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I2RS Information Model for OSPF protocol
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Abstract

As one of well-known link-state protocols, OSPF has been widely used in the routing of intra domain networks. During the past decades, it has been deployed with the help of typical interfaces such as CLI, SNMP and NETCONF. As modern networks grow in scale and complexity, the necessity for rapid and dynamic control has been increased. The I2RS is a standard-based interface which provides a programmatic way to achieve this goal.

This document specifies an information model for the OSPF protocol to facilitate the definition of a standardized data model, which can be used to define interfaces to the OSPF from an entity that may even be external to the routing system. Based on standardized data model and interfaces, use cases of IGP protocols defined by I2RS-WG can be supported.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on March 30, 2015.

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1. Introduction

As one of well-known link-state protocols, OSPF[RFC2328] has been widely used in the routing of intra domain networks. During the past decades, it has been deployed with the help of typical interfaces such as CLI, SNMP and NETCONF. As modern networks grow in scale and complexity, the necessity for rapid and dynamic control has been increased. The I2RS[I-D.ietf-i2rs-architecture] is a standard-based interface which provides a programmatic way to achieve this goal.

This document specifies an information model for the OSPF protocol to facilitate the definition of a standardized data model, which can be used to define interfaces to the OSPF from an entity that may even be external to the routing system. Based on standardized data model and interfaces, use cases of IGP protocols defined by [I-D.wu-i2rs-igp-usecases] can be supported.

In order to support large intra-domain, OSPF has been organized hierarchically into areas. The topology of one area is hidden from the rest of networks, which is beneficial from the reduction of routing traffic. Based on flooding mechanism, each routing-system in one OSPF area will maintain the identical database from which a pair-wise shortest tree is calculated in the distributed manner. As one client of RIB, OSPF SHOULD populate its routing information into RIB as stated in [I-D.ietf-i2rs-rib-info-model].

2. OSPF data

This section describes the data involved in the OSPF information model in detail. Please note OSPF in this document means both OSPFv2 and OSPFv3[RFC5340] protocol unless specified. OSPF data includes information related to OSPF instance, OSPF area, OSPF multi-topology, OSPF interfaces, OSPF adjacencies and OSPF routes. A high-level architecture of the OSPF contents is shown as below.

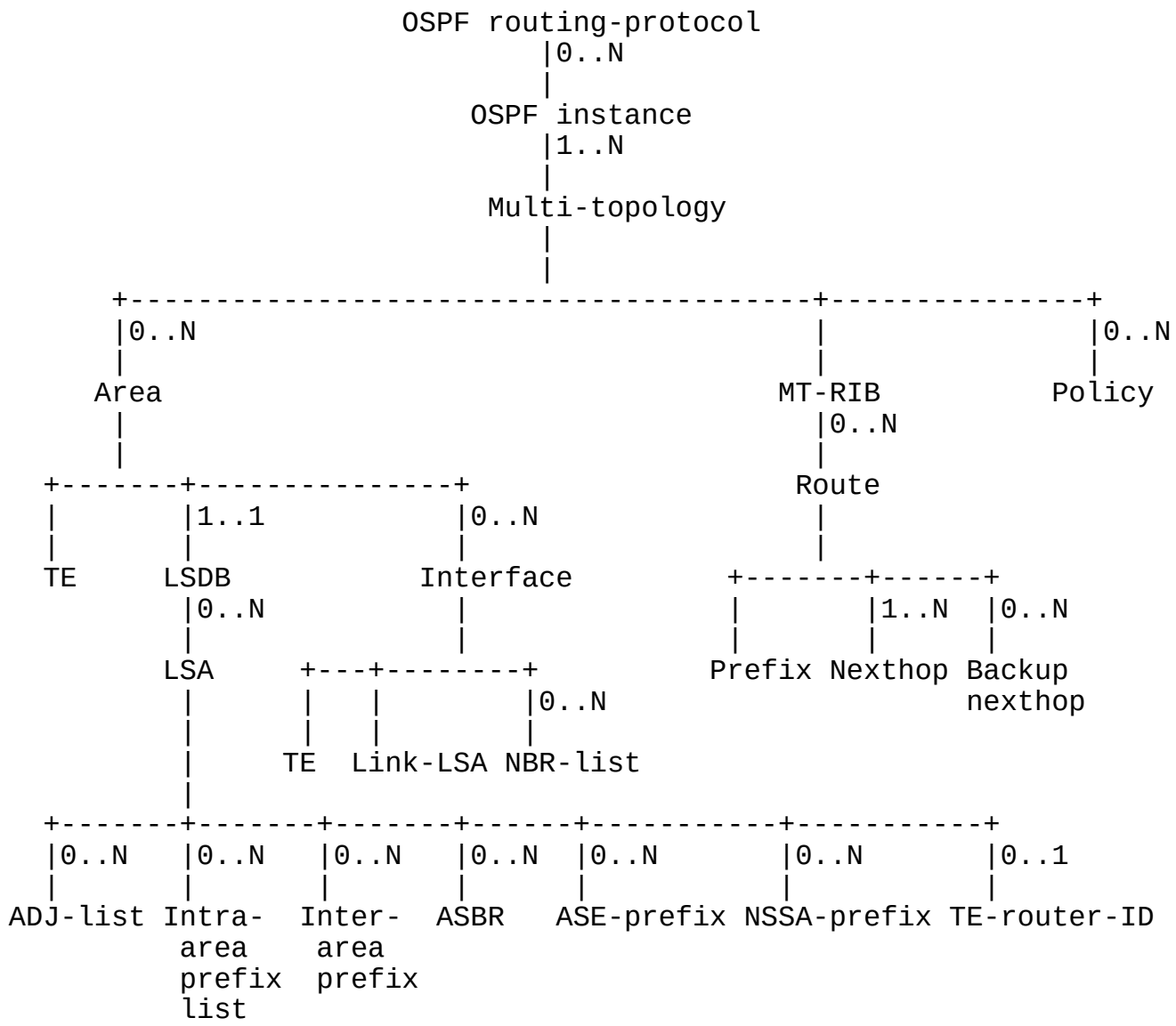

Figure 1: Architecture of OSPF information model

2.1. OSPF instance

In the context of OSPF information model, instance behaves like an independent virtual OSPF routing system which contains the instance parameters and the multi-topology list. Multiple instances MAY be supported on one network device.

```
module: ospf-protocol
   +--rw ospf-instance
   |  +--rw ospf-instance-name          string
   |  +--rw ospf-vpn-name?              string
   |  +--rw router-id                   inet:ip-address
   |  +--ro protocol-status             enumeration
   |  +--ro ospf-type                   enumeration
   |  +--rw version                     enumeration
   |  +--ro ospf-process-create-mode    enumeration
   |  +--rw preference                  uint32
   |  +--rw hostname?                   string
   |  +--rw mt-list
```

Figure 2 YANG model of OSPF instance

2.1.1. Instance parameters

- ospf-instance-name: A name uniquely identifying OSPF instance across all of those supported on one network device.
- ospf-vpn-name: The name of the VPN instance which this instance is binded to.
- router-id: The identification of this process. Every router-id MUST be unique among the OSPF network.
- protocol-status: The status of current process. Valid status could include Active, Suppressed, Shutdown, Stub, Reset or etc.
- ospf-type: This indicates whether this OSPF routing system is acting as an ABR or ASBR in this instance.
- version: The version number of OSPF protocol. Valid input SHOULD be V2 or V3.
- ospf-instance-create-mode: The mode used to create OSPF instance through I2RS Agent.
- preference: The OSPF route preference for current process.
- hostname: The symbolic name used to represent current process, which would be more preferable for human eyes.

