abstract

this document defines a YANG data model that can be used to configure
and manage IS-IS Segment Routing.

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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]. YANG is proving relevant beyond its initial confines, as bindings to other interfaces (e.g., ReST) and encodings other than XML (e.g., JSON) are being defined. Furthermore, YANG data models can be used as the basis for implementation of other interfaces, such as CLI and programmatic APIs.

This document defines a YANG data model that can be used to configure and manage IS-IS Segment Routing.
Internet-Draft                isis-sr-yang                     July 2019

[I-D.ietf-isis-segment-routing-extensions] and it is an augmentation
to the IS-IS YANG data model.

The YANG modules in this document conform to the Network Management
Datastore Architecture (NMDA) [RFC8342].

2. 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.

3. Tree Diagrams

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

4. IS-IS Segment Routing

This document defines a model for IS-IS Segment Routing feature. It
is an augmentation of the IS-IS base model.

The IS-IS SR YANG module requires support for the base segment
routing module [I-D.ietf-spring-sr-yang], which defines the global
segment routing configuration independent of any specific routing
protocol configuration, and support of IS-IS base model
[I-D.ietf-isis-yang-isis-cfg] which defines basic IS-IS configuration
and state.

The figure below describes the overall structure of the isis-sr YANG
module:

```
module: ietf-isis-sr
  augment /rt:routing/rt:control-plane-protocols
      /rt:control-plane-protocol/isis:isis:
        +--rw segment-routing
            |    +--rw enabled?    boolean
            |    +--rw bindings
            |        +--rw advertise
            |            |    +--rw policies*   string
            |    +--rw receive?     boolean
            +--rw protocol-srgb {sr:protocol-srgb}?
                +--rw srgb* [lower-bound upper-bound]
                |    +--rw lower-bound    uint32
                +--rw upper-bound    uint32
```

/rt:control-plane-protocol/isis:isis/isis:interfaces

++rw segment-routing
  +--rw adjacency-sid
    +--rw adj-sids* [value]
      |  +--rw value-type?  enumeration
      |  +--rw value        uint32
      |  +--rw protected?   boolean
    +--rw advertise-adj-group-sid* [group-id]
      |  +--rw group-id     uint32
    +--rw advertise-protection?  enumeration

augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:interfaces
/isis:interface/isis:fast-reroute:
  +--rw ti-lfa {ti-lfa}?
  +--rw enable?  boolean

augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:interfaces
/isis:interface/isis:fast-reroute/isis:lfa/isis:remote-lfa:
  +--rw use-segment-routing-path?  boolean {remote-lfa-sr}?

augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:interfaces
/isis:interface/isis:adjacencies/isis:adjacency:
  +--ro adjacency-sid* [value]
    |  +--ro af?  iana-rt-types:address-family
    |  +--ro value          uint32
    |  +--ro weight?        uint8
    |  +--ro protection-requested?  boolean

augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:router-capabilities:
  +--ro sr-capability
    |  +--ro flags?         bits
    |  +--ro global-blocks
      |    +--ro global-block*
      |       +--ro range-size?  uint32
      |       +--ro sid-sub-tlv
      |         +--ro sid?  uint32
    +--ro sr-algorithms
      |  +--ro sr-algorithm*  uint8
  +--ro local-blocks
    |  +--ro local-block*
    |       +--ro range-size?  uint32
    |       +--ro sid-sub-tlv
    |          +--ro sid?  uint32
  +--ro srms-preference
    +--ro preference?  uint8

augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:extended-is-neighbor
/isis:neighbor:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro weight?       uint8
  |   +--ro neighbor-id?  isis:system-id
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:mt-is-neighbor/isis:neighbor:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro weight?       uint8
  |   +--ro neighbor-id?  isis:system-id
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:extended-ipv4-reachability
/isis:prefixes:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro algorithm?    uint8
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:mt-extended-ipv4-reachability
/isis:prefixes:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro algorithm?    uint8
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:ipv6-reachability/isis:prefixes:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro algorithm?    uint8
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols
/rt:control-plane-protocol/isis:isis/isis:database
/isis:levels/isis:lsp/isis:mt-ipv6-reachability
/isis:prefixes:
  +--ro sid-list* [value]
  |   +--ro flags?        bits
  |   +--ro algorithm?    uint8
  |   +--ro value         uint32
augment /rt:routing/rt:control-plane-protocols

5. IS-IS Segment Routing configuration

5.1. Segment Routing activation

Activation of segment-routing IS-IS is done by setting the "enable" leaf to true. This triggers advertisement of segment-routing extensions based on the configuration parameters that have been setup using the base segment routing module.

