined in RFC 3623
            for OSPFv2 and RFC 5187 for OSPFv3.";
    }
    leaf helper-enable {
        type boolean;
        description
            "Enable graceful restart helper support for restarting
            routers (RFC 3623 Section 3).";
    }
    leaf restart-interval {
        type uint16 {
            range "1..1800";
        }
    }
}
```

```
    units seconds;
    default "120";
    description
        "Interval to attempt graceful restart prior
         to failing (RFC 3623 Section B.1) (seconds)";
}
leaf helper-strict-lsa-checking {
    type boolean;
    description
        "Terminate graceful restart when an LSA topology change
         is detected (RFC 3623 Section B.2).";
}
}

container auto-cost {
    if-feature auto-cost;
    description
        "Interface Auto-cost configuration state.";
    leaf enable {
        type boolean;
        description
            "Enable/Disable interface auto-cost.";
    }
    leaf reference-bandwidth {
        when "../enable = 'true'" {
            description "Only when auto cost is enabled";
        }
        type uint32 {
            range "1..4294967";
        }
        units Mbits;
        description
            "Configure reference bandwidth used to automatically
             determine interface cost (Mbits). The cost is the
             reference bandwidth divided by the interface speed
             with 1 being the minimum cost.";
    }
}

container spf-control {
    leaf paths {
        if-feature max-ecmp;
        type uint16 {
            range "1..65535";
        }
        description
            "Maximum number of Equal-Cost Multi-Path (ECMP) paths.";
    }
}
```

```
    container ietf-spf-delay {
      if-feature ietf-spf-delay;
      uses ietf-spf-delay;
      description
        "IETF SPF delay algorithm configuration.";
    }
  description "SPF calculation control.";
}

container database-control {
  leaf max-lsa {
    if-feature max-lsa;
    type uint32 {
      range "1..4294967294";
    }
    description
      "Maximum number of LSAs OSPF the router will accept.";
  }
  description "Database maintenance control.";
}

container stub-router {
  if-feature stub-router;
  description "Set maximum metric configuration";

  choice trigger {
    description
      "Specific triggers which will enable stub
      router state.";
    container always {
      presence
        "Enables unconditional stub router support";
      description
        "Unconditional stub router state (advertise
        transit links with MaxLinkMetric";
      reference "RFC 6987: OSPF Stub Router
        Advertisement";
    }
  }
}

container mpls {
  description
    "OSPF MPLS config state.";
  container te-rid {
    if-feature te-rid;
    description
      "Stable OSPF Router IP Address used for Traffic
```

```
        Engineering (TE)";
    leaf ipv4-router-id {
        type inet:ipv4-address;
        description
            "Explicitly configure the TE IPv4 Router ID.";
    }
    leaf ipv6-router-id {
        type inet:ipv6-address;
        description
            "Explicitly configure the TE IPv6 Router ID.";
    }
}
container ldp {
    description
        "OSPF MPLS LDP config state.";
    leaf igp-sync {
        if-feature ldp-igp-sync;
        type boolean;
        description
            "Enable LDP IGP synchronization.";
    }
}
}
uses instance-fast-reroute-config;
uses node-tag-config;
}

grouping instance-state {
    description
        "OSPF instance operational state.";

    leaf router-id {
        type rt-types:router-id;
        config false;
        description
            "Defined in RFC 2328. A 32-bit number
            that uniquely identifies the router.";
    }

    uses local-rib;

    container statistics {
        config false;
        description "Per-instance statistics";
        uses instance-stat;
    }

    container database {
```

```

config false;
description "AS-scope Link State Database.";
list as-scope-lsa-type {
  key "lsa-type";
  description "List OSPF AS-scope LSAs.";
  leaf lsa-type {
    type uint16;
    description "OSPF AS scope LSA type.";
  }
  container as-scope-lsas {
    description "All AS-scope of LSA of this LSA type.";
    list as-scope-lsa {
      key "lsa-id adv-router";
      description "List of OSPF AS-scope LSAs";
      uses lsa-key;
      uses lsa {
        refine "version/ospfv2/ospfv2" {
          must "derived-from-or-self( "
            + ".../.../.../.../.../..."
            + "rt:type, 'ospfv2')" {
            description "OSPFv2 LSA.";
          }
        }
        refine "version/ospfv3/ospfv3" {
          must "derived-from-or-self( "
            + ".../.../.../.../.../..."
            + "rt:type, 'ospfv3')" {
            description "OSPFv3 LSA.";
          }
        }
      }
    }
  }
}
uses spf-log;
uses lsa-log;
}

grouping multi-topology-area-common-config {
  description
    "OSPF multi-topology area common configuration state.";
  leaf summary {
    when "derived-from(.../.../.../area-type, 'stub-nssa-area')" {
      description
        "Summary advertisement into the stub/NSSA area.";
    }
    type boolean;
  }
}

```

