SPRING Working Group
Internet-Draft
Intended status: Standards Track
Expires: April 19, 2016

S. Litkowski
Orange Business Service
Y. Qu
Cisco Systems
P. Sarkar
Juniper Networks
J. Tantsura
Ericsson

October 17, 2015

YANG Data Model for Segment Routing
draft-ietf-spring-sr-yang-01

Abstract

This document defines a YANG data model ([RFC6020]) for segment routing ([I-D.ietf-spring-segment-routing]) configuration and operation. This YANG model is intended to be used on network elements to configure or operate segment routing. This document defines also generic containers that SHOULD be reused by IGP protocol modules to support segment routing.

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 [RFC2119].

Status of This Memo

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

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on April 19, 2016.

Table of Contents

1. Introduction

This document defines a YANG data model for segment routing configuration and operation. This document does not define the IGP extensions to support segment routing but defines generic groupings that SHOULD be reused by IGP extension modules. The reason of this design choice is to not require implementations to support all IGP extensions. For example, an implementation may support IS-IS extension but not OSPF.

1.1. Tree diagram

A simplified graphical representation of the data model is presented in Section 2.

The meaning of the symbols in these diagrams is as follows:

- Brackets "[" and "]" enclose list keys.
- Curly braces "{" and "}" contain names of optional features that make the corresponding node conditional.
- Abbreviations before data node names: "rw" means configuration (read-write), and "ro" state data (read-only).
- Symbols after data node names: "?" means an optional node and "*" denotes a "list" or "leaf-list".
- Parentheses enclose choice and case nodes, and case nodes are also marked with a colon (":").
- Ellipsis ("...") stands for contents of subtrees that are not shown.

2. Design of the Data Model

As the module definition is just starting, it is expected that there will be changes as the module matures.

```
module: ietf-segment-routing
augment /rt:routing/rt:routing-instance:
   +--rw segment-routing
      +--rw transport-type?   identityref
      +--rw bindings
      |  +--rw mapping-server {mapping-server}?
      |  |  +--rw policy* [name]
      |  |     +--rw name    string
      |  |     +--rw ipv4
      |  |     |  +--rw mapping-entry* [prefix]
      |  |     |     +--rw prefix        inet:ipv4-prefix
      |  |     |     +--rw value-type?   enumeration
      |  |     |     +--rw start-sid     uint32
      |  |     |     +--rw range?        uint32
      |  |     +--rw ipv6
      |  |        +--rw mapping-entry* [prefix]
      |  |           +--rw prefix        inet:ipv6-prefix
      |  |           +--rw value-type?   enumeration
      |  |           +--rw start-sid     uint32
```

```
      |  |           +--rw range?        uint32
      |  +--rw connected-prefix-sid-map
      |     +--rw ipv4
      |     |  +--rw ipv4-prefix-sid* [prefix]
      |     |     +--rw prefix               inet:ipv4-prefix
      |     |     +--rw value-type?          enumeration
      |     |     +--rw start-sid            uint32
      |     |     +--rw range?               uint32
      |     |     +--rw last-hop-behavior?   enumeration {sid-last-hop-
behavior}?
      |     +--rw ipv6
      |        +--rw ipv6-prefix-sid* [prefix]
      |           +--rw prefix               inet:ipv6-prefix
      |           +--rw value-type?          enumeration
      |           +--rw start-sid            uint32
      |           +--rw range?               uint32
      |           +--rw last-hop-behavior?   enumeration {sid-last-hop-
behavior}?
      +--rw global-srgb
         +--rw srgb* [lower-bound upper-bound]
            +--rw lower-bound    uint32
            +--rw upper-bound    uint32
augment /rt:routing-state/rt:routing-instance:
   +--ro segment-routing
      +--ro node-capabilities
      |  +--ro transport-planes* [transport-plane]
      |  |  +--ro transport-plane    identityref
      |  +--ro segment-stack-push-limit?     uint8
      |  +--ro readable-label-stack-depth?   uint8
      +--ro label-blocks*
      |  +--ro lower-bound?   uint32
      |  +--ro upper-bound?   uint32
      |  +--ro size?          uint32
      |  +--ro free?          uint32
      |  +--ro used?          uint32
      +--ro global-sid-list
         +--ro sid* [target sid source source-protocol binding-type]
            +--ro target             string
            +--ro sid                uint32
            +--ro algorithm?         uint8
            +--ro source             inet:ip-address
            +--ro used?              boolean
            +--ro source-protocol    leafref
            +--ro binding-type       enumeration
notifications:
   +---n segment-routing-global-sid-collision
   |  +--ro received-target?    string
   |  +--ro original-target?    string
```

```
   |  +--ro index?              uint32
   |  +--ro routing-protocol?   leafref
```

```
   +---n segment-routing-index-out-of-range
      +--ro received-target?    string
      +--ro received-index?     uint32
      +--ro routing-protocol?   leafref
```

