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A YANG Data Model for Protocol Independent Multicast (PIM)
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Abstract

This document defines a YANG data model that can be used to configure and manage devices supporting Protocol Independent Multicast (PIM). The model covers the PIM protocol configuration, operational state, and event notifications data.

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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1. Introduction

YANG [RFC7950] is a data modeling language that was introduced to model the configuration and operational state of a device managed using network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. YANG is now also being used as a component of other management interfaces, such as CLIs.

This document defines a YANG data model that can be used to configure and manage devices supporting Protocol Independent Multicast (PIM). This model supports the core PIM protocol, as well as many other features described in Section 2.1. Non-core features are defined as optional in the provided data model.

1.1. Terminology

The terminology for describing YANG data models is found in [RFC7950].

The following abbreviations are used in this document and the defined model:

ASM:
Any-Source Multicast service model [RFC3569] [RFC4607].

BFD:
Bidirectional Forwarding Detection [RFC5880].

BSR:
Bootstrap Router [RFC5059].

DF:
Designated Forwarder [RFC5015].

DR:
Designated Router [RFC7761].

IGMP:
Internet Group Management Protocol [RFC3376].

MLD:
Multicast Listener Discovery [RFC3810].

MSDP:
Multicast Source Discovery Protocol [RFC3618].

mLDP:
Multipoint extensions for LDP [RFC6388].

MRIB:
Multicast Routing Information Base [RFC3973] [RFC5015] [RFC7761].

mVPN:
Multicast VPN.

PIM:
Protocol Independent Multicast. [RFC3973] [RFC5015] [RFC7761].

PIM-BIDIR:
Protocol Independent Multicast - Bidirectional Mode [RFC5015].

PIM-DM:
Protocol Independent Multicast - Dense Mode [RFC3973].

PIM-SM:
Protocol Independent Multicast - Sparse Mode [RFC7761].

RP:
Rendezvous Point. [RFC7761].

RPA:
Rendezvous Point Address. [RFC5015].

RPF:
Reverse Path Forwarding. [RFC3973] [RFC5015] [RFC7761].

RPT:
Rendezvous-Point Tree. [RFC7761].

SPT:
Shortest Path Tree. [RFC7761].

SSM:
Source-Specific Multicast service model [RFC3569] [RFC4607].

VRF:
Virtual Routing and Forwarding.

1.2. Tree Diagrams

Tree diagrams used in this document follow the notation defined in [RFC8340].

In addition, the following notation is used as a placeholder at the location of the name of a tree node, to represent a section of nodes:

<summary description of a section of nodes>

1.3. 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
yang	ietf-yang-types	[RFC6991]
inet	ietf-inet-types	[RFC6991]
if	ietf-interfaces	[RFC8343]
rt	ietf-routing	[RFC8349]
rt-types	ietf-routing-types	[RFC8294]
bfd-types	ietf-bfd-types	[I-D.ietf-bfd-yang]

Table 1: Prefixes and Corresponding YANG Modules

2. Design of Data Model

2.1. Scope of Model

The model covers PIM Sparse Mode [RFC7761], including the Source-Specific subset [RFC3569] [RFC4607], Dense Mode [RFC3973], and Bi-directional PIM [RFC5015].

The PIM extensions represented in the model include BSR [RFC5059] and Anycast-RP [RFC4610].

The data model can be used to configure and manage these protocol features. The operational state data and statistics can be retrieved by this model. The protocol specific notifications are also defined in the model.

This model does not cover other multicast protocols such as IGMP/MLD, MSDP, mVPN, or mLDP in-band signalling. It does not cover any configuration required to generate the MRIB. These will be specified in separate documents.

2.2. Optional Capabilities

This model is designed to represent the capabilities of devices supporting PIM with various specifications, including some with basic subsets of the PIM protocol. The main design goals of this document are that any major now-existing implementation may be said to support the base model, and that the configuration of all implementations meeting the specification is easy to express through some combination of the features in the base model and simple vendor augmentations.

