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**RIB YANG Data Model**  
**draft-acee-rtgwg-yang-rib-extend-10.txt**

Abstract

The Routing Information Base (RIB) is a list of routes and their corresponding administrative data and operational state.

[RFC 8349](#) defines the basic building blocks for RIB, and this model augments it to support multiple next-hops (aka, paths) for each route as well as additional attributes.

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## [1.](#) Introduction

This document defines a YANG, [[RFC6020](#)][[RFC7950](#)], data model which extends the generic data model for RIB by augmenting the ietf-routing model as defined in [[RFC8349](#)].

RIB is a collection of best routes from all routing protocols. Within a protocol routes are selected based on the metrics in use by that protocol, and the protocol install its best routes to RIB. RIB selects the best route by comparing the route preference (aka, administrative distance) of the associated protocol.

The augmentations described herein extend the RIB to support multiple paths per route, route metrics, and administrative tags.

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



## 2. Terminology and Notation

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.

The following terms are defined in [[RFC8342](#)]:

- o client
- o server
- o configuration
- o system state
- o operational state
- o intended configuration

The following terms are defined in [[RFC7950](#)]:

- o action
- o augment
- o container
- o container with presence
- o data model
- o data node
- o feature
- o leaf
- o list
- o mandatory node
- o module
- o schema tree



- o RPC (Remote Procedure Call) operation

**2.1. Glossary of New Terms**

Routing Information Base (RIB): An object containing a list of routes, together with other information. See [\[RFC8349\]](#) [Section 5.2](#) for details.

**2.2. Tree Diagrams**

Tree diagrams used in this document follow the notation defined in [\[RFC8340\]](#).

**2.3. Prefixes in Data Node Names**

In this document, names of data nodes, actions, and other data model objects are often used without a prefix, as long as it is clear from the context in which YANG module each name is defined. Otherwise, names are prefixed using the standard prefix associated with the corresponding YANG module, as shown in Table 1.

| Prefix | YANG module               | Reference                 |
|--------|---------------------------|---------------------------|
| if     | ietf-interfaces           | <a href="#">[RFC8343]</a> |
| rt     | ietf-routing              | <a href="#">[RFC8349]</a> |
| v4ur   | ietf-ipv4-unicast-routing | <a href="#">[RFC8349]</a> |
| v6ur   | ietf-ipv6-unicast-routing | <a href="#">[RFC8349]</a> |
| inet   | ietf-inet-types           | <a href="#">[RFC6991]</a> |

Table 1: Prefixes and Corresponding YANG Modules

**3. Design of the Model**

The YANG definitions in this document augment the ietf-routing model defined in [\[RFC8349\]](#), which provides a basis for routing system data model development. Together with modules defined in [\[RFC8349\]](#), a generic RIB Yang model is defined to implement and monitor RIB.

The models in [\[RFC8349\]](#) also define the basic configuration and operational state for both IPv4 and IPv6 static routes and this document also provides augmentations for static routes to support multiple next-hop and more next-hop attributes.



### **[3.1.](#) RIB Tags and Preference**

Individual routes tags will be supported at both the route and next-hop level. A preference per next-hop is also supported for selection of the most preferred reachable static route.

### **[3.2.](#) Multiple next-hops**

Both Ipv4 and IPv6 static route configuration defined in [[RFC8349](#)] have been augmented with a multi-next-hop option.

A static route/prefix can be configured to have multiple next-hops, each with their own tag and route preference.

In RIB, a route may have multiple next-hops. They can be either equal cost multiple paths (ECMP), or they may have different metrics.

### **[3.3.](#) Repair path**

The loop-free alternate (LFA) Fast Reroute (FRR) pre-computes repair paths by routing protocols, and RIB stores the best repair path.

A repair path is augmented in RIB operation state for each path.