3. Configuration

This module augments the "/rt:routing/rt:routing-instance:" with a segment-routing container. This container defines all the configuration parameters related to segment-routing for this particular routing-instance.

The segment-routing configuration is split in global routing-instance configuration and interface configuration.

The global configuration includes :

- segment-routing transport type : The underlying transport type for segment routing. The version of the model limits the transport type to an MPLS dataplane. The transport-type is only defined once for a particular routing-instance and is agnostic to the control plane used. Only a single transport-type is supported in this version of the model.

- bindings : Defines prefix to SID mappings. The operator can control advertisement of Prefix-SID independently for IPv4 and IPv6. Two types of mappings are available :

  * Mapping-server : maps non local prefixes to a segment ID. Configuration of bindings does not automatically allow advertisement of those bindings. Advertisement must be controlled by each routing-protocol instance (see Section 4). Multiple mapping policies may be defined.

  * Connected prefixes : maps connected prefixes to a segment ID. Advertisement of the mapping will be done by IGP when enabled for segment routing (see Section 4). The SID value can be expressed as an index (default), or an absolute value. The "last-hop-behavior" configuration dictates the PHP behavior: "explicit-null", "php", or "non-php".

- SRGB (Segment Routing Global Block): Defines a list of label blocks represented by a pair of lower-bound/upper-bound labels. The SRGB is also agnostic to the control plane used. So all routing-protocol instance will have to advertise the same SRGB.

4. IGP Control plane configuration

Support of segment-routing extensions for a particular IGP control plane is done by augmenting routing-protocol configuration with segment-routing extensions. This augmentation SHOULD be part of separate YANG modules in order to not create any dependency for implementations to support all protocol extensions.

This module defines groupings that SHOULD be used by IGP segment routing modules.

The "controlplane-cfg" grouping defines the generic global configuration for the IGP.

The "enabled" leaf enables segment-routing extensions for the routing-protocol instance.

The "bindings" container controls the routing-protocol instance's advertisement of local bindings and the processing of received bindings.

4.1. IGP interface configuration

The interface configuration is part of the "igp-interface-cfg" grouping and includes Adjacency SID properties.

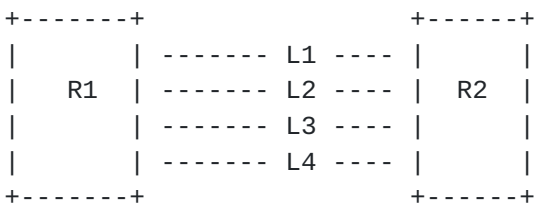
4.1.1. Adjacency SID properties

4.1.1.1. Bundling

This section is a first proposal on how to use S-bit in Adj-SID to create bundles. Authors would like to trigger discussion based on this first proposal.

In case of parallel IP links between routers, an additional Adjacency SID may be advertised representing more than one adjacency (i.e., a bundle of adjacencies). The "advertise-adj-group-sid" configuration controls whether or not an additional adjacency SID is advertised.