2.1.2. Multi-topology-list

This represents the list of topologies associated with this OSPF instance. Each OSPF instance MAY support multiple topologies to represent different involvement within those topologies. The list is

mandatory for OSPF instance and MUST support one topology at least. More discussion for this list is in below section.

2.2. OSPF multi-topology

A set of independent Multi-Topologies (MTs) can be supported on the same OSPF routing domain. This section describes the information model related to MT.

- o mt-id: The identifier of this MT. This ID is globally unique across the routing domain.
- o address-family: The address family supported on this MT.
- o mt-status: The status of this MT. Valid input MAY be Active or Inactive.
- o policy-list: This list contains those policies referenced within this OSPF MT. It is optional for the MT to reference policy or not.
- o mt-rib: The routing information base for this MT.
- o area-list: This is the list of area involved in this OSPF MT. The information model of area-list will be elaborated in the section below.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
   |     +--rw multi-topo* [mt-id]
   |        +--rw mt-id             uint16
   |        +--rw address-family    address-family-def
   |        +--rw mt-status?        enumeration
   |        +--rw policy-list* [policy-id]
   |        |  +--rw policy-id    string
   |        +--rw mt-rib
   |               ...
   |        +--rw area-list
```

Figure 3 YANG model of OSPF MT

2.2.1. OSPF MT route

- o prefix: The destination address of this route.
- o nexthop-list: The nexthops of this route.

- backup nexthop: The backup nexthop for this route.
- metric: The metric for this routes.
- type: The type for this route. Valid input MAY be OSPF or OSPF_ASE.
- route-state-info: The current and previous state of this route, the reason for this change and the related LSA invovled for this route.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
    |    +--rw multi-topo* [mt-id]
              ...
    |       +--rw mt-rib
    |       |  +--rw route* [prefix]
    |       |     +--rw prefix              inet:ipv4-prefix
    |       |     +--rw nexthop-list
    |       |     |  +--rw nexthop* [ospf-nexthop]
    |       |     |     +--rw ospf-nexthop    inet:ipv4-prefix
    |       |     +--rw back-nexthop?       inet:ipv4-prefix
    |       |     +--rw metric?             uint32
    |       |     +--rw type?               ospf-route-type-def
    |       |     +--rw route-state-info
    |       |        +--rw metric?                 uint32
    |       |        +--rw route-current-state?    ospf-route-state-def
    |       |        +--rw route-previous-state?   ospf-route-state-def
    |       |        +--rw route-chg-reason?       route-chg-reason-def
    |       |        +--rw lsid?                   inet:ip-address
    |       |        +--rw lsa-type?               lsa-type-def
    |       |        +--rw advertiser?             inet:ip-address
```

Figure 4 YANG model of OSPF RIB and route

2.3. OSPF area

OSPF area is used to organize routing network in a hierarchical manner. OSPF process has to contain one area at least to work properly. The maximum number of area supported in one OSPF process is implementation dependent. Each area SHOULD contain information related to area parameters, link-state database and so on.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
   |           +--rw area* [area-id]
   |              +--rw area-id            uint16
   |              +--rw area-type?         area-type-def
   |              +--rw area-status?       area-status-def
   |              +--rw lsa-arrival-int?   uint32
   |              +--rw lsa-orig-int?      uint32
   |              +--rw router-number?     uint32
   |              +--rw area-auth
                        ...
   |              +--rw lsdb
                        ...
   |              +--rw interface-list
                        ...
   |              +--rw network-list* [network-prefix mask]
                        ...
   |              +--rw route-info-list* [route-info-index]
                        ...
```

Figure 5 YANG model of OSPF area

2.3.1. Area parameters

This section demonstrates those parameters in area scope.

- area-id: The identification of this level which SHOULD be level-1 or level-2.
- area-type: The type of current area. Valid choice SHOULD be Normal, STUB or NSSA.
- area-status: The status of current area. Valid input SHOULD be Active, Shutdown or Reset.
- lsa-arrival-int: The interval of arrival between two consecutive LSA.
- lsa-orig-int: The interval of origination between two consecutive LSA.
- router-number: The total number of routers working in current area.

- o area-auth: The information related to area authentication, including authentication mode, password and other attributes.

2.3.2. Link state database

Link State Database (LSDB) is composed of all link-state information advertised in the corresponding area. These pieces of link-state information are organized in the form of Link State Advertisement (LSA) which can be divided into two groups: self-originated LSA and remote-generated LSA. Some attributes of database can also be included in the information model.

- o lsdb-status: This represents the current status for database. It MAY be Normal or Overflow or something else.

- o lsdb-overflow-limit: The limit for overflow threshold of corresponding LSDB. When reaching or recovering from this threshold, one notification SHOULD be sent to I2RS Client.

- o lsdb-size: The size of database in the form of LSP number or bytes or percentage.

- o lsa-list: This list indicates those LSAs which are advertised in current area by either remote router or self-origination.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
                     ...
   |              +--rw lsdb
   |              |     +--rw lsdb-status?         enumeration
   |              |     +--rw lsdb-overflow-limit? uint32
   |              |     +--rw lsdb-size?           uint32
   |              |  +--rw lsa* [lsa-v2-type link-state-id advertiser-id]
                           ...
```

Figure 5 YANG model of OSPF LSDB

2.3.3. OSPFv2 Link State Advertisement

Link State Advertisement (LSA) is a data unit used to hold and organize link-state information in the area scope. OSPF routers in the same area depend on the exchange of LSAes to synchronize their database which is the basis for per-hop forwarding paradigm. This section demonstrates some important components of LSA for OSPFv2 protocol.

- lsa-age: The time in seconds since the LSA was originated.
- lsa-options: The optional capabilities supported by the described portion of the routing domain.
- lsa-v2-type: The type of LSA. There are 6 types of LSA for OSPFv2 in total.
- link-state-id: The identifier for this LSA which is decided by originating router.
- advertiser-id: The Router ID of the router that originated the LSA.
- seq-no: The sequence number of a LSA. It is used to differentiate between the old instance and the new one for the LSA from the same place.
- chksum: The Fletcher checksum of the complete contents of the LSA, including the LSA header but excluding the lsa-age field.
- lsa-length: The length in bytes of the LSA.
- router-lsa: Router-LSAs are the Type 1 LSAs. Each router in an area originates a router-LSA. The LSA describes the state and cost of the router’s links to the area.
- network-lsa: Network-LSAs are the Type 2 LSAs. A network-LSA is originated for each broadcast and NBMA network in the area which supports two or more routers. The network-LSA is originated by the network’s Designated Router.
- summary-lsa: Summary-LSAs are the Type 3 and 4 LSAs. These LSAs are originated by area border routers. Summary-LSAs describe inter-area destinations.
- as-external-lsa: AS-external-LSAs are the Type 5 LSAs. These LSAs are originated by AS boundary routers, and describe destinations external to the AS.
- nssa-lsa: NSSA-LSAs are the Type 7 LSAs. There LSAs are originated by NSSA AS boundary routers for imported external routes.
- te-router-lsa: This LSA is used to carry the Router Address TLV, which specifies a stable IP address of the advertising router that is always reachable if there is any connectivity to it.