```
        description
            "Enable/Disable summary advertisement into the
            topology in the stub or NSSA area.";
    }
    leaf default-cost {
        when "derived-from ../../../../area-type, 'stub-nssa-area'" {
            description
                "Cost for LSA default route advertised into the
                topology into the stub or NSSA area.";
        }
        type ospf-metric;
        description
            "Set the summary default route cost for a
            stub or NSSA area.";
    }
}

grouping multi-topology-area-config {
    description
        "OSPF multi-topology area configuration state.";

    uses multi-topology-area-common-config;
    uses address-family-area-config;
}

grouping multi-topology-state {
    description
        "OSPF multi-topology operational state.";

    uses local-rib;
}

grouping multi-topology-interface-config {
    description
        "OSPF multi-topology configuration state.";

    leaf cost {
        type ospf-link-metric;
        description
            "Interface cost for this topology.";
    }
}

grouping ospfv3-interface-config {
    description
        "OSPFv3 interface specific configuration state.";

    leaf instance-id {
```

```
    type uint8 {
      range "0 .. 31";
    }
    description
      "OSPFv3 instance ID.";
  }
}

grouping ospfv3-interface-state {
  description
    "OSPFv3 interface specific operational state.";

  leaf interface-id {
    type uint16;
    config false;
    description
      "OSPFv3 interface ID.";
  }
}

grouping lsa-identifiers {
  description
    "The parameters that uniquely identify an LSA.";
  leaf area-id {
    type area-id-type;
    description
      "Area ID";
  }
  leaf type {
    type uint16;
    description
      "LSA type.";
  }
  leaf lsa-id {
    type union {
      type inet:ipv4-address;
      type yang:dotted-quad;
    }
    description "Link-State ID.";
  }
  leaf adv-router {
    type rt-types:router-id;
    description
      "LSA advertising router.";
  }
  leaf seq-num {
    type uint32;
    description

```

```
        "LSA sequence number.";
    }
}

grouping spf-log {
    description
        "Grouping for SPF log.";
    container spf-log {
        config false;
        description
            "This container lists the SPF log.";
        list event {
            key id;
            description
                "List of SPF log entries represented
                as a wrapping buffer in chronological
                order with the oldest entry returned
                first.";
            leaf id {
                type uint32;
                description
                    "Event identifier - Purely internal value.";
            }
            leaf spf-type {
                type enumeration {
                    enum full {
                        description
                            "SPF computation was a Full SPF.";
                    }
                    enum intra {
                        description
                            "SPF computation was only for intra-area routes.";
                    }
                    enum inter {
                        description
                            "SPF computation was only for inter-area
                            summary routes.";
                    }
                    enum external {
                        description
                            "SPF computation was only for AS external routes.";
                    }
                }
            }
            description
                "The SPF computation type for the SPF log entry.";
        }
        leaf schedule-timestamp {
            type yang:timestamp;
        }
    }
}
```

```
        description
            "This is the timestamp when the computation was
            scheduled.";
    }
    leaf start-timestamp {
        type yang:timestamp;
        description
            "This is the timestamp when the computation was
            started.";
    }
    leaf end-timestamp {
        type yang:timestamp;
        description
            "This the timestamp when the computation was
            completed.";
    }
    list trigger-lsa {
        description
            "The list of LSAs that triggered the computation.";
        uses lsa-identifiers;
    }
}
}
```

```
grouping lsa-log {
    description
        "Grouping for the LSA log.";
    container lsa-log {
        config false;
        description
            "This container lists the LSA log.
            Local LSA modifications are also included
            in the list.";
        list event {
            key id;
            description
                "List of LSA log entries represented
                as a wrapping buffer in chronological order
                with the oldest entries returned first.";
            leaf id {
                type uint32;
                description
                    "Event identifier - purely internal value.";
            }
            container lsa {
                description
                    "This container describes the logged LSA.";
            }
        }
    }
}
```

```
        uses lsa-identifiers;
    }
    leaf received-timestamp {
        type yang:timestamp;
        description
            "This is the timestamp when the LSA was received.
            In case of local LSA update, the timestamp refers
            to the LSA origination time.";
    }
    leaf reason {
        type identityref {
            base lsa-log-reason;
        }
        description
            "This reason for the LSA log entry.";
    }
}
}
}

augment "/rt:routing/rt:control-plane-protocols/"
+ "rt:control-plane-protocol" {
    when "derived-from(rt:type, 'ospf')" {
        description
            "This augmentation is only valid for a routing protocol
            instance of OSPF (type 'ospfv2' or 'ospfv3').";
    }
    description "OSPF protocol ietf-routing module
        control-plane-protocol augmentation.";

    container ospf {
        description
            "OSPF protocol Instance";

        leaf address-family {
            type iana-rt-types:address-family;
            description
                "Address-family of the instance.";
        }

        uses instance-config;
        uses instance-state;

        container areas {
            description "All areas.";
            list area {
                key "area-id";
                description

```