The "advertise-adj-group-sid" would be a list of "group-id". The "group-id" will permit to identify interfaces that must be bundled together.



In the figure above, R1 and R2 are interconnected by four links. A routing protocol adjacency is established on each link. Operator would like to create segment-routing Adj-SID that represent some bundles of links. We can imagine two different bundles : L1/L2 and L2/L3. To achieve this behavior, the service provider will configure a "group-id" X for both interfaces L1 and L2 and a "group-id" Y for both interfaces L3 and L3. This will result in R1 advertising an additional Adj-SID for each adjacency, for example a Adj-SID with S flag set and value of 400 will be added to L1 and L2. A Adj-SID with S flag set and value of 500 will be added to L3 and L4. As L1/L2 and L3/L4 does not share the same "group-id", a different SID value will be allocated.

4.1.1.2. Protection

The "advertise-protection" defines how protection for an interface is advertised. It does not control the activation or deactivation of protection. If the "single" option is used, a single Adj-SID will be advertised for the interface. If the interface is protected, the B-Flag for the Adj-SID advertisement will be set. If the "dual" option is used and if the interface is protected, two Adj-SIDs will be advertised for the interface adjacencies. One Adj-SID will always have the B-Flag set and the other will have the B-Flag clear. This option is intended to be used in the case of traffic engineering where a path must use either protected segments or non-protected segments.

5. States

The operational states contains information reflecting the usage of allocated SRGB labels.

It also includes a list of all global SIDs, their associated bindings, and other information such as the source protocol and algorithm.

6. Notifications

The model proposes two notifications for segment-routing.

- segment-routing-global-sid-collision: Raised when a control plane advertised index is already associated with another target (in this version, the only defined targets are IPv4 and IPv6 prefixes).

- segment-routing-index-out-of-range: Raised when a control plane advertised index fall outside the range of SRGBs configured for the network device.