## **[4.](#) RIB Model Tree**

The tree associated with the "ietf-rib-extension" module follows. The meaning of the symbols can be found in [[RFC8340](#)]. The ietf-routing.yang tree with the augmentations herein is included in [Appendix A](#).

```
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v4ur:ipv4
  /v4ur:route/v4ur:next-hop/v4ur:next-hop-options
  /v4ur:simple-next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v4ur:ipv4
  /v4ur:route/v4ur:next-hop/v4ur:next-hop-options
  /v4ur:next-hop-list/v4ur:next-hop-list/v4ur:next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v6ur:ipv6
  /v6ur:route/v6ur:next-hop/v6ur:next-hop-options
```





```

    /v6ur:simple-next-hop:
  +-rw preference?      uint32
  +-rw tag?             uint32
  +-rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v6ur:ipv6
  /v6ur:route/v6ur:next-hop/v6ur:next-hop-options
  /v6ur:next-hop-list/v6ur:next-hop-list/v6ur:next-hop:
  +-rw preference?      uint32
  +-rw tag?             uint32
  +-rw application-tag? uint32
augment /rt:routing/rt:ribs/rt:rib:
  +-ro rib-summary-statistics
    +-ro total-routes?      uint32
    +-ro total-active-routes? uint32
    +-ro total-route-memory? uint64
    +-ro protocol-rib-statistics* []
      +-ro rib-protocol?      identityref
      +-ro protocol-total-routes? uint32
      +-ro protocol-active-routes? uint32
      +-ro protocol-route-memory? uint64
augment /rt:routing/rt:ribs/rt:rib/rt:routes/rt:route:
  +-ro metric?      uint32
  +-ro tag?         uint32
  +-ro application-tag? uint32
augment /rt:routing/rt:ribs/rt:rib/rt:routes:
  +-ro repair-route* [id]
    +-ro id          string
    +-ro next-hop
      | +-ro outgoing-interface? if:interface-state-ref
      | +-ro next-hop-address?   inet:ip-address
    +-ro metric?      uint32
augment /rt:routing/rt:ribs/rt:rib/rt:routes/rt:route
  /rt:next-hop/rt:next-hop-options/rt:simple-next-hop:
  +-ro repair-path?
    -> /rt:routing/ribs/rib/routes/repair-route/id
augment /rt:routing/rt:ribs/rt:rib/rt:routes/rt:route
  /rt:next-hop/rt:next-hop-options/rt:special-next-hop:
  +-ro repair-path?
    -> /rt:routing/ribs/rib/routes/repair-route/id
augment /rt:routing/rt:ribs/rt:rib/rt:routes/rt:route
  /rt:next-hop/rt:next-hop-options/rt:next-hop-list
  /rt:next-hop-list/rt:next-hop:
  +-ro repair-path?
    -> /rt:routing/ribs/rib/routes/repair-route/id

```



## 5. RIB YANG Model

```
<CODE BEGINS> file "ietf-rib-extension@2019-03-01.yang"
module ietf-rib-extension {
  yang-version "1.1";
  namespace "urn:ietf:params:xml:ns:yang:ietf-rib-extension";

  prefix rib-ext;

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

  import ietf-interfaces {
    prefix "if";
  }

  import ietf-routing {
    prefix "rt";
  }

  import ietf-ipv4-unicast-routing {
    prefix "v4ur";
  }

  import ietf-ipv6-unicast-routing {
    prefix "v6ur";
  }

  organization
    "IETF RTGWG - Routing Working Group";

  contact
    "WG Web: <http://datatracker.ietf.org/group/rtgwg/>
    WG List: <mailto:rtgwg@ietf.org>

    Author: Acee Lindem
           <mailto:acee@cisco.com>
    Author: Yingzhen Qu
           <mailto:yingzhen.qu@huawei.com>";

  description
    "This YANG module extends the generic data model for
    RIB by augmenting the ietf-netmod-routing-cfg
    model. It is intended that the module will be extended
    by vendors to define vendor-specific RIB parameters.

    This YANG model conforms to the Network Management
```



Datastore Architecture (NDMA) as described in [RFC 8342](#).