```

    "List of OSPF areas";
  leaf area-id {
    type area-id-type;
    description
      "Area ID";
  }

  uses area-config;
  uses area-state;

  container virtual-links {
    when "derived-from-or-self(..../area-type, 'normal-area') "
      + "and ..../area-id = '0.0.0.0'" {
      description
        "Virtual links must be in backbone area.";
    }
    description "All virtual links.";
    list virtual-link {
      key "transit-area-id router-id";
      description
        "OSPF virtual link";
      leaf transit-area-id {
        type leafref {
          path "..../..../..../area/area-id";
        }
        must "derived-from-or-self("
          + "..../..../..../area[area-id=current()]/area-type, "
          + "'normal-area') and "
          + "..../..../..../area[area-id=current()]/area-id != "
          + "'0.0.0.0'" {
          error-message "Virtual link transit area must "
            + "be non-zero.";
          description
            "Virtual-link transit area must be
              non-zero area.";
        }
        description
          "Virtual link transit area ID.";
      }
      leaf router-id {
        type rt-types:router-id;
        description
          "Virtual Link remote endpoint Router ID.";
      }
    }

    uses virtual-link-config;
    uses virtual-link-state;
  }

```

```

    }
  container sham-links {
    if-feature pe-ce-protocol;
    description "All sham links.";
    list sham-link {
      key "local-id remote-id";
      description
        "OSPF sham link";
      leaf local-id {
        type inet:ip-address;
        description
          "Address of the local sham Link endpoint.";
      }
      leaf remote-id {
        type inet:ip-address;
        description
          "Address of the remote sham Link endpoint.";
      }
      uses sham-link-config;
      uses sham-link-state;
    }
  }
  container interfaces {
    description "All interfaces.";
    list interface {
      key "name";
      description
        "List of OSPF interfaces.";
      leaf name {
        type if:interface-ref;
        description
          "Interface name reference.";
      }
      uses interface-config;
      uses interface-state;
    }
  }
}
}
}
}

augment "/rt:routing/rt:control-plane-protocols/"
+ "rt:control-plane-protocol/ospf" {
  when "derived-from(../rt:type, 'ospf')" {
    description
      "This augmentation is only valid for OSPF
      (type 'ospfv2' or 'ospfv3').";
  }
}

```

```

    }
    if-feature multi-topology;
    description
      "OSPF multi-topology instance configuration
      state augmentation.";
    container topologies {
      description "All topologies.";
      list topology {
        key "name";
        description
          "OSPF topology - The OSPF topology address-family
          must coincide with the routing-instance
          address-family.";
        leaf name {
          type leafref {
            path "../..../..../..../rt:ribs/rt:rib/rt:name";
          }
          description "RIB name corresponding to the OSPF
            topology.";
        }

        uses multi-topology-state;
      }
    }
  }
}

augment "/rt:routing/rt:control-plane-protocols/"
  + "rt:control-plane-protocol/ospf/"
  + "areas/area" {
  when "derived-from-or-self(..../..../rt:type, "
    + "'ospfv2')" {
    description
      "This augmentation is only valid for OSPFv2.";
  }
  if-feature multi-topology;
  description
    "OSPF multi-topology area configuration state
    augmentation.";
  container topologies {
    description "All topologies for the area.";
    list topology {
      key "name";
      description "OSPF area topology.";
      leaf name {
        type leafref {
          path "../..../..../..../..../..../"
            + "rt:ribs/rt:rib/rt:name";
        }
      }
    }
  }
}

```

```

        description
            "Single topology enabled for this area.";
    }

    uses multi-topology-area-config;
}

}

}

augment "/rt:routing/rt:control-plane-protocols/"
+ "rt:control-plane-protocol/ospf/"
+ "areas/area/interfaces/interface" {
when "derived-from-or-self(..../..../..../rt:type, "
+ "'ospfv2')" {
description
    "This augmentation is only valid for OSPFv2.";
}
if-feature multi-topology;
description
    "OSPF multi-topology interface configuration state
augmentation.";
container topologies {
description "All topologies for the interface.";
list topology {
key "name";
description "OSPF interface topology.";
leaf name {
type leafref {
path "..../..../..../..../..../..../..../..../"
+ "rt:ribs/rt:rib/rt:name";
}
description
    "Single topology enabled on this interface.";
}
}
uses multi-topology-interface-config;
}
}
}

augment "/rt:routing/rt:control-plane-protocols/"
+ "rt:control-plane-protocol/ospf/"
+ "areas/area/interfaces/interface" {
when "derived-from-or-self(..../..../..../rt:type, "
+ "'ospfv3')" {
description
    "This augmentation is only valid for OSPFv3.";
}
}
}

```

```
    description
      "OSPFv3 interface specific configuration state
      augmentation.";
    uses ospfv3-interface-config;
    uses ospfv3-interface-state;
  }

  grouping route-content {
    description
      "This grouping defines OSPF-specific route attributes.";
    leaf metric {
      type uint32;
      description "OSPF route metric.";
    }
    leaf tag {
      type uint32;
      default "0";
      description "OSPF route tag.";
    }
    leaf route-type {
      type route-type;
      description "OSPF route type";
    }
  }

  augment "/rt:routing/rt:ribs/rt:rib/rt:routes/rt:route" {
    when "derived-from(rt:source-protocol, 'ospf')" {
      description
        "This augmentation is only valid for routes whose
        source protocol is OSPF.";
    }
    description
      "OSPF-specific route attributes.";
    uses route-content;
  }

  /*
  * RPCs
  */

  rpc clear-neighbor {
    description
      "This RPC request clears a particular set of OSPF neighbors.
      If the operation fails for OSPF internal reason, then
      error-tag and error-app-tag should be set to a meaningful
      value.";
    input {
      leaf routing-protocol-name {
```

```
    type leafref {
      path "/rt:routing/rt:control-plane-protocols/"
        + "rt:control-plane-protocol/rt:name";
    }
    mandatory "true";
    description
      "OSPF protocol instance which information for neighbors
      are to be cleared.