7. YANG Module

```
<CODE BEGINS> file "ietf-segment-routing@2015-10-17.yang"

module ietf-segment-routing {
  namespace "urn:ietf:params:xml:ns:"
          + "yang:ietf-segment-routing";
  prefix sr;

  import ietf-inet-types {
    prefix "inet";
  }

  import ietf-routing {
    prefix "rt";
  }

  organization
   "IETF SPRING Working Group";

  contact
    "WG List:  <mailto:spring@ietf.org>

    Editor:    Stephane Litkowski
               <mailto:stephane.litkowski@orange.com>

    Author:    Acee Lindem
               <mailto:acee@cisco.com>
    Author:    Yingzhen Qu
               <mailto:yiqu@cisco.com>
    Author:    Pushpasis Sarkar
               <mailto:psarkar@juniper.net>
    Author:    Ing-Wher Chen
               <mailto:ing-wher.chen@ericsson.com>
    Author:    Jeff Tantsura
               <jeff.tantsura@ericsson.com>

    ";
```

```
    description
      "The YANG module defines a generic configuration model for
      Segment routing common across all of the vendor
      implementations.";

    revision 2015-10-17 {
      description "
        * Add per-protocol SRGB config feature
        * Move SRBG config to a grouping
      ";
      reference
        "RFC XXXX: YANG Data Model for Segment Routing.";
    }
    revision 2015-06-22 {
      description "
        * Prefix SID config moved to
          connected-prefix-sid-map in global SR cfg
          rather than IGP.
        ";
        reference "draft-litkowski-spring-sr-yang-01";
    }
    revision 2015-04-23 {
      description "
        * Node flag deprecated from prefixSID
        * SR interface cfg moved to protocol
        * Adding multiple binding policies for SRMS
        ";
        reference "";
    }
    revision 2015-02-27 {
      description "Initial";
      reference "draft-litkowski-spring-sr-yang-00";
    }

    /* Identities */
    identity segment-routing-transport {
      description
      "Base identity for segment routing transport.";
    }
    identity segment-routing-transport-mpls {
      base segment-routing-transport;
      description
      "This identity represents MPLS transport for segment
      routing.";
    }

    /* Features */
```

```
     feature mapping-server {
       description
        "Support of SRMS.";
     }

     feature sid-last-hop-behavior {
       description
         "Configurable last hop behavior.";
     }

     feature protocol-srgb {
       description
         "Support per-protocol srgb configuration.";
     }

     /* Groupings */

     grouping srgb-cfg {
       list srgb {
         key "lower-bound upper-bound";
         ordered-by user;
         leaf lower-bound {
           type uint32;
           description
             "Lower value in the block.";
         }
         leaf upper-bound {
           type uint32;
           description
             "Upper value in the block.";
         }
         description
           "List of global blocks to be
            advertised.";
       }
       description
         "Grouping for SRGB configuration.";
     }

     grouping controlplane-cfg {
       container segment-routing {
         leaf enabled {
           type boolean;
           default false;
           description
            "Enables segment-routing
            protocol extensions.";
         }
```

```
        container bindings {
          container advertise {
            leaf-list policies {
                          type string;
                          description
                           "List of policies to be advertised.";
                        }
            description
                    "Authorize the advertise
            of local mappings in binding TLV.";
          }
          leaf receive {
            type boolean;
            default true;
            description
            "Authorize the reception and usage
            of binding TLV.";
          }
          description
           "Control of binding advertisement
           and reception.";
        }

        description
        "segment routing global config.";
      }
      description
       "Defines protocol configuration.";
    }

    grouping sid-value-type {
      leaf value-type {
        type enumeration {
          enum index {
            description
              "The value will be
               interpreted as an index.";
          }
          enum absolute {
            description
              "The value will become
               interpreted as an absolute
               value.";
          }
        }
        default index;
        description
          "This leaf defines how value
```

```
            must be interpreted.";
      }
          description
           "Defines how the SID value is expressed.";
    }

    grouping ipv4-sid-cfg {

        leaf prefix {
          type inet:ipv4-prefix;
          description
            "connected prefix sid.";
        }

      uses sid-value-type;

        leaf start-sid {
          type uint32;
          mandatory true;
          description
          "Value associated with
          prefix. The value must
          be interpreted in the
          context of value-type.";
        }

        leaf range {
          type uint32;
          description
            "Describes how many SIDs could be
             allocated.";
        }
      description
       "This grouping defines cfg of prefix SID.";
    }

    grouping ipv6-sid-cfg {
        leaf prefix {
          type inet:ipv6-prefix;
          description
            "connected prefix sid.";
        }

      uses sid-value-type;

        leaf start-sid {
          type uint32;
          mandatory true;
```

```
          description
          "Value associated with
          prefix. The value must
          be interpreted in the
          context of value-type.";
        }

        leaf range {
          type uint32;
          description
            "Describes how many SIDs could be
             allocated.";
        }

      description
       "This grouping defines cfg of prefix SID.";
    }

    grouping last-hop-behavior {
      leaf last-hop-behavior {
        if-feature sid-last-hop-behavior;