There is also value in widely-supported features being standardized, to save work for individual vendors, and so that mapping between different vendors' configuration is not needlessly complicated. Therefore, these modules declare a number of features representing capabilities that not all deployed devices support.

The extensive use of feature declarations should also substantially simplify the capability negotiation process for a vendor's PIM implementation.

On the other hand, operational state parameters are not so widely designated as features, as there are many cases where the defaulting of an operational state parameter would not cause any harm to the system, and it is much more likely that an implementation without native support for a piece of operational state would be able to derive a suitable value for a state variable that is not natively supported.

For the same reason, wide constant ranges (for example, timer maxima and minima) are used in the model. It is expected that vendors will augment the model with any specific extensions and restrictions needed to adapt it to their vendor-specific implementation.

2.3. Datastore Applicability

This model conforms to the Network Management Datastore Architecture (NMDA) [RFC8342]. The operational state data is combined with the associated configuration data in the same hierarchy [I-D.ietf-netmod-rfc6087bis].

2.4. Module and Hierarchy Organization

This model defines several separate modules for modelling PIM configuration, defined below. Again, this separation makes it easier to express the specific capabilities of a PIM device. The module organization, along with the usage of the YANG extensible features such as identity, allows the model to be easily augmented for new capabilities.

The hierarchy of PIM configuration is designed so that objects that are only relevant for one situation or feature are collected in a container for that feature. For example, the configuration for PIM-SM that is not relevant for an SSM-only implementation is collected in an ASM container.

Where fields are not genuinely essential to protocol operation, they are marked as optional. Some fields are essential but have a default specified, so they need not be explicitly configured.

This module structure also applies, where applicable, to the operational state and notifications of the model.

2.5. Position of Address Family in Hierarchy

This document contains address-family as a node in the hierarchy multiple times: both under the interface list, and under the PIM instance.

The reasoning for this is to make it easier for implementations in which configuration options are not supported for specific address families.

For these implementations, the restriction that interface configuration must be address-family independent may either be expressed as a vendor augmentation of an address-family-independent

parameter above the address-family level, or by a constraint on the base model objects of a form similar to:

```
deviation "/rt:routing/rt:control-plane-protocols/"
  + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
  + "pim-base:address-family" {

  deviate add {
    must "(address-family = 'rt:ipv4' and dr-priority = "
      + "../address-family[address-family = 'rt:ipv6']/"
      + "dr-priority) or "
      + "(address-family = 'rt:ipv6' and dr-priority = "
      + "../address-family[address-family = 'rt:ipv4']/"
      + "dr-priority)" {
      error-message
        "Error: IPv6 DR priority must match IPv4 DR priority.";
      error-app-tag "dr-priority-mismatch";
    }
  }
}
```

3. Module Structure

3.1. PIM Base Module

The PIM base module defines the base framework not specific to any PIM mode, and is imported by the other modules. The base module by itself does not provide sufficient data for any PIM mode to operate. Other mode specific and feature specific modules need to be implemented in addition to this module, depending on the feature set required by the implementation.

This model augments the core routing data model "ietf-routing" specified in [RFC8349]. The PIM base model augments "/rt:routing/rt:control-plane-protocols" as opposed to augmenting "/rt:routing/rt:control-plane-protocols/rt:control-plane-protocol", as the latter would allow multiple protocol instances, while the PIM protocol is designed to be enabled or disabled as a single protocol instance on a network instance or a logical network element.