      If the referenced OSPF instance doesn't exist, then
      this operation SHALL fail with error-tag 'data-missing'
      and error-app-tag
      'routing-protocol-instance-not-found'.";
  }

  leaf interface {
    type if:interface-ref;
    description
      "Name of the OSPF interface for which neighbors are to
      be cleared.

      If the referenced OSPF interface doesn't exist, then
      this operation SHALL fail with error-tag
      'data-missing' and error-app-tag
      'ospf-interface-not-found'.";
  }
}

rpc clear-database {
  description
    "This RPC request clears a particular OSPF Link State
    Database. If the operation fails for OSPF internal reason,
    then error-tag and error-app-tag should be set to a
    meaningful value.";
  input {
    leaf routing-protocol-name {
      type leafref {
        path "/rt:routing/rt:control-plane-protocols/"
          + "rt:control-plane-protocol/rt:name";
      }
      mandatory "true";
      description
        "OSPF protocol instance whose Link State Database is to
        be cleared.

        If the referenced OSPF instance doesn't exist, then
        this operation SHALL fail with error-tag 'data-missing'";
    }
  }
}
```

```
        and error-app-tag
          'routing-protocol-instance-not-found'.";
      }
    }
  }

/*
 * Notifications
 */

grouping notification-instance-hdr {
  description
    "This grouping describes common instance specific
    data for OSPF notifications.";

  leaf routing-protocol-name {
    type leafref {
      path "/rt:routing/rt:control-plane-protocols/"
        + "rt:control-plane-protocol/rt:name";
    }
    must "derived-from( "
      + "/rt:routing/rt:control-plane-protocols/"
      + "rt:control-plane-protocol[rt:name=current()]/"
      + "rt:type, 'ospf')";
    description
      "OSPF routing protocol instance name.";
  }

  leaf address-family {
    type leafref {
      path "/rt:routing/"
        + "rt:control-plane-protocols/rt:control-plane-protocol"
        + "[rt:name=current()]/../routing-protocol-name]/"
        + "ospf/address-family";
    }
    description
      "Address family of the OSPF instance.";
  }
}

grouping notification-interface {
  description
    "This grouping provides interface information
    for the OSPF interface specific notification.";

  choice if-link-type-selection {
    description
      "Options for link type.";
  }
}
```

```
    container interface {
      description "Normal interface.";
      leaf interface {
        type if:interface-ref;
        description "Interface.";
      }
    }
    container virtual-link {
      description "virtual-link.";
      leaf transit-area-id {
        type area-id-type;
        description "Area ID.";
      }
      leaf neighbor-router-id {
        type rt-types:router-id;
        description "Neighbor Router ID.";
      }
    }
    container sham-link {
      description "sham link.";
      leaf area-id {
        type area-id-type;
        description "Area ID.";
      }
      leaf local-ip-addr {
        type inet:ip-address;
        description "Sham link local address.";
      }
      leaf remote-ip-addr {
        type inet:ip-address;
        description "Sham link remote address.";
      }
    }
  }
}

grouping notification-neighbor {
  description
    "This grouping provides the neighbor information
    for neighbor specific notifications.";

  leaf neighbor-router-id {
    type rt-types:router-id;
    description "Neighbor Router ID.";
  }

  leaf neighbor-ip-addr {
    type inet:ip-address;
  }
}
```

```
        description "Neighbor address.";
    }
}

notification if-state-change {
    uses notification-instance-hdr;
    uses notification-interface;

    leaf state {
        type if-state-type;
        description "Interface state.";
    }
    description
        "This notification is sent when an interface
        state change is detected.";
}

notification if-config-error {
    uses notification-instance-hdr;
    uses notification-interface;

    leaf packet-source {
        type inet:ip-address;
        description "Source address.";
    }

    leaf packet-type {
        type packet-type;
        description "OSPF packet type.";
    }

    leaf error {
        type enumeration {
            enum "bad-version" {
                description "Bad version.";
            }
            enum "area-mismatch" {
                description "Area mismatch.";
            }
            enum "unknown-nbma-nbr" {
                description "Unknown NBMA neighbor.";
            }
            enum "unknown-virtual-nbr" {
                description "Unknown virtual link neighbor.";
            }
            enum "auth-type-mismatch" {
                description "Auth type mismatch.";
            }
        }
    }
}
```