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

```
revision 2019-03-01 {
  description
    "Initial RFC Version";
  reference
    "RFC XXXX: A YANG Data Model for RIB Extensions.";
}

/* Groupings */
grouping rib-statistics {
  description "Statistics grouping used for RIB augmentation";
  container rib-summary-statistics {
    config false;
    description "Container for RIB statistics";
    leaf total-routes {
      type uint32;
      description
        "Total routes in the RIB from all protocols";
    }
    leaf total-active-routes {
      type uint32;
      description
        "Total active routes in the RIB";
    }
    leaf total-route-memory {
      type uint64;
      description
        "Total memory for all routes in the RIB from all
        protocol clients";
    }
  }
  list protocol-rib-statistics {
    description "List protocol statistics";
    leaf rib-protocol {
      type identityref {
```



```
        base rt:routing-protocol;
    }
    description "Routing protocol for statistics";
}
leaf protocol-total-routes {
    type uint32;
    description
        "Total number routes for protocol in the RIB";
}
leaf protocol-active-routes {
    type uint32;
    description
        "Number active routes for protocol in the RIB";
}
leaf protocol-route-memory {
    type uint64;
    description
        "Total memory for all routes in the RIB for protocol";
}
}
}
}
}

grouping next-hop {
    description
        "Next-hop grouping";
    leaf interface {
        type if:interface-ref;
        description
            "Outgoing interface";
    }
    leaf address {
        type inet:ip-address;
        description
            "IPv4 or IPv6 Address of the next-hop";
    }
}

grouping attributes {
    description
        "Common attributes applicable to all paths";
    leaf metric {
        type uint32;
        description "Route metric";
    }
    leaf tag {
        type uint32;
        description "Route tag";
    }
}
```





```
    }
    leaf application-tag {
      type uint32;
      description "Additional Application-Specific Route tag";
    }
  }
  grouping path-attribute {
    description
      "Path attribute grouping";
    leaf repair-path {
      type leafref {
        path "/rt:routing/rt:ribs/rt:rib/"
          + "rt:routes/repair-route/id";
      }
      description
        "IP Fast ReRoute (IPFRR) repair path, use a path
        from repair-route list";
    }
  }
}

augment "/rt:routing/rt:control-plane-protocols/"
  + "rt:control-plane-protocol/rt:static-routes/v4ur:ipv4/"
  + "v4ur:route/v4ur:next-hop/v4ur:next-hop-options/"
  + "v4ur:simple-next-hop"
{
  description
    "Augment 'simple-next-hop' case in IPv4 unicast route.";
  leaf preference {
    type uint32;
    default "1";
    description "Route preference - Used to select among multiple
      static routes with a lower preference next-hop
      preferred and equal preference paths yielding
      Equal Cost Multi-Path (ECMP).";
  }
  leaf tag {
    type uint32;
    default "0";
    description "Route tag";
  }
  leaf application-tag {
    type uint32;
    description "Additional Application-Specific Route tag";
  }
}

augment "/rt:routing/rt:control-plane-protocols/"
  + "rt:control-plane-protocol/rt:static-routes/v4ur:ipv4/"
```



```
    + "v4ur:route/v4ur:next-hop/v4ur:next-hop-options/"
    + "v4ur:next-hop-list/v4ur:next-hop-list/v4ur:next-hop"
  {
    description
      "Augment static route configuration 'next-hop-list'.";

    leaf preference {
      type uint32;
      default "1";
      description "Route preference - Used to select among multiple
        static routes with a lower preference next-hop
        preferred and equal preference paths yielding
        Equal Cost Multi-Path (ECMP).";
    }
    leaf tag {
      type uint32;
      default "0";
      description "Route tag";
    }
    leaf application-tag {
      type uint32;
      description "Additional Application-Specific Route tag";
    }
  }
}

augment "/rt:routing/rt:control-plane-protocols/"
  + "rt:control-plane-protocol/rt:static-routes/v6ur:ipv6/"
  + "v6ur:route/v6ur:next-hop/v6ur:next-hop-options/"
  + "v6ur:simple-next-hop"
{
  description
    "Augment 'simple-next-hop' case in IPv6 unicast route.";
  leaf preference {
    type uint32;
    default "1";
    description "Route preference - Used to select among multiple
      static routes with a lower preference next-hop
      preferred and equal preference paths yielding
      Equal Cost Multi-Path (ECMP).";
  }
  leaf tag {
    type uint32;
    default "0";
    description "Route tag";
  }
  leaf application-tag {
    type uint32;
    description "Additional Application-Specific Route tag";
  }
}
```



```
    }
  }

  augment "/rt:routing/rt:control-plane-protocols/"
    + "rt:control-plane-protocol/rt:static-routes/v6ur:ipv6/"
    + "v6ur:route/v6ur:next-hop/v6ur:next-hop-options/"
    + "v6ur:next-hop-list/v6ur:next-hop-list/v6ur:next-hop"
  {
    description
      "Augment static route configuration 'next-hop-list'.";

    leaf preference {
      type uint32;
      default "1";
      description "Route preference - Used to select among multiple
        static routes with a lower preference next-hop
        preferred and equal preference paths yielding
        Equal Cost Multi-Path (ECMP).";
    }
    leaf tag {
      type uint32;
      default "0";
      description "Route tag";
    }
    leaf application-tag {
      type uint32;
      description "Additional Application-Specific Route tag";
    }
  }

  augment "/rt:routing/rt:ribs/rt:rib"
  {
    description "Augment a RIB with statistics";
    uses rib-statistics;
  }

  augment "/rt:routing/rt:ribs/rt:rib/"
    + "rt:routes/rt:route"
  {
    description
      "Augment a route in RIB with tag.";
    uses attributes;
  }

  augment "/rt:routing/rt:ribs/rt:rib/"
    + "rt:routes"
  {
    description
```



```
    "Augment a route with a list of repair-paths.";
list repair-route {
  key "id";
  description
    "A repair-path entry, which can be referenced
    by a repair-path.";
  leaf id {
    type string;
    description
      "A unique identifier.";
  }

  container next-hop {
    description
      "Route's next-hop attribute.";
    leaf outgoing-interface {
      type if:interface-state-ref;
      description
        "Name of the outgoing interface.";
    }
    leaf next-hop-address {
      type inet:ip-address;
      description
        "IP address of the next hop.";
    }
  }
  leaf metric {
    type uint32;
    description "Route metric";
  }
}

augment "/rt:routing/rt:ribs/rt:rib/"
  + "rt:routes/rt:route/rt:next-hop/rt:next-hop-options/"
  + "rt:simple-next-hop"
{
  description
    "Add more parameters to a path.";
  uses path-attribute;
}

augment "/rt:routing/rt:ribs/rt:rib/"
  + "rt:routes/rt:route/rt:next-hop/rt:next-hop-options/"
  + "rt:special-next-hop"
{
  description
    "Add more parameters to a path.";
```





```
    uses path-attribute;
  }

  augment "/rt:routing/rt:ribs/rt:rib/"
    + "rt:routes/rt:route/rt:next-hop/rt:next-hop-options/"
    + "rt:next-hop-list/rt:next-hop-list/rt:next-hop"
  {
    description
      "This case augments the 'next-hop-options' in the routing
      model.";
    uses path-attribute;
  }
}
<CODE ENDS>
```