3.1.1. High-Level Structure

The high-level structure of the model is shown below:

```
module: ietf-pim-base
  augment /rt:routing/rt:control-plane-protocols:
    +--rw pim!
       +--rw <global configuration>
       +--ro <global operational state>
       +--rw address-family* [address-family]
       |  +--rw address-family        identityref
       |  +--rw <per address family configuration>
       |  +--ro <per address family operational state>
       +--rw interfaces
          +--rw interface* [name]
             +--rw name              if:interface-ref
             +--rw address-family* [address-family]
                +--rw address-family       identityref
                +--rw <per interface configuration>
                +--ro <per interface operational state>
                +--ro neighbors
                   +--ro ipv4-neighbor* [address]
                   |  +--ro address            inet:ipv4-address
                   |  +--ro <IPv4 per neighbor operational state>
                   +--ro ipv6-neighbor* [address]
                      +--ro address            inet:ipv6-address
                      +--ro <IPv4 per neighbor operational state>
```

The presence of the top-level container "pim" enables the PIM protocols.

3.1.2. Global Data

The global configuration and operational state data covers the support for graceful restart in the PIM base model. Additional features can be added by augmentation if required by an implementation.

3.1.3. Per Address Family Data

The support for per address family data is shown below:

```
   +--rw pim!
      +--rw address-family* [address-family]
      |  +--rw address-family        identityref
      |  +--rw graceful-restart
               ...
      |  +--ro statistics
      |  |  +--ro discontinuity-time?   yang:date-and-time
      |  |  +--ro error
      |  |  |  +--ro assert?                       yang:counter32
                  ...
      |  |  +--ro queue
      |  |  |  +--ro size?       uint32
      |  |  |  +--ro overflow?   yang:counter32
      |  |  +--ro received
      |  |  |  +--ro assert?                       yang:counter32
                  ...
      |  |  +--ro sent
      |  |     +--ro assert?                       yang:counter32
                  ...
      |  +--ro topology-tree-info
      |  |  +--ro ipv4-route* [group source-address is-rpt]
      |  |  |  +--ro group
      |  |  |  |       rt-types:ipv4-multicast-group-address
      |  |  |  +--ro source-address
      |  |  |  |       rt-types:ipv4-multicast-source-address
      |  |  |  +--ro is-rpt                boolean
      |  |  +--ro ipv6-route* [group source-address is-rpt]
      |  |     +--ro group
      |  |     |       rt-types:ipv6-multicast-group-address
      |  |     +--ro source-address
      |  |     |       rt-types:ipv6-multicast-source-address
      |  |     +--ro is-rpt                boolean
                  ...
      |  |     +--ro incoming-interface?   if:interface-ref
                  ...
      |  |     +--ro outgoing-interface* [name]
      |  |        +--ro name          if:interface-ref
      |  |        +--ro expiration?   rt-types:timer-value-seconds16
      |  |        +--ro up-time?      rt-types:timeticks64
      |  |        +--ro jp-state?     enumeration
```

This is the location that most of the PIM RP module (ietf-pim-rp) augments. Each of the mode specific modules also augments this schema tree.

3.1.4. PIM Interface Modeling

The configuration and operational state data of PIM interfaces is modeled as below:

```
+--rw pim!
   +--rw interfaces
      +--rw interface* [name]
         +--rw name              if:interface-ref
         +--rw address-family* [address-family]
            +--rw address-family       identityref
            +--rw bfd {bfd}?
                  ...
            +--rw dr-priority?         uint32 {intf-dr-priority}?
            +--rw hello-interval?      rt-types:timer-value-seconds16
            |       {intf-hello-interval}?
            +--rw (hello-holdtime-or-multiplier)?
            |  +--:(holdtime) {intf-hello-holdtime}?
            |  |  +--rw hello-holdtime?
            |  |          rt-types:timer-value-seconds16
            |  +--:(multiplier) {intf-hello-multiplier}?
            |     +--rw hello-multiplier?
            |             rt-types:timer-multiplier
            +--rw jp-interval?         rt-types:timer-value-seconds16
            |       {intf-jp-interval}?
            +--rw (jp-holdtime-or-multiplier)?
            |  +--:(holdtime) {intf-jp-holdtime}?
            |  |  +--rw jp-holdtime?
            |  |          rt-types:timer-value-seconds16
            |  +--:(multiplier) {intf-jp-multiplier}?
            |     +--rw jp-multiplier?
            |             rt-types:timer-multiplier
            +--rw override-interval?   uint16
            |       {intf-override-interval}?
            +--rw propagation-delay?   uint16
            |       {intf-propagation-delay}?
            +--ro oper-status?         enumeration
            +--ro gen-id?              uint32
            +--ro hello-expiration?    rt-types:timer-value-seconds16
            +--ro ipv4
            |  +--ro address*      inet:ipv4-address
            |  +--ro dr-address?   inet:ipv4-address
            +--ro ipv6
            |  +--ro address*      inet:ipv6-address
            |  +--ro dr-address?   inet:ipv6-address
```