```
    enum "auth-failure" {
      description "Auth failure.";
    }
    enum "net-mask-mismatch" {
      description "Network mask mismatch.";
    }
    enum "hello-interval-mismatch" {
      description "Hello interval mismatch.";
    }
    enum "dead-interval-mismatch" {
      description "Dead interval mismatch.";
    }
    enum "option-mismatch" {
      description "Option mismatch.";
    }
    enum "mtu-mismatch" {
      description "MTU mismatch.";
    }
    enum "duplicate-router-id" {
      description "Duplicate Router ID.";
    }
    enum "no-error" {
      description "No error.";
    }
  }
  description "Error code.";
}
description
  "This notification is sent when an interface
  config error is detected.";
}

notification nbr-state-change {
  uses notification-instance-hdr;
  uses notification-interface;
  uses notification-neighbor;

  leaf state {
    type nbr-state-type;
    description "Neighbor state.";
  }

  description
    "This notification is sent when a neighbor
    state change is detected.";
}

notification nbr-restart-helper-status-change {
```

```
uses notification-instance-hdr;
uses notification-interface;
uses notification-neighbor;

leaf status {
  type restart-helper-status-type;
  description "Restart helper status.";
}

leaf age {
  type rt-types:timer-value-seconds16;
  description
    "Remaining time in current OSPF graceful restart
     interval when the router is acting as a restart
     helper for the neighbor.";
}

leaf exit-reason {
  type restart-exit-reason-type;
  description
    "Restart helper exit reason.";
}
description
  "This notification is sent when a neighbor restart
   helper status change is detected.";
}

notification if-rx-bad-packet {
  uses notification-instance-hdr;
  uses notification-interface;

  leaf packet-source {
    type inet:ip-address;
    description "Source address.";
  }

  leaf packet-type {
    type packet-type;
    description "OSPF packet type.";
  }

  description
    "This notification is sent when an OSPF packet that
     cannot be parsed is received on an OSPF interface.";
}

notification lsdbs-approaching-overflow {
  uses notification-instance-hdr;
```

```
leaf ext-lsdb-limit {
  type uint32;
  description
    "The maximum number of non-default AS-external LSAs
    entries that can be stored in the Link State Database.";
}

description
  "This notification is sent when the number of LSAs
  in the router's Link State Database has exceeded
  ninety percent of the AS-external limit (ext-lsdb-limit).";
}

notification lsdb-overflow {
  uses notification-instance-hdr;

  leaf ext-lsdb-limit {
    type uint32;
    description
      "The maximum number of non-default AS-external LSAs
      entries that can be stored in the Link State Database.";
  }

  description
    "This notification is sent when the number of LSAs
    in the router's Link State Database has exceeded the
    AS-external limit (ext-lsdb-limit).";
}

notification nssa-translator-status-change {
  uses notification-instance-hdr;

  leaf area-id {
    type area-id-type;
    description "Area ID.";
  }

  leaf status {
    type nssa-translator-state-type;
    description
      "NSSA translator status.";
  }

  description
    "This notification is sent when there is a change
    in the router's role in translating OSPF NSSA LSAs
    to OSPF AS-External LSAs.";
}
```

```
notification restart-status-change {
  uses notification-instance-hdr;

  leaf status {
    type restart-status-type;
    description
      "Restart status.";
  }

  leaf restart-interval {
    type uint16 {
      range 1..1800;
    }
    units seconds;
    default "120";
    description
      "Restart interval.";
  }

  leaf exit-reason {
    type restart-exit-reason-type;
    description
      "Restart exit reason.";
  }

  description
    "This notification is sent when the graceful restart
     state for the router has changed.";
}
}
<CODE ENDS>
```

4. Security Considerations

The YANG modules specified in this document define 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 NETCONF Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a pre-configured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in `ietf-ospf.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. Writable data node represent configuration of each instance, area, virtual link, sham-link, and interface. These correspond to the following schema nodes:

```
/ospf
/ospf/areas/
/ospf/areas/area[area-id]
/ospf/virtual-links/
/ospf/virtual-links/virtual-link[transit-area-id router-id]
/ospf/areas/area[area-id]/interfaces
/ospf/areas/area[area-id]/interfaces/interface[name]
/ospf/area/area[area-id]/sham-links
/ospf/area/area[area-id]/sham-links/sham-link[local-id remote-id]
```

For OSPF, the ability to modify OSPF configuration will allow the entire OSPF domain to be compromised including peering with unauthorized routers to misroute traffic or mount a massive Denial-of-Service (DoS) attack. For example, adding OSPF on any unprotected interface could allow an OSPF adjacency to be formed with an unauthorized and malicious neighbor. Once an adjacency is formed, traffic could be hijacked. As a simpler example, a Denial-of-Service attack could be mounted by changing the cost of an OSPF interface to be asymmetric such that a hard routing loop ensues. In general, unauthorized modification of most OSPF features will pose their own set of security risks and the "Security Considerations" in the respective reference RFCs should be consulted.

Some of the readable data nodes in the `ietf-ospf.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. The exposure of the Link State Database (LSDB) will expose the detailed topology of the network. There is a separate Link State Database for each instance, area, virtual link, sham-link, and interface. These correspond to the following schema nodes:

```
/ospf/database
```

```
/ospf/areas/area[area-id]/database
```

```
/ospf/virtual-links/virtual-link[transit-area-id router-id]/database
```

```
/ospf/areas/area[area-id]/interfaces/interface[name]/database
```

```
/ospf/area/area[area-id]/sham-links/sham-link[local-id remote-id]/database
```

Exposure of the Link State Database includes information beyond the scope of the OSPF router and this may be undesirable since exposure may facilitate other attacks. Additionally, in the case of an area LSDB, the complete IP network topology and, if deployed, the traffic engineering topology of the OSPF area can be reconstructed. Network operators may consider their topologies to be sensitive confidential data.

For OSPF authentication, configuration is supported via the specification of key-chains [RFC8177] or the direct specification of key and authentication algorithm. Hence, authentication configuration using the "auth-table-trailer" case in the "authentication" container inherits the security considerations of [RFC8177]. This includes the considerations with respect to the local storage and handling of authentication keys.

Additionally, local specification of OSPF authentication keys and the associated authentication algorithm is supported for legacy implementations that do not support key-chains [RFC8177] It is RECOMMENDED that implementations migrate to key-chains due the seamless support of key and algorithm rollover, as well as, the hexadecimal key specification affording more key entropy, and encryption of keys using the Advanced Encryption Standard (AES) Key Wrap Padding Algorithm [RFC5649].

Some of the RPC operations in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control access to these operations. The OSPF YANG module supports the "clear-neighbor" and "clear-database" RPCs. If access to either of these is compromised, they can result in temporary network outages be employed to mount DoS attacks.

The actual authentication key data (whether locally specified or part of a key-chain) is sensitive and needs to be kept secret from unauthorized parties; compromise of the key data would allow an

attacker to forge OSPF traffic that would be accepted as authentic, potentially compromising the entirety OSPF domain.

5. IANA Considerations

This document registers a URI in the IETF XML registry [RFC3688]. Following the format in [RFC3688], the following registration is requested to be made:

```
URI: urn:ietf:params:xml:ns:yang:ietf-ospf
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
```

This document registers a YANG module in the YANG Module Names registry [RFC6020].