5.2. Advertising mapping server policy

The base segment routing module defines mapping server policies. By default, IS-IS will not advertise nor receive any mapping server entry. The IS-IS segment-routing module allows to advertise one or multiple mapping server policies through the "bindings/advertise/policies" leaf-list. The "bindings/receive" leaf allows to enable the reception of mapping server entries.

5.3. IP Fast reroute

IS-IS SR model augments the fast-reroute container under interface. It brings the ability to activate TI-LFA (topology independent LFA) and also enhances remote LFA to use segment-routing tunneling instead of LDP.

6. IS-IS Segment Routing YANG Module

<CODE BEGINS> file "ietf-isis-sr@2019-07-07.yang"
module ietf-isis-sr {
    namespace "urn:ietf:params:xml:ns:" + "yang:ietf-isis-sr";
    prefix isis-sr;

    import ietf-routing {
import ietf-segment-routing { prefix "sr"; }
import ietf-segment-routing-common { prefix "sr-cmn"; }
import ietf-isis { prefix "isis"; }
import iana-routing-types { prefix "iana-rt-types"; }
organization "IETF LSR - LSR Working Group";
contact "WG List: <mailto:lsr@ietf.org>
    Editor: Stephane Litkowski
       <mailto:stephane.litkowski@orange.com>
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    Author: Pushpasis Sarkar
       <mailto:pushpasis.ietf@gmail.com>
    Author: Ing-Wher Chen
       <mailto:ingwherchen@mitre.org>
    Author: Jeff Tantsura
       <mailto:jefftant.ietf@gmail.com>
    ";
description "The YANG module defines a generic configuration model for
    Segment routing ISIS extensions common across all of the vendor
    implementations.";
revision 2019-07-07 {
description

"Initial revision.";
reference "RFC XXXX";
}

/* Identities */

/* Features */

feature remote-lfa-sr {
  description
    "Enhance rLFA to use SR path.";
}

feature ti-lfa {
  description
    "Enhance IPFRR with ti-lfa support";
}

/* Groupings */

grouping sid-sub-tlv {
  description "SID/Label sub-TLV grouping.";
  container sid-sub-tlv {
    description
      "Used to advertise the SID/Label associated with a prefix or adjacency.";
    leaf sid {
      type uint32;
      description
        "Segment Identifier (SID) - A 20 bit label or 32 bit SID.";
    }
  }
}


grouping sr-capability {
  description
    "SR capability grouping.";
  container sr-capability {
    description
      "Segment Routing capability.";
    leaf flags {
      type bits {
        bit mpls-ipv4 {
position 0;
description
  "If set, then the router is capable of
   processing SR MPLS encapsulated IPv4 packets
   on all interfaces.";
}
bit mpls-ipv6 {
  position 1;
  description
  "If set, then the router is capable of
   processing SR MPLS encapsulated IPv6 packets
   on all interfaces.";
}
}
description
  "Flags.";
}
container global-blocks {
  description
  "Segment Routing Global Blocks.";
list global-block {
  description "Segment Routing Global Block.";
  leaf range-size {
    type uint32;
    description "The SID range.";
  }
  uses sid-sub-tlv;
}
}
}


grouping sr-algorithm {
  description
  "SR algorithm grouping.";
container sr-algorithms {
  description "All SR algorithms.";
leaf-list sr-algorithm {
  type uint8;
  description
    "The Segment Routing (SR) algorithms that the router is
     currently using.";
}
}
}

grouping srlb {
  description
"SR Local Block grouping.";
container local-blocks {
  description "List of SRLBs.";
  list local-block {
    description "Segment Routing Local Block.";
    leaf range-size {
      type uint32;
      description "The SID range.";
    }
    uses sid-sub-tlv;
  }
}