The support for bfd is achieved by using a grouping provided by an external module ietf-bfd-types, defined in [I-D.ietf-bfd-yang].

3.1.5. Neighbor Modeling

For each PIM interface, there can be a list of neighbors, which contain operational state data. To model such data, the following structure is specified:

```
+--rw pim!
   +--rw interfaces
      +--rw interface* [name]
         +--rw address-family* [address-family]
            +--ro neighbors
               +--ro ipv4-neighbor* [address]
               |  +--ro address            inet:ipv4-address
               |  +--ro bfd-status?        enumeration
               |  +--ro expiration?
               |  |       rt-types:timer-value-seconds16
               |  +--ro dr-priority?       uint32
               |  +--ro gen-id?            uint32
               |  +--ro lan-prune-delay
               |  |  +--ro present?             boolean
               |  |  +--ro override-interval?   uint16
               |  |  +--ro propagation-delay?   uint16
               |  |  +--ro t-bit?               boolean
               |  +--ro up-time?           rt-types:timeticks64
               +--ro ipv6-neighbor* [address]
                  +--ro address            inet:ipv6-address
                  +--ro bfd-status?        enumeration
                  +--ro expiration?
                  |       rt-types:timer-value-seconds16
                  +--ro dr-priority?       uint32
                  +--ro gen-id?            uint32
                  +--ro lan-prune-delay
                  |  +--ro present?             boolean
                  |  +--ro override-interval?   uint16
                  |  +--ro propagation-delay?   uint16
                  |  +--ro t-bit?               boolean
                  +--ro up-time?           rt-types:timeticks64
```

3.1.6. Notifications

The PIM base module also defines the notifications for PIM interface and neighbor events, as shown below:

```
  notifications:
    +---n pim-neighbor-event
    |  +--ro event-type?          neighbor-event-type
    |  +--ro interface-ref?       leafref
    |  +--ro interface-af-ref?    leafref
    |  +--ro neighbor-ipv4-ref?   leafref
    |  +--ro neighbor-ipv6-ref?   leafref
    |  +--ro up-time?             rt-types:timeticks64
    +---n pim-interface-event
       +--ro event-type?      interface-event-type
       +--ro interface-ref?   leafref
       +--ro ipv4
       |  +--ro address*      inet:ipv4-address
       |  +--ro dr-address?   inet:ipv4-address
       +--ro ipv6
          +--ro address*      inet:ipv6-address
          +--ro dr-address?   inet:ipv6-address
```

3.2. PIM RP Module

The PIM RP module augments the PIM base module to define the configuration and operational state information scoped to RP related features:

```
module: ietf-pim-rp
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family:
    +--rw rp
       +--rw static-rp
             ...
       +--rw bsr {bsr}?
             ...
       +--ro rp-list
             ...
       +--ro rp-mappings
             ...
```

This module is shared by the PIM-SM mode and the PIM-BIDIR mode, but not by the PIM-DM mode. PIM-SM module and PIM-BIDIR module augment this module to cover mode specific data.

The following sections describe the features and capabilities covered in this module.