o te-link-lsa: This LSA is used to carry the Link TLV which describes traffic engineering information related to a single link.

```
module: ospf-protocol
   +--rw ospf-v4ur-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
                     ...
   |              +--rw lsdb
   |              |  +--rw lsa* [lsa-v2-type link-state-id advertiser-id]
   |              |     +--rw lsa-age?            uint32
   |              |     +--rw lsa-options?        uint8
   |              |     +--rw lsa-v2-type         enumeration
   |              |     +--rw link-state-id       inet:ipv4-address
   |              |     +--rw advertiser-id       inet:ip-prefix
   |              |     +--rw seq-no?             uint32
   |              |     +--rw chksum?             uint32
   |              |     +--rw lsa-length?         uint32
   |              |     +--rw (ls-type)?
   |              |        +--:(router-lsa)
   |              |        |  +--rw ospf-v2-router-lsa
                                ...
   |              |        +--:(network-lsa)
   |              |        |  +--rw ospf-v2-network-lsa
                                ...
   |              |        +--:(summary-lsa)
   |              |        |  +--rw ospf-v2-summary-lsa
                                ...
   |              |        +--:(as-external-lsa)
   |              |        |  +--rw ospf-v2-as-external-lsa
                                ...
   |              |        +--:(nssa-external-lsa)
   |              |        |  +--rw ospf-v2-nssa-external-lsa
                                ...
   |              |        +--:(te-router-lsa)
   |              |        |  +--rw ospf-v2-te-router-lsa
                                ...
   |              |        +--:(te-link-lsa)
   |              |           +--rw ospf-v2-te-link-lsa
                                ...
```

Figure 6 YANG model of OSPFv2 LSA

2.3.4. OSPFv3 Link State Advertisement

This section demonstrates some important components of LSA for OSPFv3 protocol.

- lsa-age: The time in seconds since the LSA was originated.
- lsa-v3-type: The type of LSA. There are 8 types of LSA for OSPFv3 in total.
- lsa-state-id: The identifier for this LSA which is decided by originating router.
- advertiser-id: The Router ID of the router that originated the LSA.
- seq-no: The sequence number of a LSA. It is used to differentiate between the old instance and the new one for the LSA from the same place.
- chksum: The Fletcher checksum of the complete contents of the LSA, including the LSA header but excluding the lsa-age field.
- lsa-length: The length in bytes of the LSA.
- router-lsa: Router-LSAs have LS type equal to 0x2001. Each router in an area originates one or more router-LSAs.
- network-lsa: Network-LSAs have LS type equal to 0x2002. A network-LSA is originated for each broadcast and NBMA link in the area that includes two or more adjacent routers. The network-LSA is originated by the link’s Designated Router.
- inter-area-prefix-lsa: Inter-area-prefix-LSAs have LS type equal to 0x2003. These LSAs are the IPv6 equivalent of OSPF for IPv4’s type 3 summary-LSAs.
- inter-area-router-lsa: Inter-area-router-LSAs have LS type equal to 0x2004. These LSAs are the IPv6 equivalent of OSPF for IPv4’s type 4 summary-LSAs.
- as-external-lsa: AS-external-LSAs have LS type equal to 0x4005. These LSAs are originated by AS boundary routers and describe destinations external to the AS.
- nssa-lsa: NSSA-LSAs have LS type equal to 0x2007. These LSAs are originated by AS boundary routers within an NSSA and describe

destinations external to the AS that may or may not be propagated outside the NSSA.

- link-lsa: Link-LSAs have LS type equal to 0x0008. A router originates a separate link-LSA for each attached physical link.

- intra-area-prefix-lsa: Intra-area-prefix-LSAs have LS type equal to 0x2009. A router uses intra-area-prefix-LSAs to advertise one or more IPv6 address prefixes that are associated with a local router address, an attached stub network segment, or an attached transit network segment.

- te-link-lsa: This LSA is used to carry the Link TLV which describes traffic engineering information related to a single link.

```
module: ospf-protocol
   +--rw ospf-v6ur-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
                     ...
                  +--rw lsdb
                  |  +--rw lsa*
                  |       [lsa-v3-type link-state-id advertiser-id]
                  |     +--rw lsa-age?         uint32
                  |     +--rw lsa-v3-type      enumeration
                  |     +--rw link-state-id    uint32
                  |     +--rw advertiser-id    inet:ip-prefix
                  |     +--rw seq-no?          uint32
                  |     +--rw chksum?          uint32
                  |     +--rw lsa-length?      uint32
                  |     +--rw (ls-type)?
                  |        +--:(router-lsa)
                  |        |  +--rw ospf-v3-router-lsa
                  |                   ...
                  |        +--:(network-lsa)
                  |        |  +--rw ospf-v3-network-lsa
                  |                   ...
                  |        +--:(inter-area-prefix-lsa)
                  |        |  +--rw ospf-v3-inter-area-prefix-lsa
                  |                   ...
                  |        +--:(inter-area-router-lsa)
                  |        |  +--rw ospf-v3-inter-area-router-lsa
                  |                   ...
                  |        +--:(as-external-lsa)
                  |        |  +--rw ospf-v3-as-external-lsa
```

```
                        ...
                |       +--:(nssa-lsa)
                |       |  +--rw ospf-v3-nssa-lsa
                |       |        ...
                |       +--:(link-lsa)
                |       |  +--rw ospf-v3-link-lsa
                |       |        ...
                |       +--:(intra-area-prefix-lsa)
                |       |  +--rw ospf-v3-intra-area-prefix-lsa
                |       |        ...
                |       +--:(te-router-ipv6-address-lsa)
                |       |  +--rw ospf-v2-te-router-ipv6-address
                |       |        ...
                |       +--:(te-link-lsa)
                |          +--rw ospf-v3-te-link-lsa
                |                ...
```

Figure 7 YANG model of OSPFv3 LSA

2.3.5. Interface-list

This list contains interfaces enabled in this area. The information model of interface-list will be elaborated in the section below.

2.3.6. Network-list

This list contains different pairs of IP address and mask which are used to enable interfaces into this area. The enabled interfaces' IP address are covered by the scope define by address & mask pair. The most exact pair is used when different pairs overlay on their scopes.

2.3.7. Router-info database

This list contains the router information of every routers from this area. Router information includes the identification of the router, the Area-ID, the hostname if possible and some attributes such as ID of neighbors. Such a population database MAY be useful for future scenarioes.

2.4. OSPF interface

This section demonstrates the information model of OSPF interfaces.

2.4.1. Interface parameters

- interface-index: The index for this interface. It MUST be unique globally in the same routing system.