## 6. Security Considerations

The YANG modules specified in this document define a schema for data that is designed to be accessed via network management protocols such as NETCONF [[RFC6241](#)] or RESTCONF [[RFC8040](#)]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [[RFC6242](#)]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [[RFC5246](#)].

The NETCONF access control model [[RFC8341](#)] provides the means to restrict access for particular NETCONF or RESTCONF users to a pre-configured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in `ietf-rib-extensions.yang` module that are writable/creatable/deletable (i.e., `config true`, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., `edit-config`) to these data nodes without proper protection can have a negative effect on network operations. For these augmentations to `ietf-routing.yang`, the ability to delete, add, and modify IPv4 and IPv6 static routes would allow traffic to be misrouted.

Some of the readable data nodes in the `ietf-rib-extensions.yang` module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via `get`, `get-config`, or notification) to these data nodes. The exposure of the Routing Information Base (RIB) will expose the routing topology of the network. This may be undesirable since both due to the fact that exposure may facilitate other attacks. Additionally, network operators may consider their topologies to be sensitive confidential data.



All the security considerations for [RFC8349] writable and readable data nodes apply to the augmentations described herein.

## 7. IANA Considerations

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

URI: urn:ietf:params:xml:ns:yang:ietf-rib-extension

Registrant Contact: The IESG.

XML: N/A, the requested URI is an XML namespace.

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

name: ietf-acl namespace: urn:ietf:params:xml:ns:yang:ietf-rib-extension prefix: ietf-rib-ext reference: RFC XXXX