3.2.1. Static RP

Static RPs can be configured by using the following portion of the module:

```
+--rw rp
   +--rw static-rp
   |  +--rw ipv4-rp* [rp-address]
   |  |  +--rw rp-address    inet:ipv4-address
   |  +--rw ipv6-rp* [rp-address]
   |     +--rw rp-address    inet:ipv6-address
```

3.2.2. BSR

The support for BSR includes both configuration data and operational state data, as shown below:

```
   +--rw rp
      +--rw bsr {bsr}?
      |  +--rw bsr-candidate!
      |  |  +--rw (interface-or-address)?
      |  |  |  +--:(interface) {candidate-interface}?
      |  |  |  |  +--rw interface           if:interface-ref
      |  |  |  +--:(ipv4-address) {candidate-ipv4}?
      |  |  |  |  +--rw ipv4-address        inet:ipv4-address
      |  |  |  +--:(ipv6-address) {candidate-ipv6}?
      |  |  |     +--rw ipv6-address        inet:ipv6-address
      |  |  +--rw hash-mask-length    uint8
      |  |  +--rw priority?           uint8
      |  +--rw rp-candidate
      |  |  +--rw interface* [name] {candidate-interface}?
      |  |  |  +--rw name             if:interface-ref
      |  |  |  +--rw policy-name?     string
      |  |  |  +--rw mode?            identityref
      |  |  +--rw ipv4-address* [address] {candidate-ipv4}?
      |  |  |  +--rw address          inet:ipv4-address
      |  |  |  +--rw policy-name?     string
      |  |  |  +--rw mode?            identityref
      |  |  +--rw ipv6-address* [address] {candidate-ipv6}?
      |  |     +--rw address          inet:ipv6-address
      |  |     +--rw policy-name?     string
      |  |     +--rw mode?            identityref
      |  +--ro bsr
      |  |  +--ro address?             inet:ip-address
      |  |  +--ro hash-mask-length?    uint8
      |  |  +--ro priority?            uint8
      |  |  +--ro up-time?             rt-types:timeticks64
      |  +--ro (election-state)? {bsr-election-state}?
      |  |  +--:(candidate)
      |  |  |  +--ro candidate-bsr-state?               enumeration
      |  |  +--:(non-candidate)
      |  |     +--ro non-candidate-bsr-state?           enumeration
      |  +--ro bsr-next-bootstrap?                uint16
      |  +--ro rp
      |  |  +--ro rp-address?    inet:ip-address
      |  |  +--ro policy-name?   string
      |  |  +--ro up-time?       rt-types:timeticks64
      |  +--ro rp-candidate-next-advertisement?   uint16
```

3.2.3. RP State Data

This portion of the model provides the operational state information for all RPs on the router, including the statically configured RPs and the BSR elected RPs.

```
+--rw rp
   +--ro rp-list
   |  +--ro ipv4-rp* [rp-address mode]
   |  |  +--ro rp-address             inet:ipv4-address
   |  |  +--ro mode                   identityref
   |  |  +--ro info-source-address?   inet:ipv4-address
   |  |  +--ro info-source-type?      identityref
   |  |  +--ro up-time?               rt-types:timeticks64
   |  |  +--ro expiration?            rt-types:timer-value-seconds16
   |  +--ro ipv6-rp* [rp-address mode]
   |     +--ro rp-address             inet:ipv6-address
   |     +--ro mode                   identityref
   |     +--ro info-source-address?   inet:ipv6-address
   |     +--ro info-source-type?      identityref
   |     +--ro up-time?               rt-types:timeticks64
   |     +--ro expiration?            rt-types:timer-value-seconds16
```

3.2.4. RP to Group Mappings

The operational state data of the mappings between RPs and multicast groups is modeled as follows:

```
+--rw rp
   +--ro rp-mappings
      +--ro ipv4-rp* [group rp-address]
      |  +--ro group         inet:ipv4-prefix
      |  +--ro rp-address    inet:ipv4-address
      |  +--ro up-time?      rt-types:timeticks64
      |  +--ro expiration?   rt-types:timer-value-seconds16
      +--ro ipv6-rp* [group rp-address]
         +--ro group         inet:ipv6-prefix
         +--ro rp-address    inet:ipv6-address
         +--ro up-time?      rt-types:timeticks64
         +--ro expiration?   rt-types:timer-value-seconds16
```