grouping srms-preference {
  description "The SRMS preference TLV is used to advertise
          a preference associated with the node that acts
          as an SR Mapping Server.";
  container srms-preference {
    description "SRMS Preference TLV.";
    leaf preference {
      type uint8 {
        range "0 .. 255";
      }
      description "SRMS preference TLV, value from 0 to 255.";
    }
  }
}

grouping adjacency-state {
  description "This group will extend adjacency state.";
  list adjacency-sid {
    key value;
    config false;
    leaf af {
      type iana-rt-types:address-family;
      description "Address-family associated with the
                  segment ID";
    }
    leaf value {
      type uint32;
      description "Value of the Adj-SID.";
    }
    leaf weight {
      type uint8;
    }
  }
}
description
"Weight associated with
the adjacency SID."
}
leaf protection-requested {
  type boolean;
  description
  "Describe if the adjacency SID
  must be protected."
}

description
"List of adjacency Segment IDs."
}
}
grouping prefix-segment-id {
  description
  "This group defines segment routing extensions
  for prefixes."
}

list sid-list {
  key value;

  leaf flags {
    type bits {
      bit readvertisment {
        position 7;
        description
        "If set, then the prefix to
        which this Prefix-SID is attached,
        has been propagated by the
        router either from another level
        or from redistribution."
      }
      bit php {
        position 5;
        description
        "If set, then the penultimate hop MUST NOT
        pop the Prefix-SID before delivering the packet
        to the node that advertised the Prefix-SID."
      }
      bit explicit-null {
        position 4;
        description
        "If set, any upstream neighbor of
        the Prefix-SID originator MUST replace
        the Prefix-SID with a
        Prefix-SID having an
Explicit-NULL value (0 for IPv4 and 2 for IPv6) before forwarding the packet.

} bit value {
    position 3;
    description
    "If set, then the Prefix-SID carries a value (instead of an index).
     By default the flag is UNSET.";
}

} bit local {
    position 2;
    description
    "If set, then the value/index carried by the Prefix-SID has local significance.
     By default the flag is UNSET.";
}

description
"Describes flags associated with the segment ID.";

}

leaf algorithm {
    type uint8;
    description
    "Algorithm to be used for path computation.";
}

leaf value {
    type uint32;
    description
    "Value of the prefix-SID.";
}

description
"List of segments.";

}

grouping adjacency-segment-id {
    description
    "This group defines segment routing extensions for adjacencies.";

    list sid-list {
        key value;

        leaf flags {
            type bits {


bit address-family {
  position 7;
  description
  "If unset, then the Adj-SID refers to an adjacency with outgoing IPv4 encapsulation. If set then the Adj-SID refers to an adjacency with outgoing IPv6 encapsulation.";
}

bit backup {
  position 6;
  description
  "If set, the Adj-SID refers to an adjacency being protected (e.g.: using IPFRR or MPLS-FRR)";
}

bit value {
  position 5;
  description
  "If set, then the SID carries a value (instead of an index). By default the flag is SET.";
}

bit local {
  position 4;
  description
  "If set, then the value/index carried by the SID has local significance. By default the flag is SET.";
}

bit set {
  position 3;
  description
  "When set, the S-Flag indicates that the Adj-SID refers to a set of adjacencies.";
}

bit persistent {
  position 2;
  description
  "When set, the P-Flag indicates that the Adj-SID is persistently allocated.";
}

description
"Describes flags associated with the segment ID.";

leaf weight {
type uint8;
    description
        "The value represents the weight of the Adj-SID
         for the purpose of load balancing.";

} leaf neighbor-id {
    type isis:system-id;
    description
        "Describes the system ID of the neighbor
         associated with the SID value. This is only
         used on LAN adjacencies.";

} leaf value {
    type uint32;
    description
        "Value of the Adj-SID.";

} description
    "List of segments.";