- interface-name: The name used to refer to this interface.
- interface-status: The state of this interface in current area. Valid state SHOULD be DOWN, P2P, WAITING, DR, BDR or DROther.
- interface-down-reason: The reason the state of this interface changed to down. Valid reason SHOULD be Physical-down, Admin-shutdown or IP-down.
- interface-net-type: The network type simulated on this interface. Valid choice SHOULD be P2P, Broadcast, NBMA, P2MP or even virtual-link.
- interface-role: The identification of DR, BDR or DROther role for this interface.
- interface-te-info: The traffic-engineer information related to this interface.
- interface-auth: The information related to interface authentication, including authentication mode, password and other attributes.
- ip-address: The IPv4 or IPv6 address of this interface.
- nbr-list: The neighbor list on this interface.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
                     ...
   |              +--rw interface-list
   |              |  +--rw interface* [interface-index]
   |              |     +--rw interface-index        uint64
   |              |     +--rw interface-name?        string
   |              |     +--rw interface-status?      interface-status-def
   |              |     +--rw interface-down-reason? interface-down-reason-d
ef
   |              |     +--rw interface-net-type?    interface-net-type-def
   |              |     +--rw interface-role?        interface-role-def
   |              |     +--rw interface-te-info
                           ...
   |              |     +--rw interface-auth
                           ...
   |              |     +--rw ip-address?            inet:ipv4-address
   |              |     +--rw nbr-list
                           ...
```

Figure 7 YANG model of OSPF interface

2.4.2. Interface neighbor

This section describes the neighbor information related to one interface.

- router-id: The Router-ID of one neighbor supported on this interface.
- interface-index: The index for the interface which this neighbor belongs to.
- interface-name: The name used to refer to this interface.
- nbr-status: The status for the adjacency with this neighbor. Valid input SHOULD be Down, Attempt, 2-way, ExStart, Exchange, Loading and Full.
- nbr-previous-status: The status for the adjacency with this neighbor before the latest change.
- nbr-down-reason: The reason this adjacency was brought. Valid choice SHOULD be Interface-down, BFD-down, Expired and CFG-change.

o nbr-address: The IPv4 or IPv6 address for this neighbor.

```
module: ospf-protocol
   +--rw ospf-instance
         ...
   |     +--rw multi-topo* [mt-id]
               ...
   |        +--rw area-list
                     ...
   |              +--rw interface-list
                     ...
   |              |     +--rw nbr-list
   |              |        +--rw nbr* [router-id]
   |              |           +--rw router-id            inet:ip-address
   |              |           +--rw interface-index?     uint64
   |              |           +--rw interface-name?      string
   |              |           +--rw nbr-status?          nbr-status-def
   |              |           +--rw nbr-previous-status? nbr-status-def
   |              |           +--rw nbr-down-reason?     nbr-down-reason-def
   |              |           +--rw nbr-address?         inet:ipv4-address
                                    ...
```

Figure 8 YANG model of OSPF neighbor

2.4.3. Interface traffic engineering

This section describes the TE related data on this interface.

o interface-index: The index for this interface. It MUST be unique globally in the same routing system.

o admin-Group: The bit mask assigned by operators used for identifying administrative group.

o ipv4-address: A 4-octet IPv4 address for the interface described by interface-index.

o nbr-ipv4-address: A single IPv4 address for a neighboring router on this link.

o max-link-bandwidth: The maximum bandwidth that can be used on this link in this direction.

o max-rsv-bandwidth: The maximum amount of bandwidth that can be reserved in this direction on this link.

o unrsv-bandwidth: The amount of bandwidth reservable in this direction on this link.

3. OSPF notification

With the help of OSPF information model, the I2RS Client can collect OSPF state data through publish/subscription mechanism. This section describes several data which is important for operating and maintaining of OSPF routing-protocol.

3.1. Adjacency

Information related to adjacencies SHOULD be readable through I2RS Agent. This includes total number of adjacencies in the network and their current status and even their history of transition. For certain specific adjacencies, the I2RS Client MAY subscribe for their data when events happened.

3.2. LSDB

Link state database is the most important part in OSPF information model. It contains the whole topology information from the network. The I2RS Agent SHOULD support reading LSDB information related to size, status and contents. It MAY be useful to subscribe some critical reachability information from LSA when specific events happened.

3.3. Route

Since the OSPF routing-table is one client for the RIB, it MAY be beneficial to read data from OSPF routes. This data may contain the size and status of the routing-table and even the detailed contents of routes. It MAY be necessary to subscribe the data and status of certain specific routes especially when the reachability was lost. Through the OSPF information model, it will be more convenient for operators to get corresponding LSA and even the adjacency when one route disappeared.

3.4. TE

It MAY be helpful to read the traffic engineering information for one area or for one specific interface. This can help to find out mistakes or data loss during the procedure of advertising and flooding.

3.5. Protocol statistics

It SHOULD be necessary to subscribe protocol statistics for health diagnostics. This statistics may contain packet discard for different reasons, adjacency transition frequency, the size of LSDB and routing-table, SPF-trigger frequency and etc.

4. OSPF operation

Based on the standardized information model of OSPF protocol as described above, use cases defined in [I-D.wu-i2rs-igp-usecases] can be supported. This section demonstrates several specific examples of these use cases.

4.1. Router number monitoring

Complaint can be heard frequently from clients about how many routers should be deployed in one area. The answer for this question is not very clear in vendor’s guide since the product specification is only for reference and what’s worse, those words like "usually", "roughly" or "most of the time" are often used from field engineers. As the consequence, it is always convenient for clients to deploy all the routers in one area, which may introduce scaling issue in future.

With the help of OSPF information model and I2RS interfaces, it is possible to give out deployment suggestion or warning dynamically in the real-time manner. Based on the statistics of router number and system resource consuming, plus the ratio relationship between them, one notification or warning can be sent to I2RS Client. From there decision can be made to expand safely or have to shrink for precaution.

4.2. Router-ID conflict recovery

It is not rare to observe router-ID conflict in networks both intra and inter area, especially when different area merged. It is time-consuming and troublesome to detect and locate the place where this trouble happened. The frequently used solution is to rename one of the conflicted router-ID to a new one then reboot the involved OSPF instance to force all adjacencies to rebuild and re-synchronize the LSDB.

It MAY be possible to alleviate this issue with the help of OSPF information model and programmatic I2RS interfaces. With the help of router-info-list, this conflict can be detected automatically. When one substantial conflict is on the horizon, no need to wait for mutual re-origination happened, ID conflict can be found in router-info-list with help of their coordinate information, no matter the conflict routers come from the same area or not. What is more, through I2RS interfaces and Agent, it is possible to rewrite one of the conflicted router-ID into a new one then reboot the routing-protocol.

5. OSPF grammar

This section demonstrates the information model of OSPF routing-protocol using the syntax stated in [RFC5511]

5.1. Instance

<OSPF routing-protocol> ::= [<OSPF instance> ...]

<OSPF instance> ::= <instance-parameters> <multi-topo-list>

<instance-parameters> ::= <OSPF_INSTANCE_NAME> [<OSPF_VPN_NAME>] <ROUTER_ID> <protocol-status> <ospf-type> <version> <ospf-instance-create-mode> [<PREFERENCE>] [<HOSTNAME>]

<ospf-type> ::= <ABR> | <ASBR> | <NONE>

<protocol-status> ::= <ACTIVE> | <RESET> | <SHUTDOWN> | <OVERLOAD>

<version> ::= <V2> | <V3>

5.2. Multi-topology

<multi-topo-list> ::= [<mt> ...]

<mt> ::= <MT_ID> <address-family> <mt-status> [<policy-list>] <mt-rib> <area-list>

<address-family> ::= <V4UR> | <V6UR> | <V4MR> | <V6MR>

<mt-status> ::= <ACTIVE> | <INACTIVE>

<mt-rib> ::= <route-list>

<area-list> ::= [<area> ...]

<policy-list> ::= [<Policy-Rule> ...]

<Policy-Rule> SHOULD follow the definition in the information model for policy as stated in [I-D.hares-i2rs-info-model-policy].

<route-list> ::= <route> [<route> ...]

<route> ::= <PREFIX> <nexthop-list> [<back-nexthop>] <METRIC> <TYPE> <route-state-info>

<backup-nexthop> ::= <nexthop>

<nexthop-list> and <nexthop> SHOULD follow the definition in the RIB iformation model as stated in [I-D.ietf-i2rs-rib-info-model].

<route-state-info> ::= <route-current-state> [<route-previous-state>] [<route-chg-reason>] [<LSID> <lsa-type> <advertiser>]

<route-current-state> ::= (<ACTIVE> | <INACTIVE>) (<PRIMARY> | <BACKUP>)

<route-previous-state> ::= (<ACTIVE> | <INACTIVE>) (<PRIMARY> | <BACKUP>)

<route-chg-reason> ::= <ORIG_ADV> | <ORIG_WITHDRAW> | <ADJ_DOWN> | <POLICY_DENY>

5.3. Area

<area-list> ::= [<area> ...]

<area> ::= <area-parameters> <lsdb> <interface-list> [<network-list>] [<router-info-list>]

<area-parameters> ::= <AREA_ID> <area-type> <area-status> [<LSA_ARRIVAL_INT>] [<LSA_ORIG_INT>] [<ROUTER_NUMBER>] [<area-auth>]

<area-type> ::= <NORMAL> | <STUB> | <NSSA>

<area-status> ::= <ACTIVE> | <RESET> | <SHUTDOWN>

<area-auth> ::= <auth-mode-type>

<auth-mode-type> ::= <mode-simple> | <mode-md5> | <mode-hmac-sha256> | <mode-keychain>

<mode-simple> ::= <PASSWORD>

<mode-md5> ::= <PASSWORD>

<mode-hmac-sha256> ::= <KEY_ID> <PASSWORD>

<mode-keychain> ::= <KEY_ID> <PASSWORD> <keychain-mode> [<SEND_TIME>] [<RECEIVE_TIME>]

<keychain-mode> ::= <ABSOLUTE> | <periodic>

<periodic> ::= <DAILY> | <WEEKLY> | <MONTHLY> | <YEARLY>