## 8. References

### 8.1. Normative References

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```

|         |         |         +--:(next-hop-list)
|         |         |         +--ro next-hop-list
|         |         |         +--ro next-hop* []
|         |         |         +--ro outgoing-interface?
|         |         |         if:interface-ref
|         |         +--ro source-protocol identityref
|         |         +--ro active? empty
|         |         +--ro last-updated? yang:date-and-time
|         +--rw description? string
o--ro routing-state
  +--ro router-id? yang:dotted-quad
  o--ro interfaces
  | o--ro interface* if:interface-state-ref
  o--ro control-plane-protocols
  | o--ro control-plane-protocol* [type name]
  |   o--ro type identityref
  |   o--ro name string
  o--ro ribs
  o--ro rib* [name]
  o--ro name string
  +--ro address-family identityref
  o--ro default-rib? boolean {multiple-ribs}?
  o--ro routes
  | o--ro route* []
  |   o--ro route-preference? route-preference
  |   o--ro next-hop
  |   | +--ro (next-hop-options)
  |   |   +--:(simple-next-hop)
  |   |   | +--ro outgoing-interface? if:interface-ref
  |   |   +--:(special-next-hop)
  |   |   | +--ro special-next-hop? enumeration
  |   |   +--:(next-hop-list)
  |   |   +--ro next-hop-list
  |   |   +--ro next-hop* []
  |   |   +--ro outgoing-interface?
  |   |   if:interface-ref
  |   +--ro source-protocol identityref
  |   +--ro active? empty
  |   +--ro last-updated? yang:date-and-time
  o---x active-route
  +--ro output
  o--ro route
  o--ro next-hop
  | +--ro (next-hop-options)
  |   +--:(simple-next-hop)
  |   | +--ro outgoing-interface?
  |   |   if:interface-ref
  |   +--:(special-next-hop)

```



```

|      | +--ro special-next-hop?      enumeration
|      +--:(next-hop-list)
|      +--ro next-hop-list
|      +--ro next-hop* []
|      +--ro outgoing-interface?
|      if:interface-ref
+--ro source-protocol  identityref
+--ro active?         empty
+--ro last-updated?  yang:date-and-time

```

module: ietf-rib-extension

```

augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v4ur:ipv4
  /v4ur:route/v4ur:next-hop/v4ur:next-hop-options
  /v4ur:simple-next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v4ur:ipv4
  /v4ur:route/v4ur:next-hop/v4ur:next-hop-options
  /v4ur:next-hop-list/v4ur:next-hop-list/v4ur:next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v6ur:ipv6
  /v6ur:route/v6ur:next-hop/v6ur:next-hop-options
  /v6ur:simple-next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:control-plane-protocols
  /rt:control-plane-protocol/rt:static-routes/v6ur:ipv6
  /v6ur:route/v6ur:next-hop/v6ur:next-hop-options
  /v6ur:next-hop-list/v6ur:next-hop-list/v6ur:next-hop:
  +--rw preference?      uint32
  +--rw tag?             uint32
  +--rw application-tag? uint32
augment /rt:routing/rt:ribs/rt:rib:
  +--ro rib-summary-statistics
  +--ro total-routes?      uint32
  +--ro total-active-routes? uint32
  +--ro total-route-memory? uint64
  +--ro protocol-rib-statistics* []
  +--ro rib-protocol?      identityref
  +--ro protocol-total-routes? uint32
  +--ro protocol-active-routes? uint32

```



```

    +--ro protocol-route-memory?    uint64
augment /rt:routing/rt:ribs/rt:rib/rt:routess/rt:route:
  +--ro metric?                    uint32
  +--ro tag?                        uint32
  +--ro application-tag?           uint32
augment /rt:routing/rt:ribs/rt:rib/rt:routess:
  +--ro repair-route* [id]
    +--ro id                        string
    +--ro next-hop
      | +--ro outgoing-interface?  if:interface-state-ref
      | +--ro next-hop-address?    inet:ip-address
    +--ro metric?                  uint32
augment /rt:routing/rt:ribs/rt:rib/rt:routess/rt:route/rt:next-hop
  /rt:next-hop-options/rt:simple-next-hop:
  +--ro repair-path? -> /rt:routing/ribs/rib/routess/repair-route/id
augment /rt:routing/rt:ribs/rt:rib/rt:routess/rt:route/rt:next-hop
  /rt:next-hop-options/rt:special-next-hop:
  +--ro repair-path? -> /rt:routing/ribs/rib/routess/repair-route/id
augment /rt:routing/rt:ribs/rt:rib/rt:routess/rt:route/rt:next-hop
  /rt:next-hop-options/rt:next-hop-list/rt:next-hop-list
  /rt:next-hop:
  +--ro repair-path? -> /rt:routing/ribs/rib/routess/repair-route/id

```

## [Appendix B.](#) `ietf-rib-extension.yang` examples

Examples will be added in a future version of this document.

## [Appendix C.](#) Acknowledgments

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