}

grouping segment-routing-binding-tlv {
    list segment-routing-bindings {
        key "fec range";

        leaf fec {
            type string;
            description
                "IP (v4 or v6) range to be bound to SIDs.";
        }

        leaf range {
            type uint16;
            description
                "Describes number of elements to assign
                 a binding to.";
        }

        leaf flags {
            type bits {
                bit address-family {
                    position 7;
                    description
                        "If unset, then the Prefix FEC
                         carries an IPv4 Prefix.
                         If set then the Prefix FEC carries an
                         IPv6 Prefix.";
            }
        }
    }
}
bit mirror {
  position 6;
  description
    "Set if the advertised SID/path corresponds to a mirrored context.";
}

bit flooding {
  position 5;
  description
    "If the S bit is set(1), the IS-IS Router CAPABILITY TLV MUST be flooded across the entire routing domain. If the S bit is not set(0), the TLV MUST NOT be leaked between levels. This bit MUST NOT be altered during the TLV leaking.";
}

bit down {
  position 4;
  description
    "When the IS-IS Router CAPABILITY TLV is leaked from level-2 to level-1, the D bit MUST be set. Otherwise, this bit MUST be clear. IS-IS Router capability TLVs with the D bit set MUST NOT be leaked from level-1 to level-2. This is to prevent TLV looping.";
}

bit attached {
  position 3;
  description
    "The originator of the SID/Label Binding TLV MAY set the A bit in order to signal that the prefixes and SIDs advertised in the SID/Label Binding TLV are directly connected to their originators.";
}

description
  "Flags of the binding.";

container binding {
  container prefix-sid {
    uses prefix-segment-id;
    description
      "Binding prefix SID to the range.";
  }
}
augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol" +
  "/isis:isis" { when "/rt:routing/rt:control-plane-protocols/" +
  "rt:control-plane-protocol/rt:type = 'isis:isis'" {
  description
  "This augment ISIS routing protocol when used";
}

uses sr:sr-controlplane;
container protocol-srgb {
  if-feature sr:protocol-srgb;
  uses sr-cmn:srgb;
  description
  "Per-protocol SRGB."
}
}

augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol" +
  "/isis:isis/isis:interfaces/isis:interface" { when "/rt:routing/rt:control-plane-protocols/" +
  "rt:control-plane-protocol/rt:type = 'isis:isis'" {
  description
  "This augment ISIS routing protocol when used";
}

uses sr:igp-interface;
augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol"+
  "/isis:isis/isis:interfaces/isis:interface"+
  "/isis:fast-reroute" {
  when "/rt:routing/rt:control-plane-protocols/"+
  "rt:control-plane-protocol/rt:type = 'isis:isis'" {
  description
  "This augment ISIS routing protocol when used";
}

description
"This augments ISIS IP FRR with TILFA."

container ti-lfa {
  if-feature ti-lfa;
  leaf enable {
    type boolean;
    description
    "Enables TI-LFA computation.";
  }
  description
  "TILFA configuration.";
}

leaf use-segment-routing-path {
  if-feature remote-lfa-sr;
  type boolean;
  description
  "force remote LFA to use segment routing
  path instead of LDP path.";
}
/* Operational states */

augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol" +
  "/isis:isis/isis:interfaces/isis:interface" +
  "/isis:adjacencies/isis:adjacency" {
  when "/rt:routing/rt:control-plane-protocols/"+
    "/rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
    "This augment ISIS routing protocol when used";
  }
  description
  "This augments ISIS protocol configuration
  with segment routing."

  uses adjacency-state;
}

augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol" +
  "/isis:isis/isis:database/isis:levels/isis:lsp" +
  "/isis:router-capabilities" {
  when "/rt:routing/rt:control-plane-protocols/"+
    "/rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
    "This augment ISIS routing protocol when used";
  }
  description
  "This augments ISIS protocol LSDB router capability.";

  uses sr-capability;
  uses sr-algorithm;
  uses srlb;
  uses srms-preference;
}

augment "/rt:routing/" +
  "rt:control-plane-protocols/rt:control-plane-protocol" +
  "/isis:isis/isis:database/isis:levels/isis:lsp" +
  "/isis:extended-is-neighbor/isis:neighbor" {
  when "/rt:routing/rt:control-plane-protocols/"+
    "/rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
    "This augment ISIS routing protocol when used";
  }
  description
  "This augments ISIS protocol LSDB neighbor.";