```
<lsdb> ::= <lsdb-status> <LSDB_SIZE> [ <LSDB_OVERFLOW_LIMIT> ] <lsa-
list>

<lsdb-status> ::= <NORMAL> | <OVERFLOW>

<network-list> ::= [ <network> ... ]

<network> ::= [ (<IPV4_ADDRESS> <MASK>) ... ]

<router-info-list> ::= [ <router-info> ... ]

<router-info> ::= <ROUTER_ID> [ <IP_ADDRESS> ...]

<lsa-list> ::= <lsa2-list> | <lsa3-list>

<lsa2-list> ::= [ <lsa2> ... ]

<lsa2> ::= <lsa2-header> <ospf-v2-lsa>

<lsa2-header> ::= <LSA_AGE> <LSA_OPTIONS> <lsa-v2-type>
<LINK_STATE_ID> <advertiser-id> <SEQ_NO> <CHKSUM> <LSA_LENGTH>

<lsa-v2-type> ::= <ROUTER_LSA> | <NETWORK_LSA> | <SUMMARY_LSA> |
<AS_EXTERNAL_LSA> | <NSSA_LSA>

<advertiser-id> ::= <ROUTER_ID>

<ospf-v2-lsa> ::= <ospf-v2-router-lsa> | <ospf-v2-network-lsa> |
<ospf-v2-summary-lsa> | <ospf-v2-as-external-lsa> | <ospf-v2-nssa-
external-lsa> | <ospf-v2-te-router-lsa> | <ospf-v2-te-link-lsa>

<lsa3-list> ::= [ <lsa3> ... ]

<lsa3> ::= <lsa3-header> <ospf-v3-lsa>

<lsa3-header> ::= <LSA_AGE> <lsa-v3-type> <link-state-id>
<advertiser-id> <SEQ_NO> <CHKSUM> <LSA_LENGTH>

<lsa-v3-type> ::= <U_BIT> <flood-scope> <function-code>

<flood-scope> ::= <LINK_LOCAL> | <AREA> | <AS>

<function-code> ::= <ROUTER_LSA> | <NETWORK_LSA> | <SUMMARY_LSA> |
<AS_EXTERNAL_LSA> | <NSSA_LSA>

<ospf-v3-lsa> ::= <ospf-v3-router-lsa> | <ospf-v3-network-lsa> |
<ospf-v3-inter-area-prefix-lsa> | <ospf-v3-inter-area-router-lsa> |
<ospf-v3-as-external-lsa> | <ospf-v3-nssa-lsa> | <ospf-v3-link-lsa> |
```

<ospf-v3-intra-area-prefix-lsa> | <ospf-v3-te-router-ipv6-address-lsa> | <ospf-v3-te-link-lsa>

5.4. Interface

<interface-list> ::= [<interface> ...]

<interface> ::= <INTERFACE_INDEX> <INTERFACE_NAME> <interface-status> <IP_ADDRESS> [<interface-down-reason>] [<interface-net-type>] [<interface-role>] [<interface-te-info>] [<interface-auth>] [<nbr-list>]

<interface-net-type> ::= <P2P> | <BRODCAST> | <NBMA> | <P2MP>

<interface-status> ::= <IF_UP> | <IF_DOWN>

<interface-down-reason> ::= <PHY_DOWN> | <ADMIN_DOWN> | <IP_DOWN>

<interface-role> ::= <DR> | <BDR> | <DROther>

<interface-auth> ::= <auth-mode-type>

<interface-te> ::= <ADMIN_GROUP> <IP_ADDR> <NBR_IP_ADDR> <MAX_BANDWIDTH> <MAX_RSV_BANDWIDTH> <UNRSV_BANDWIDTH>

<nbr-list> ::= <nbr> [<nbr> ...]

<nbr> ::= <ROUTER_ID> <INTERFACE_INDEX> <INTERFACE_NAME> <nbr-status> [<nbr-previous-status>] [<nbr-down-reason>] <nbr-address>

<nbr-status> ::= <DOWN> | <ATTEMPT> | <2-WAY> | <EXSTAT> | <EXCHANGE> | <LOADING> | <FULL>

<nbr-previous-status> ::= <DOWN> | <ATTEMPT> | <2-WAY> | <EXSTAT> | <EXCHANGE> | <LOADING> | <FULL>

<nbr-down-reason> ::= <IF_DOWN> | <BFD_DOWN> | <EXPIRATION> | <CFD_CHG> | <I2RS_DOWN>

<nbr-address> ::= <IP_ADDRESS>

6. I2RS YANG model of OSPF