        type enumeration {
          enum explicit-null {
            description
              "Use explicit-null for the SID.";
          }
          enum no-php {
            description
              "Do no use PHP for the SID.";
          }
          enum php {
              description
               "Use PHP for the SID.";
          }
        }
        description
          "Configure last hop behavior.";
      }
          description
           "Defines last hop behavior";
    }

    grouping igp-interface-cfg {
          container segment-routing {

           container adjacency-sid {
                  list advertise-adj-group-sid {
                    key group-id;
```

```
                  leaf group-id {
                        type uint32;
                        description

                         "The value is an internal value to identify
                         a group-ID. Interfaces with the same
                         group-ID will be bundled together.
                         ";
                  }
                  description
                   "Control advertisement of S flag.
                         Enable to advertise a common Adj-SID
                         for parallel links.";
                }
                leaf advertise-protection {
                  type enumeration {
                        enum "single" {
                          description
                           "A single Adj-SID is associated
                           with the adjacency and reflects
                           the protection configuration.";
                        }
                        enum "dual" {
                          description
                           "Two Adj-SIDs will be associated
                           with the adjacency if interface
                           is protected. In this case
                           one will be enforced with
                           backup flag set, the other
                           will be enforced to backup flag unset.
                           In case, protection is not configured,
                           a single Adj-SID will be advertised
                           with backup flag unset.";
                        }
                  }
                  description
                   "If set, the Adj-SID refers to an
                  adjacency being protected.";
                }
                description
                 "Defines the adjacency SID properties.";
          }
          description
           "container for SR interface cfg.";
        }
          description
           "Grouping for IGP interface cfg.";
    }
```

```
     /* Cfg */

     augment "/rt:routing/rt:routing-instance" {
       description
        "This augments routing-instance
        configuration with segment-routing.";
       container segment-routing {
         leaf transport-type {
           type identityref {
             base segment-routing-transport;
           }
           default "segment-routing-transport-mpls";
           description "Dataplane to be used.";
         }
         container bindings {
           container mapping-server {
             if-feature mapping-server;
             list policy {
               key name;
               leaf name {
                 type string;
                 description
                   "Name of the mapping policy.";
             }
             container ipv4 {
               list mapping-entry {
                 key prefix;
                 uses ipv4-sid-cfg;

                 description
                   "Mapping entries.";
               }
               description
                 "IPv4 mapping entries.";
             }
             container ipv6 {
               list mapping-entry {
                 key prefix;
                 uses ipv6-sid-cfg;
                 description
                   "Mapping entries.";
               }
               description
                 "IPv6 mapping entries.";
             }
             description
               "Definition of mapping policy.";
           }
```

```
          description
            "Configuration of mapping-server
             local entries.";
        }
        container connected-prefix-sid-map {
          container ipv4 {
            list ipv4-prefix-sid {
              key prefix;
              uses ipv4-sid-cfg;
              uses last-hop-behavior;
              description
                "List of prefix SID
                 mapped to IPv4 local prefixes.";
            }
            description
              "Parameters associated with IPv4 prefix SID";
          }
          container ipv6 {
            list ipv6-prefix-sid {
              key prefix;
              uses ipv6-sid-cfg;
              uses last-hop-behavior;
              description
                "List of prefix SID
                 mapped to IPv6 local prefixes.";
            }
            description
              "Parameters associated with IPv6 prefix SID";
          }
          description
            "Prefix SID configuration.";
        }
        description
          "List of bindings.";
      }
      container global-srgb {
        uses srgb-cfg;
        description
          "Global SRGB configuration.";
      }
      description
        "segment routing global config.";
      }
    }

    /* Operational states */
```

```
     augment "/rt:routing-state/rt:routing-instance" {
       description
        "This augments the operational states
         with segment-routing.";
       container segment-routing {
         container node-capabilities {
           list transport-planes {
             key transport-plane;
             leaf transport-plane {
               type identityref {
                 base segment-routing-transport;
               }
               description
                 "Transport plane supported";
             }
             description
               "List of supported transport planes.";
           }
           leaf segment-stack-push-limit {
             type uint8;
             description
               "Describes the number of segments