  uses adjacency-segment-id;
augment "/rt:routing/" +
    "rt:control-plane-protocols/rt:control-plane-protocol" +
    "/isis:isis/isis:database/isis:levels/isis:lsp" +
    "isis:mt-is-neighbor/isis:neighbor" {
  when "/rt:routing/rt:control-plane-protocols/" +
    "rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
      "This augment ISIS routing protocol when used";
  }
  description
    "This augments ISIS protocol LSDB neighbor.";
    uses adjacency-segment-id;
}

augment "/rt:routing/" +
    "rt:control-plane-protocols/rt:control-plane-protocol" +
    "/isis:isis/isis:database/isis:levels/isis:lsp" +
    "/isis:extended-ipv4-reachability/isis:prefixes" {
  when "/rt:routing/rt:control-plane-protocols/" +
    "rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
      "This augment ISIS routing protocol when used";
  }
  description
    "This augments ISIS protocol LSDB prefix.";
    uses prefix-segment-id;
}

augment "/rt:routing/" +
    "rt:control-plane-protocols/rt:control-plane-protocol" +
    "/isis:isis/isis:database/isis:levels/isis:lsp" +
    "isis:mt-extended-ipv4-reachability/isis:prefixes" {
  when "/rt:routing/rt:control-plane-protocols/" +
    "rt:control-plane-protocol/rt:type = 'isis:isis'" {
    description
      "This augment ISIS routing protocol when used";
  }
  description
    "This augments ISIS protocol LSDB prefix.";
    uses prefix-segment-id;
}

augment "/rt:routing/" +
    "rt:control-plane-protocols/rt:control-plane-protocol" +
    "/isis:isis/isis:database/isis:levels/isis:lsp" +
    "/isis:ipv6-reachability/isis:prefixes" {
7. Security Considerations

Configuration and state data defined in this document are designed to be accessed via the NETCONF protocol [RFC6241].
As IS-IS is an IGP protocol (critical piece of the network), ensuring stability and security of the protocol is mandatory for the network service.

Authors recommends to implement NETCONF access control model ([RFC6536]) to restrict access to all or part of the configuration to specific users.

8. Contributors

Authors would like to thank Derek Yeung, Acee Lindem, Yi Yang for their major contributions to the draft.

9. Acknowledgements

Author affiliation with The MITRE Corporation is provided for identification purposes only, and is not intended to convey or imply MITRE’s concurrence with, or support for, the positions, opinions or viewpoints expressed. MITRE has approved this document for Public Release, Distribution Unlimited, with Public Release Case Number 18-3281.

10. IANA Considerations

The IANA is requested to assign two new URIs from the IETF XML registry ([RFC3688]). Authors are suggesting the following URI:

   Registrant Contact: IS-IS WG
   XML: N/A, the requested URI is an XML namespace

This document also requests one new YANG module name in the YANG Module Names registry ([RFC6020]) with the following suggestion:

   name: ietf-isis-sr
   prefix: isis-sr
   reference: RFC XXXX

11. Change log for ietf-isis-sr YANG module

11.1. From version -03 to version -04

   o Fixed yang module indentations.
11.2. From version -02 to version -03
   o Change address-family type according to routing types.

11.3. From isis-sr document version -01 to version -02
   o NMDA compliancy.
   o Added SRLB in configuration and LSDB.
   o Added SR capability in LSDB.
   o Added SR algorithms in LSDB.
   o Added SRMS preference in LSDB.
   o Alignment with iana-rt-types module.
   o Align binding SID with draft-ietf-isis-segment-routing-extensions-13.

11.4. From isis-sr document version -00 to version -01
   o Added P-Flag in Adj-SID.

11.5. From isis document version -12 to isis-sr document version -00
   o Separate document for IS-IS SR extensions.

11.6. From isis document version -12 to version -13
   o Align with new segment routing common module.

11.7. From isis document version -09 to version -11
   o Fixed XPATH in ‘when’ expressions.

11.8. From isis document version -08 to version -09
   o Align to draft-ietf-netmod-routing-cfg-23.

11.9. From isis document version -07 to version -08
   o Align to draft-ietf-netmod-routing-cfg-21.
12.  Normative References

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