```
      module: ospf-protocol
    +--rw ospf-v4ur-instance
    |  +--rw ospf-instance-name          string
    |  +--rw ospf-vpn-name?              string
    |  +--rw router-id                   inet:ip-address
    |  +--ro protocol-status             protocol-status-def
    |  +--ro ospf-type                   ospf-type-def
    |  +--ro version                     ospf-version-def
    |  +--ro ospf-process-create-mode    ospf-process-create-mode-def
    |  +--rw preference                  uint32
    |  +--rw hostname?                   string
    |  +--rw mt-list
    |     +--rw multi-topo* [mt-id]
    |        +--rw mt-id             uint16
    |        +--rw address-family    address-family-def
    |        +--rw mt-status?        enumeration
    |        +--rw policy-list* [policy-id]
    |        |  +--rw policy-id    string
    |        +--rw mt-rib
    |        |  +--rw route* [prefix]
    |        |     +--rw prefix              inet:ipv4-prefix
    |        |     +--rw nexthop-list
    |        |     |  +--rw nexthop* [ospf-nexthop]
    |        |     |     +--rw ospf-nexthop    inet:ipv4-prefix
    |        |     +--rw back-nexthop?       inet:ipv4-prefix
    |        |     +--rw metric?             uint32
    |        |     +--rw type?               ospf-route-type-def
    |        |     +--rw route-state-info
    |        |        +--rw metric?                 uint32
    |        |        +--rw route-current-state?    ospf-route-state-def
    |        |        +--rw route-previous-state?   ospf-route-state-def
    |        |        +--rw route-chg-reason?       route-chg-reason-def
    |        |        +--rw lsid?                   inet:ip-address
    |        |        +--rw lsa-type?               lsa-type-def
    |        |        +--rw advertiser?             inet:ip-address
```

```
|        +--rw area-list
|              +--rw area-id             uint16
|              +--rw area-type?          area-type-def
|              +--rw area-status?        area-status-def
|              +--rw lsa-arrival-int?    uint32
|              +--rw lsa-orig-int?       uint32
|              +--rw router-number?      uint32
|              +--rw area-auth
|              |  +--rw (auth-mode-type)?
|              |     +--:(mode-simple)
|              |     |  +--rw simple-password?     string
|              |     +--:(mode-md5)
|              |     |  +--rw md5-password?        string
|              |     +--:(mode-hmac-sha256)
|              |     |  +--rw hmac-key-id?         uint32
|              |     |  +--rw hmac-password?       string
|              |     +--:(mode-keychain)
|              |        +--rw keychain-key-id?     uint32
|              |        +--rw keychain-password?   string
|              |        +--rw keychain-mode?       enumeration
|              |        +--rw keychain-periodic?   enumeration
|              |        +--rw send_time?           uint32
|              |        +--rw receive_tim?         uint32
```

```
   |              +--rw lsdb
   |              |  +--rw lsa*[lsa-v2-type link-state-id advertiser-id]
   |              |     +--rw lsa-age?            uint32
   |              |     +--rw lsa-options?        uint8
   |              |     +--rw lsa-v2-type         enumeration
   |              |     +--rw link-state-id       inet:ipv4-address
   |              |     +--rw advertiser-id       inet:ip-prefix
   |              |     +--rw seq-no?             uint32
   |              |     +--rw chksum?             uint32
   |              |     +--rw lsa-length?         uint32
   |              |     +--rw (ls-type)?
   |              |        +--:(ospf-v2-router-lsa)
   |              |        |  +--rw ospf-v2-router-lsa
   |              |        |     +--rw bit-flag   uint16
   |              |        |     +--rw link-num   uint16
   |              |        |     +--rw link-list* [link-id link-data]
   |              |        |        +--rw link-id   inet:ipv4-address
   |              |        |        +--rw link-data inet:ipv4-address
   |              |        |        +--rw link-type enumeration
   |              |        |        +--rw mt-num    uint16
   |              |        |        +--rw metric    uint16
   |              |        |        +--rw mt-metric* [mt-id]
   |              |        |           +--rw mt-id  uint16
   |              |        |           +--rw metric? uint16
   |              |        +--:(ospf-v2-network-lsa)
   |              |        |  +--rw ospf-v2-network-lsa
   |              |        |     +--rw network-mask  inet:ipv4-prefix
   |              |        |     +--rw attached-router* [router-id]
   |              |        |        +--rw router-id  inet:ipv4-address
   |              |        +--:(ospf-v2-summary-lsa)
   |              |        |  +--rw ospf-v2-summary-lsa
   |              |        |     +--rw network-mask  inet:ipv4-prefix
   |              |        |     +--rw mt-metric* [mt-id]
   |              |        |        +--rw mt-id     uint16
   |              |        |        +--rw metric?   uint16
   |              |        +--:(ospf-v2-as-external-lsa)
   |              |        |  +--rw ospf-v2-as-external-lsa
   |              |        |     +--rw network-mask  inet:ipv4-prefix
   |              |        |     +--rw mt-metric* [mt-id]
   |              |        |        +--rw e-bit?     uint8
   |              |        |        +--rw mt-id      uint8
   |              |        |        +--rw metric?    uint16
   |              |        |        +--rw forwarding-address?
   |              |        |                inet:ipv4-address
   |              |        |        +--rw external-route-tag?  uint32

   |              |        +--:(ospf-v2-nssa-external-lsa)
   |              |        |  +--rw ospf-v2-nssa-external-lsa
```

```
   |               |         |     +--rw network-mask    inet:ipv4-prefix
   |               |         |     +--rw mt-metric* [mt-id]
   |               |         |        +--rw e-bit?      uint8
   |               |         |        +--rw mt-id       uint8
   |               |         |        +--rw metric?     uint32
   |               |         |        +--rw forwarding-address?
   |               |         |                   inet:ipv4-address
   |               |         |        +--rw external-route-tag? uint32
   |               |         +--:(ospf-v2-te-router-lsa)
   |               |         |  +--rw ospf-v2-te-router-lsa
   |               |         |     +--rw type?        uint8
   |               |         |     +--rw length?      uint32
   |               |         |     +--rw router-id?   inet:ipv4-address
   |               |         +--:(ospf-te-link-lsa)
   |               |            +--rw ospf-te-link-lsa
   |               |               +--rw type?           uint8
   |               |               +--rw length?         uint32
   |               |               +--rw link-type-stlv
   |               |               |  +--rw type?        uint8
   |               |               |  +--rw length?      uint32
   |               |               |  +--rw link-type?   enumeration
   |               |               +--rw link-id-tlv-stlv
   |               |               |  +--rw type?      uint8
   |               |               |  +--rw length?    uint32
   |               |               |  +--rw link-id?   inet:ipv4-address
   |               |               +--rw local-address-stlv
   |               |               |  +--rw type?        uint8
   |               |               |  +--rw length?      uint32
   |               |               |  +--rw local-address-list*
   |               |               |                  [remote-address]
   |               |               |     +--rw remote-address
   |               |               |                   inet:ipv4-address
   |               |               +--rw remote-address-stlv
   |               |               |  +--rw type?         uint8
   |               |               |  +--rw length?       uint32
   |               |               |  +--rw remote-address-list*
   |               |               |                  [remote-address]
   |               |               |     +--rw remote-address
   |               |               |                   inet:ipv4-address
   |               |               +--rw te-metric-stlv
   |               |               |  +--rw type?     uint8
   |               |               |  +--rw length?   uint32
   |               |               |  +--rw value?    uint32
   |               |               +--rw maximum-bandwidth-stlv
   |               |               |  +--rw type?     uint8
   |               |               |  +--rw length?   uint32
   |               |               |  +--rw value?    uint32
   |               |               +--rw maximum-reservable-bandwidth-stlv
```