3.2.5. Notifications

The PIM RP module also defines the notifications for RP related events, as shown below:

```
  notifications:
    +---n pim-rp-event
       +--ro event-type?        rp-event-type
       +--ro instance-af-ref?   leafref
       +--ro group?             rt-types:ip-multicast-group-address
       +--ro rp-address?        inet:ip-address
       +--ro is-rpt?            boolean
       +--ro mode?              pim-base:pim-mode
       +--ro message-origin?    inet:ip-address
```

3.3. PIM-SM Module

The PIM-SM module covers Sparse Mode modeling, including PIM-ASM and PIM-SSM. This module has dependencies on PIM base module and PIM RP module, both of which are augmented by this module.

The augmentation to the address-family branch of the PIM base module is shown below:

```
module: ietf-pim-sm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family:
    +--rw sm
       +--rw asm
       |  +--rw anycast-rp!
       |  |  +--rw ipv4-anycast-rp* [anycast-address rp-address]
       |  |  |  +--rw anycast-address    inet:ipv4-address
       |  |  |  +--rw rp-address         inet:ipv4-address
       |  |  +--rw ipv6-anycast-rp* [anycast-address rp-address]
       |  |     +--rw anycast-address    inet:ipv6-address
       |  |     +--rw rp-address         inet:ipv6-address
       |  +--rw spt-switch
       |     +--rw infinity! {spt-switch-infinity}?
       |        +--rw policy-name?   string {spt-switch-policy}?
       +--rw ssm!
          +--rw range-policy?   string
```

To support SM mode on an interface, this module augments the interface branch of the PIM base module, as follows:

```
module: ietf-pim-sm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:interfaces/pim-base:interface/pim-base:address-family:
    +--rw sm!
       +--rw passive?   empty
```

This module also augments the PIM RP module to allow an RP to be configured in the PIM-SM mode:

```
module: ietf-pim-sm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family/pim-rp:rp/pim-rp:static-rp/pim-rp:ipv4-rp:
    +--rw sm!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family/pim-rp:rp/pim-rp:static-rp/pim-rp:ipv6-rp:
    +--rw sm!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
```

3.4. PIM-DM Module

The PIM-DM module covers Dense Mode modeling. This module augments the PIM base module, but it has no dependency on the PIM RP module.

```
module: ietf-pim-dm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family:
    +--rw dm!
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:interfaces/pim-base:interface
            /pim-base:address-family:
    +--rw dm!
```

3.5. PIM-BIDIR Module

The PIM-BIDIR module covers Bidirectional PIM modeling. Like PIM-SM, this module augments both PIM base module and PIM RP module.

The followings are the augmentations to the PIM base module, on the address-family, the interface, and the neighbor branches:

```
module: ietf-pim-bidir
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family:
    +--rw bidir!

  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:interfaces/pim-base:interface/pim-base:address-family:
    +--rw bidir!
       +--rw df-election {intf-df-election}?
          +--rw offer-interval?     uint16
          +--rw backoff-interval?   uint16
          +--rw offer-multiplier?   uint8

  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:interfaces/pim-base:interface/pim-base:address-family
/pim-base:neighbors/pim-base:ipv4-neighbor:
    +--ro bidir-capable?   boolean

  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:interfaces/pim-base:interface/pim-base:address-family
/pim-base:neighbors/pim-base:ipv6-neighbor:
    +--ro bidir-capable?   boolean
```