```
name: ietf-ospf
namespace: urn:ietf:params:xml:ns:yang:ietf-ospf
prefix: ospf
reference: RFC XXXX
```

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7. References

7.1. Normative References

- [I-D.ietf-bfd-yang]
Rahman, R., Zheng, L., Jethanandani, M., Networks, J., and G. Mirsky, "YANG Data Model for Bidirectional Forwarding Detection (BFD)", draft-ietf-bfd-yang-17 (work in progress), August 2018.
- [RFC1765] Moy, J., "OSPF Database Overflow", RFC 1765, DOI 10.17487/RFC1765, March 1995, <<https://www.rfc-editor.org/info/rfc1765>>.
- [RFC1793] Moy, J., "Extending OSPF to Support Demand Circuits", RFC 1793, DOI 10.17487/RFC1793, April 1995, <<https://www.rfc-editor.org/info/rfc1793>>.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC2328] Moy, J., "OSPF Version 2", STD 54, RFC 2328, DOI 10.17487/RFC2328, April 1998, <<https://www.rfc-editor.org/info/rfc2328>>.
- [RFC3101] Murphy, P., "The OSPF Not-So-Stubby Area (NSSA) Option", RFC 3101, DOI 10.17487/RFC3101, January 2003, <<https://www.rfc-editor.org/info/rfc3101>>.
- [RFC3623] Moy, J., Pillay-Esnault, P., and A. Lindem, "Graceful OSPF Restart", RFC 3623, DOI 10.17487/RFC3623, November 2003, <<https://www.rfc-editor.org/info/rfc3623>>.
- [RFC3630] Katz, D., Kompella, K., and D. Yeung, "Traffic Engineering (TE) Extensions to OSPF Version 2", RFC 3630, DOI 10.17487/RFC3630, September 2003, <<https://www.rfc-editor.org/info/rfc3630>>.
- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC4552] Gupta, M. and N. Melam, "Authentication/Confidentiality for OSPFv3", RFC 4552, DOI 10.17487/RFC4552, June 2006, <<https://www.rfc-editor.org/info/rfc4552>>.

- [RFC4576] Rosen, E., Psenak, P., and P. Pillay-Esnault, "Using a Link State Advertisement (LSA) Options Bit to Prevent Looping in BGP/MPLS IP Virtual Private Networks (VPNs)", RFC 4576, DOI 10.17487/RFC4576, June 2006, <<https://www.rfc-editor.org/info/rfc4576>>.
- [RFC4577] Rosen, E., Psenak, P., and P. Pillay-Esnault, "OSPF as the Provider/Customer Edge Protocol for BGP/MPLS IP Virtual Private Networks (VPNs)", RFC 4577, DOI 10.17487/RFC4577, June 2006, <<https://www.rfc-editor.org/info/rfc4577>>.
- [RFC4915] Psenak, P., Mirtorabi, S., Roy, A., Nguyen, L., and P. Pillay-Esnault, "Multi-Topology (MT) Routing in OSPF", RFC 4915, DOI 10.17487/RFC4915, June 2007, <<https://www.rfc-editor.org/info/rfc4915>>.
- [RFC4973] Srisuresh, P. and P. Joseph, "OSPF-xTE: Experimental Extension to OSPF for Traffic Engineering", RFC 4973, DOI 10.17487/RFC4973, July 2007, <<https://www.rfc-editor.org/info/rfc4973>>.
- [RFC5082] Gill, V., Heasley, J., Meyer, D., Savola, P., Ed., and C. Pignataro, "The Generalized TTL Security Mechanism (GTSM)", RFC 5082, DOI 10.17487/RFC5082, October 2007, <<https://www.rfc-editor.org/info/rfc5082>>.
- [RFC5185] Mirtorabi, S., Psenak, P., Lindem, A., Ed., and A. Oswal, "OSPF Multi-Area Adjacency", RFC 5185, DOI 10.17487/RFC5185, May 2008, <<https://www.rfc-editor.org/info/rfc5185>>.
- [RFC5187] Pillay-Esnault, P. and A. Lindem, "OSPFv3 Graceful Restart", RFC 5187, DOI 10.17487/RFC5187, June 2008, <<https://www.rfc-editor.org/info/rfc5187>>.
- [RFC5250] Berger, L., Bryskin, I., Zinin, A., and R. Coltun, "The OSPF Opaque LSA Option", RFC 5250, DOI 10.17487/RFC5250, July 2008, <<https://www.rfc-editor.org/info/rfc5250>>.
- [RFC5286] Atlas, A., Ed. and A. Zinin, Ed., "Basic Specification for IP Fast Reroute: Loop-Free Alternates", RFC 5286, DOI 10.17487/RFC5286, September 2008, <<https://www.rfc-editor.org/info/rfc5286>>.
- [RFC5309] 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, <<https://www.rfc-editor.org/info/rfc5309>>.

- [RFC5329] Ishiguro, K., Manral, V., Davey, A., and A. Lindem, Ed., "Traffic Engineering Extensions to OSPF Version 3", RFC 5329, DOI 10.17487/RFC5329, September 2008, <<https://www.rfc-editor.org/info/rfc5329>>.
- [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>>.
- [RFC5613] Zinin, A., Roy, A., Nguyen, L., Friedman, B., and D. Yeung, "OSPF Link-Local Signaling", RFC 5613, DOI 10.17487/RFC5613, August 2009, <<https://www.rfc-editor.org/info/rfc5613>>.
- [RFC5642] Venkata, S., Harwani, S., Pignataro, C., and D. McPherson, "Dynamic Hostname Exchange Mechanism for OSPF", RFC 5642, DOI 10.17487/RFC5642, August 2009, <<https://www.rfc-editor.org/info/rfc5642>>.
- [RFC5709] Bhatia, M., Manral, V., Fanto, M., White, R., Barnes, M., Li, T., and R. Atkinson, "OSPFv2 HMAC-SHA Cryptographic Authentication", RFC 5709, DOI 10.17487/RFC5709, October 2009, <<https://www.rfc-editor.org/info/rfc5709>>.
- [RFC5714] Shand, M. and S. Bryant, "IP Fast Reroute Framework", RFC 5714, DOI 10.17487/RFC5714, January 2010, <<https://www.rfc-editor.org/info/rfc5714>>.
- [RFC5838] Lindem, A., Ed., Mirtorabi, S., Roy, A., Barnes, M., and R. Aggarwal, "Support of Address Families in OSPFv3", RFC 5838, DOI 10.17487/RFC5838, April 2010, <<https://www.rfc-editor.org/info/rfc5838>>.
- [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>>.