```
|              |              |  +--rw type?     uint8
|              |              |  +--rw length?   uint32
|              |              |  +--rw value?    uint32
|              |              +--rw unreserved-bandwidth-stlv
|              |              |  +--rw type?     uint8
|              |              |  +--rw length?   uint32
|              |              |  +--rw value?    uint32
|              |              +--rw administrative-group-stlv
|              |                 +--rw type?     uint8
|              |                 +--rw length?   uint32
|              |                 +--rw value?    uint32

|              +--rw interface-list
|              |  +--rw interface* [interface-index]
|              |     +--rw interface-index    uint64
|              |     +--rw interface-name?    string
|              |     +--rw interface-status?  interface-status-def
|              |     +--rw interface-down-reason?
|              |                    interface-down-reason-def
|              |     +--rw interface-net-type? interface-net-type-def
|              |     +--rw interface-role?     interface-role-def
|              |     +--rw interface-te-info
|              |     |  +--rw admin_group?     uint32
|              |     |  +--rw max_bandwidth?   uint32
|              |     |  +--rw max_rsv_bandwidth?  uint32
|              |     |  +--rw unrsv_bandwidth?    uint32
|              |     +--rw interface-auth
|              |     |  +--rw (auth-mode-type)?
|              |     |     +--:(mode-simple)
|              |     |     |  +--rw simple-password?    string
|              |     |     +--:(mode-md5)
|              |     |     |  +--rw md5-password?       string
|              |     |     +--:(mode-hmac-sha256)
|              |     |     |  +--rw hmac-key-id?        uint32
|              |     |     |  +--rw hmac-password?      string
|              |     |     +--:(mode-keychain)
|              |     |        +--rw keychain-key-id?    uint32
|              |     |        +--rw keychain-password?  string
|              |     |        +--rw keychain-mode?      enumeration
|              |     |        +--rw keychain-periodic?  enumeration
|              |     |        +--rw send_time?          uint32
|              |     |        +--rw receive_tim?        uint32
|              |     +--rw ip-address?       inet:ipv4-address
|              |     +--rw nbr-list
|              |        +--rw nbr* [router-id]
|              |           +--rw router-id   inet:ip-address
|              |           +--rw interface-index?  uint64
|              |           +--rw interface-name?   string
```

```
   |              |           +--rw nbr-status?       nbr-status-def
   |              |           +--rw nbr-previous-status? nbr-status-def
   |              |           +--rw nbr-down-reason? nbr-down-reason-def
   |              |           +--rw nbr-address?     inet:ipv4-address
   |              |           +--rw ip-address?      inet:ipv4-address
   |              +--rw network-list* [network-prefix mask]
   |              |  +--rw network-prefix    inet:ipv4-prefix
   |              |  +--rw mask              inet:ipv4-prefix
   |              +--rw route-info-list* [route-info-index]
   |                 +--rw route-info-index    uint32
   |                 +--rw router-id           inet:ipv4-address
   |                 +--rw ip-address-list* [ip-address]
   |                    +--rw ip-address    inet:ipv4-address

  +--rw ospf-v6ur-instance
     +--rw ospf-instance-name          string
     +--rw ospf-vpn-name?              string
     +--rw router-id                   inet:ip-address
     +--ro protocol-status             protocol-status-def
     +--ro ospf-type                   ospf-type-def
     +--ro version                     ospf-version-def
     +--ro ospf-process-create-mode    ospf-process-create-mode-def
     +--rw preference                  uint32
     +--rw hostname?                   string
     +--rw mt-list
        +--rw multi-topo* [mt-id]
           +--rw mt-id             uint16
           +--rw address-family    address-family-def
           +--rw mt-status?        enumeration
           +--rw policy-list* [policy-id]
           |  +--rw policy-id    string
           +--rw mt-rib
           |  +--rw route* [prefix]
           |     +--rw prefix              inet:ipv6-prefix
           |     +--rw nexthop-list
           |     |  +--rw nexthop* [ospf-nexthop]
           |     |     +--rw ospf-nexthop  inet:ipv6-prefix
           |     +--rw back-nexthop?       inet:ipv6-prefix
           |     +--rw metric?             uint32
           |     +--rw type?               ospf-route-type-def
           |     +--rw route-state-info
           |        +--rw metric?                uint32
           |        +--rw route-current-state?   ospf-route-state-def
           |        +--rw route-previous-state?  ospf-route-state-def
           |        +--rw route-chg-reason?      route-chg-reason-def
           |        +--rw lsid?                  inet:ip-address
           |        +--rw lsa-type?              lsa-type-def
           |        +--rw advertiser?            inet:ip-address
```

```
            +--rw area-list
               +--rw area* [area-id]
                  +--rw area-id             uint16
                  +--rw area-type?          area-type-def
                  +--rw area-status?        area-status-def
                  +--rw lsa-arrival-int?    uint32
                  +--rw lsa-orig-int?       uint32
                  +--rw router-number?      uint32
                  +--rw area-auth
                  |  +--rw (auth-mode-type)?
                  |     +--:(mode-simple)
                  |     |  +--rw simple-password?     string
                  |     +--:(mode-md5)
                  |     |  +--rw md5-password?        string
                  |     +--:(mode-hmac-sha256)
                  |     |  +--rw hmac-key-id?         uint32
                  |     |  +--rw hmac-password?       string
                  |     +--:(mode-keychain)
                  |        +--rw keychain-key-id?     uint32
                  |        +--rw keychain-password?   string
                  |        +--rw keychain-mode?       enumeration
                  |        +--rw keychain-periodic?   enumeration
                  |        +--rw send_time?           uint32
                  |        +--rw receive_tim?         uint32
                  +--rw lsdb
                  |  +--rw lsa* [lsa-v3-type link-state-id advertiser-id]
                  |     +--rw lsa-age?                uint32
                  |     +--rw lsa-v3-type             enumeration
                  |     +--rw link-state-id           uint32
                  |     +--rw advertiser-id           inet:ip-prefix
                  |     +--rw seq-no?                 uint32
                  |     +--rw chksum?                 uint32
                  |     +--rw lsa-length?             uint32
                  |     +--rw (ls-type)?
                  |        +--:(ospf-v3-router-lsa)
                  |        |  +--rw ospf-v3-router-lsa
                  |        |     +--rw option         uint16
                  |        |     +--rw link-list*
                  |        |       [link-type interface-id neighbor-interfac
e-id]
                  |        |        +--rw link-type    enumeration
                  |        |        +--rw metric?      uint32
                  |        |        +--rw interface-id uint32
                  |        |        +--rw neighbor-interface-id uint32
                  |        |        +--rw neighbor-router-id?
                  |        |                        inet:ipv4-address
                  |        +--:(ospf-v3-network-lsa)
                  |        |  +--rw ospf-v3-network-lsa
                  |        |     +--rw option       uint32
```