                that can be pushed by the node.";
           }
           leaf readable-label-stack-depth {
             type uint8;
             description
               "Number of MPLS labels that
                can be read in the stack.";
           }
           description
             "Shows the SR capability of the node.";
         }
         list label-blocks {
           leaf lower-bound {
             type uint32;
             description
              "Lower bound of the label block.";
           }
           leaf upper-bound {
             type uint32;
             description
              "Upper bound of the label block.";
           }
           leaf size {
             type uint32;
             description
              "Number of indexes in the block.";
```

```
          }
          leaf free {
            type uint32;
            description
             "Number of indexes free in the block.";
          }
          leaf used {
            type uint32;
            description
             "Number of indexes used in the block.";
          }
          description
           "List of labels blocks currently
           in use.";
        }

        container global-sid-list {
          list sid {
            key "target sid source source-protocol binding-type";
            ordered-by system;
            leaf target {
              type string;
              description
               "Defines the target of the binding.
               It can be a prefix or something else.";
            }
            leaf sid {
              type uint32;
              description
               "Index associated with the prefix.";
            }
            leaf algorithm {
              type uint8;
              description
               "Algorithm to be used for the prefix
               SID.";
            }
            leaf source {
              type inet:ip-address;
              description
               "IP address of the router than own
                the binding.";
            }
            leaf used {
              type boolean;
              description
               "Defines if the binding is used
                in forwarding plane.";
```

```
            }
            leaf source-protocol {
              type leafref {
                path "/rt:routing-state/rt:routing-instance/" +
                "rt:routing-protocols/rt:routing-protocol/rt:name";
              }
              description
               "Rtg protocol that owns the binding";
            }
            leaf binding-type {
              type enumeration {
                enum prefix-sid {
                  description
                   "Binding is learned from
                   a prefix SID.";
                }
                enum binding-tlv {
                  description
                   "Binding is learned from
                   a binding TLV.";
                }
              }
              description
               "Type of binding.";
            }
            description
              "Binding.";

          }
          description
           "List of prefix and SID associations.";
        }
        description
         "Segment routing operational states.";
      }
    }


    /* Notifications */

    notification segment-routing-global-sid-collision {
      leaf received-target {
        type string;
        description
        "Target received in the controlplane that
                          caused SID collision.";
      }
      leaf original-target {
```

```
        type string;
        description
        "Target already available in database that have the same SID
        as the received target.";
      }
      leaf index {
        type uint32;
        description
        "Value of the index used by two different prefixes.";
      }
      leaf routing-protocol {
        type leafref {
          path "/rt:routing-state/rt:routing-instance/" +
          "rt:routing-protocols/rt:routing-protocol/rt:name";
        }
        description
         "Routing protocol reference that received the event.";
      }
      description
        "This notification is sent when a new mapping is learned
        , containing mapping
        where the SID is already used.
        The notification generation must be throttled with at least
         a 5 second gap. ";
    }
    notification segment-routing-index-out-of-range {
      leaf received-target {
        type string;
        description
        "Target received in the controlplane
                          that caused SID collision.";
      }
      leaf received-index {
        type uint32;
        description
        "Value of the index received.";
      }
      leaf routing-protocol {
        type leafref {
          path "/rt:routing-state/rt:routing-instance/" +
          "rt:routing-protocols/rt:routing-protocol/rt:name";
        }
        description
         "Routing protocol reference that received the event.";
      }
      description
        "This notification is sent when a binding
        is received, containing a segment index
```

```
        which is out of the local configured ranges.
        The notification generation must be throttled with at least
         a 5 second gap. ";
    }
  }
  <CODE ENDS>
```

8. Security Considerations

TBD.

9. Acknowledgements

Authors would like to thank Derek Yeung, Acee Lindem, Greg Hankins, Hannes Gredler, Uma Chunduri, Jeffrey Zhang, Shradda Hedge for their contributions.

10. IANA Considerations

TBD.

11. Normative References

[I-D.ietf-spring-segment-routing]
Filsfils, C., Previdi, S., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", draft-ietf-spring-segment-routing-03 (work in progress), May 2015.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC6020] Bjorklund, M., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, October 2010.

Authors' Addresses

Stephane Litkowski
Orange Business Service

Email: stephane.litkowski@orange.com

Yingzhen Qu
Cisco Systems

Email: yiqu@cisco.com

Pushpasis Sarkar
Juniper Networks

Email: psarkar@juniper.net

Jeff Tantsura
Ericsson

Email: jeff.tantsura@ericsson.com