- [RFC6565] Pillay-Esnault, P., Moyer, P., Doyle, J., Ertekin, E., and M. Lundberg, "OSPFv3 as a Provider Edge to Customer Edge (PE-CE) Routing Protocol", RFC 6565, DOI 10.17487/RFC6565, June 2012, <<https://www.rfc-editor.org/info/rfc6565>>.
- [RFC6845] Sheth, N., Wang, L., and J. Zhang, "OSPF Hybrid Broadcast and Point-to-Multipoint Interface Type", RFC 6845, DOI 10.17487/RFC6845, January 2013, <<https://www.rfc-editor.org/info/rfc6845>>.
- [RFC6860] Yang, Y., Retana, A., and A. Roy, "Hiding Transit-Only Networks in OSPF", RFC 6860, DOI 10.17487/RFC6860, January 2013, <<https://www.rfc-editor.org/info/rfc6860>>.
- [RFC6987] Retana, A., Nguyen, L., Zinin, A., White, R., and D. McPherson, "OSPF Stub Router Advertisement", RFC 6987, DOI 10.17487/RFC6987, September 2013, <<https://www.rfc-editor.org/info/rfc6987>>.
- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [RFC7166] Bhatia, M., Manral, V., and A. Lindem, "Supporting Authentication Trailer for OSPFv3", RFC 7166, DOI 10.17487/RFC7166, March 2014, <<https://www.rfc-editor.org/info/rfc7166>>.
- [RFC7474] Bhatia, M., Hartman, S., Zhang, D., and A. Lindem, Ed., "Security Extension for OSPFv2 When Using Manual Key Management", RFC 7474, DOI 10.17487/RFC7474, April 2015, <<https://www.rfc-editor.org/info/rfc7474>>.
- [RFC7490] Bryant, S., Filss, C., Previdi, S., Shand, M., and N. So, "Remote Loop-Free Alternate (LFA) Fast Reroute (FRR)", RFC 7490, DOI 10.17487/RFC7490, April 2015, <<https://www.rfc-editor.org/info/rfc7490>>.
- [RFC7684] Psenak, P., Gredler, H., Shakir, R., Henderickx, W., Tantsura, J., and A. Lindem, "OSPFv2 Prefix/Link Attribute Advertisement", RFC 7684, DOI 10.17487/RFC7684, November 2015, <<https://www.rfc-editor.org/info/rfc7684>>.
- [RFC7770] Lindem, A., Ed., Shen, N., Vasseur, JP., Aggarwal, R., and S. Shaffer, "Extensions to OSPF for Advertising Optional Router Capabilities", RFC 7770, DOI 10.17487/RFC7770, February 2016, <<https://www.rfc-editor.org/info/rfc7770>>.

- [RFC7777] Hegde, S., Shakir, R., Smirnov, A., Li, Z., and B. Decraene, "Advertising Node Administrative Tags in OSPF", RFC 7777, DOI 10.17487/RFC7777, March 2016, <<https://www.rfc-editor.org/info/rfc7777>>.
- [RFC7884] Pignataro, C., Bhatia, M., Aldrin, S., and T. Ranganath, "OSPF Extensions to Advertise Seamless Bidirectional Forwarding Detection (S-BFD) Target Discriminators", RFC 7884, DOI 10.17487/RFC7884, July 2016, <<https://www.rfc-editor.org/info/rfc7884>>.
- [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>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [RFC8177] Lindem, A., Ed., Qu, Y., Yeung, D., Chen, I., and J. Zhang, "YANG Data Model for Key Chains", RFC 8177, DOI 10.17487/RFC8177, June 2017, <<https://www.rfc-editor.org/info/rfc8177>>.
- [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>>.
- [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>>.
- [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>>.

- [RFC8343] Bjorklund, M., "A YANG Data Model for Interface Management", RFC 8343, DOI 10.17487/RFC8343, March 2018, <<https://www.rfc-editor.org/info/rfc8343>>.
- [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>>.
- [RFC8405] Decraene, B., Litkowski, S., Gredler, H., Lindem, A., Francois, P., and C. Bowers, "Shortest Path First (SPF) Back-Off Delay Algorithm for Link-State IGP", RFC 8405, DOI 10.17487/RFC8405, June 2018, <<https://www.rfc-editor.org/info/rfc8405>>.
- [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>>.
- [RFC8476] Tantsura, J., Chunduri, U., Aldrin, S., and P. Psenak, "Signaling Maximum SID Depth (MSD) Using OSPF", RFC 8476, DOI 10.17487/RFC8476, December 2018, <<https://www.rfc-editor.org/info/rfc8476>>.

7.2. Informative References

- [RFC0905] "ISO Transport Protocol specification ISO DP 8073", RFC 905, DOI 10.17487/RFC0905, April 1984, <<https://www.rfc-editor.org/info/rfc905>>.
- [RFC4750] Joyal, D., Ed., Galecki, P., Ed., Giacalone, S., Ed., Coltun, R., and F. Baker, "OSPF Version 2 Management Information Base", RFC 4750, DOI 10.17487/RFC4750, December 2006, <<https://www.rfc-editor.org/info/rfc4750>>.
- [RFC5443] Jork, M., Atlas, A., and L. Fang, "LDP IGP Synchronization", RFC 5443, DOI 10.17487/RFC5443, March 2009, <<https://www.rfc-editor.org/info/rfc5443>>.
- [RFC5643] Joyal, D., Ed. and V. Manral, Ed., "Management Information Base for OSPFv3", RFC 5643, DOI 10.17487/RFC5643, August 2009, <<https://www.rfc-editor.org/info/rfc5643>>.
- [RFC5649] Housley, R. and M. Dworkin, "Advanced Encryption Standard (AES) Key Wrap with Padding Algorithm", RFC 5649, DOI 10.17487/RFC5649, September 2009, <<https://www.rfc-editor.org/info/rfc5649>>.

- [RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", RFC 5880, DOI 10.17487/RFC5880, June 2010, <<https://www.rfc-editor.org/info/rfc5880>>.
- [RFC5881] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD) for IPv4 and IPv6 (Single Hop)", RFC 5881, DOI 10.17487/RFC5881, June 2010, <<https://www.rfc-editor.org/info/rfc5881>>.

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