```
                |       |     +--rw link-list* [attached-router-id]
                |       |        +--rw attached-router-id
                |       |                      inet:ipv4-address
                |       +--:(ospf-v3-inter-area-prefix-lsa)
                |       |  +--rw ospf-v3-inter-area-prefix-lsa
                |       |     +--rw metric?               uint32
                |       |     +--rw prefix-length         uint8
                |       |     +--rw prefix-options        uint8
                |       |     +--rw address-prefix-list* [address-prefix]
                |       |        +--rw address-prefix    inet:ipv6-prefix
                |       +--:(ospf-v3-inter-area-router-lsa)
                |       |  +--rw ospf-v3-inter-area-router-lsa
                |       |     +--rw options                uint8
                |       |     +--rw metric?                uint32
                |       |     +--rw destination-router-id? inet:ipv4-addr
ess
                |       +--:(ospf-v3-as-external-lsa)
                |       |  +--rw ospf-v3-as-external-lsa
                |       |     +--rw options                    uint16
                |       |     +--rw metric                     uint16
                |       |     +--rw prefix-length              uint8
                |       |     +--rw prefix-options             uint8
                |       |     +--rw referenced-ls-type         uint8
                |       |     +--rw address-prefix-list* [address-prefix]
                |       |     |  +--rw address-prefix    inet:ipv6-prefix
                |       |     +--rw forwarding-address?  inet:ipv6-prefix
                |       |     +--rw external-route-tag?  uint32
                |       |     +--rw referenced-link-state-id?   uint32
                |       +--:(ospf-v3-nssa-lsa)
                |       |  +--rw ospf-v3-nssa-lsa
                |       |     +--rw options                    uint16
                |       |     +--rw metric                     uint16
                |       |     +--rw prefixlength               uint8
                |       |     +--rw prefixoptions              uint8
                |       |     +--rw referenced-ls-type         uint8
                |       |     +--rw address-prefix-list* [address-prefix]
                |       |     |  +--rw address-prefix    inet:ipv6-prefix
                |       |     +--rw forwarding-address?  inet:ipv6-prefix
                |       |     +--rw external-route-tag?  uint32
                |       |     +--rw referenced-link-state-id?   uint32
                |       +--:(ospf-v3-link-lsa)
                |       |  +--rw ospf-v3-link-lsa
                |       |     +--rw priority             uint8
                |       |     +--rw options              uint32
                |       |     +--rw link-local-interface-address?
                |       |                              inet:ipv6-address
                |       |     +--rw prefixes                        uint3
2
                |       |     +--rw address-prefix-list*
                |       |                        [address-prefix-index]
```

```
                |       |       +--rw address-prefix-index    uint32
                |       |       +--rw prefix-length           uint8
                |       |       +--rw prefix-options?         uint8
                |       |       +--rw address-prefix* [address]
                |       |          +--rw address    inet:ipv6-prefix
                |       +--:(ospf-v3-intra-area-prefix-lsa)
                |       |  +--rw ospf-v3-intra-area-prefix-lsa
                |       |     +--rw prefixes                        uint
32
                |       |     +--rw referenced-ls-type              uint
16
                |       |     +--rw referenced-link-state-id        uint
32
                |       |     +--rw referenced-advertising-router
                |       |                 inet:ipv4-address
                |       |     +--rw address-prefix-list*
                |       |                 [address-prefix-index]
                |       |       +--rw address-prefix-index    uint32
                |       |       +--rw prefix-length           uint8
                |       |       +--rw prefix-options          uint8
                |       |       +--rw address-prefix* [address]
                |       |          +--rw address    inet:ipv6-prefix
                |       +--:(ospf-v3-te-router-ipv6-address-lsa)
                |       |  +--rw ospf-v3-te-router-ipv6-address
                |       |     +--rw type         uint8
                |       |     +--rw length       uint16
                |       |     +--rw router-id    inet:ipv6-address
                |       +--:(te-link-lsa)
                |          +--rw ospf-te-link-lsa
                |             +--rw type?           uint8
                |             +--rw length?         uint32
                |             +--rw link-type-stlv
                |             |  +--rw type?        uint8
                |             |  +--rw length?      uint32
                |             |  +--rw link-type?   enumeration
                |             +--rw link-id-tlv-stlv
                |             |  +--rw type?      uint8
                |             |  +--rw length?    uint32
                |             |  +--rw link-id?   inet:ipv4-address
                |             +--rw local-address-stlv
                |             |  +--rw type?                uint8
                |             |  +--rw length?              uint32
                |             |  +--rw local-address-list*
                |             |                [remote-address]
                |             |     +--rw remote-address
                |             |                inet:ipv4-address
                |             +--rw remote-address-stlv
                |             |  +--rw type?              uint8
                |             |  +--rw length?            uint32
                |             |  +--rw remote-address-list*
                |             |                [remote-address]
```

```
|              |     +--rw remote-address
|              |                inet:ipv4-address
|              +--rw te-metric-stlv
|              |  +--rw type?     uint8
|              |  +--rw length?   uint32
|              |  +--rw value?    uint32
|              +--rw maximum-bandwidth-stlv
|              |  +--rw type?     uint8
|              |  +--rw length?   uint32
|              |  +--rw value?    uint32
|              +--rw maximum-reservable-bandwidth-stlv
|              |  +--rw type?     uint8
|              |  +--rw length?   uint32
|              |  +--rw value?    uint32
|              +--rw unreserved-bandwidth-stlv
|              |  +--rw type?     uint8
|              |  +--rw length?   uint32
|              |  +--rw value?    uint32
|              +--rw administrative-group-stlv
|                 +--rw type?     uint8
|                 +--rw length?   uint32
|                 +--rw value?    uint32
|           +--rw interface-list
|           |  +--rw interface* [interface-index]
|           |     +--rw interface-index        uint64
|           |     +--rw interface-name?        string
|           |     +--rw interface-status?      interface-status-def
|           |     +--rw interface-down-reason?
|           |                  interface-down-reason-def
|           |     +--rw interface-net-type?    interface-net-type-def
|           |     +--rw interface-role?        interface-role-def
|           |     +--rw interface-te-info
|           |     |  +--rw admin_group?        uint32
|           |     |  +--rw max_bandwidth?      uint32
|           |     |  +--rw max_rsv_bandwidth?  uint32
|           |     |  +--rw unrsv_bandwidth?    uint32
|           |     +--rw interface-auth
|           |     |  +--rw (auth-mode-type)?
|           |     |     +--:(mode-simple)
|           |     |     |  +--rw simple-password?     string
|           |     |     +--:(mode-md5)
|           |     |     |  +--rw md5-password?        string
|           |     |     +--:(mode-hmac-sha256)
|           |     |     |  +--rw hmac-key-id?         uint32
|           |     |     |  +--rw hmac-password?       string
|           |     |     +--:(mode-keychain)
|           |     |        +--rw keychain-key-id?     uint32
|           |     |        +--rw keychain-password?   string
```

```
|     |        +--rw keychain-mode?       enumeration
|     |        +--rw keychain-periodic?   enumeration
|     |        +--rw send_time?           uint32
|     |        +--rw receive_tim?         uint32
|     +--rw ip-address               inet:ipv6-address
|     +--rw nbr-list
|        +--rw nbr* [router-id]
|           +--rw router-id          inet:ip-address
|           +--rw interface-index?   uint64
|           +--rw interface-name?    string
|           +--rw nbr-status?        nbr-status-def
|           +--rw nbr-previous-status? nbr-status-def
|           +--rw nbr-down-reason?   nbr-down-reason-def
|           +--rw nbr-address?       inet:ipv6-address
|           +--rw ip-address         inet:ipv6-address
+--rw network-list* [network-index]
|  +--rw network-index     uint32
|  +--rw network-prefix    inet:ipv4-prefix
|  +--rw mask              inet:ipv4-prefix
+--rw route-info-list* [route-info-index]
   +--rw route-info-index    uint32
   +--rw router-id           inet:ipv4-address
   +--rw ip-address-list* [ip-address]
      +--rw ip-address    inet:ipv4-address
```

Figure 1 The I2RS YANG model of OSPF

7. IANA Considerations

This draft includes no request to IANA.

8. Security Considerations

This document introduces no new security threat and SHOULD follow the security requirements as stated in [I-D.ietf-i2rs-architecture].

9. Acknowledgements

TBD

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