This module also augments the PIM RP module to extend the capabilities of RP for the PIM-BIDIR mode:

```
module: ietf-pim-bidir
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family/pim-rp:rp/pim-rp:static-rp/pim-rp:ipv4-rp:
    +--rw bidir!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?

  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family/pim-rp:rp/pim-rp:static-rp/pim-rp:ipv6-rp:
    +--rw bidir!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?

  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
/pim-base:address-family/pim-rp:rp:
    +--ro bidir
       +--ro df-election
       |  +--ro ipv4-rp* [rp-address]
       |  |  +--ro rp-address    inet:ipv4-address
       |  +--ro ipv6-rp* [rp-address]
       |     +--ro rp-address    inet:ipv6-address
       +--ro interface-df-election
          +--ro ipv4-rp* [rp-address interface-name]
          |  +--ro rp-address                 inet:ipv4-address
          |  +--ro interface-name             if:interface-ref
          |  +--ro df-address?                inet:ipv4-address
          |  +--ro interface-state?           identityref
          |  +--ro up-time?                   rt-types:timeticks64
          |  +--ro winner-metric?             uint32
          |  +--ro winner-metric-preference?  uint32
          +--ro ipv6-rp* [rp-address interface-name]
             +--ro rp-address                 inet:ipv6-address
             +--ro interface-name             if:interface-ref
             +--ro df-address?                inet:ipv6-address
             +--ro interface-state?           identityref
             +--ro up-time?                   rt-types:timeticks64
             +--ro winner-metric?             uint32
             +--ro winner-metric-preference?  uint32
```

4. Complete Tree Structure

4.1. PIM Base Module

```
module: ietf-pim-base
  augment /rt:routing/rt:control-plane-protocols:
    +--rw pim!
```

```
          +--rw graceful-restart
          |  +--rw enabled?    boolean
          |  +--rw duration?   uint16
          +--rw address-family* [address-family]
          |  +--rw address-family        identityref
          |  +--rw graceful-restart
          |  |  +--rw enabled?    boolean
          |  |  +--rw duration?   uint16
          |  +--ro statistics
          |  |  +--ro discontinuity-time?   yang:date-and-time
          |  |  +--ro error
          |  |  |  +--ro assert?                       yang:counter64
          |  |  |  +--ro bsr?                          yang:counter64
          |  |  |  +--ro candidate-rp-advertisement?   yang:counter64
          |  |  |  +--ro df-election?                  yang:counter64
          |  |  |  +--ro graft?                        yang:counter64
          |  |  |  +--ro graft-ack?                    yang:counter64
          |  |  |  +--ro hello?                        yang:counter64
          |  |  |  +--ro join-prune?                   yang:counter64
          |  |  |  +--ro register?                     yang:counter64
          |  |  |  +--ro register-stop?                yang:counter64
          |  |  |  +--ro state-refresh?                yang:counter64
          |  |  |  +--ro checksum?                     yang:counter64
          |  |  |  +--ro format?                       yang:counter64
          |  |  +--ro queue
          |  |  |  +--ro size?       uint32
          |  |  |  +--ro overflow?   yang:counter32
          |  |  +--ro received
          |  |  |  +--ro assert?                       yang:counter64
          |  |  |  +--ro bsr?                          yang:counter64
          |  |  |  +--ro candidate-rp-advertisement?   yang:counter64
          |  |  |  +--ro df-election?                  yang:counter64
          |  |  |  +--ro graft?                        yang:counter64
          |  |  |  +--ro graft-ack?                    yang:counter64
          |  |  |  +--ro hello?                        yang:counter64
          |  |  |  +--ro join-prune?                   yang:counter64
          |  |  |  +--ro register?                     yang:counter64
          |  |  |  +--ro register-stop?                yang:counter64
          |  |  |  +--ro state-refresh?                yang:counter64
          |  |  +--ro sent
          |  |     +--ro assert?                       yang:counter64
          |  |     +--ro bsr?                          yang:counter64
          |  |     +--ro candidate-rp-advertisement?   yang:counter64
          |  |     +--ro df-election?                  yang:counter64
          |  |     +--ro graft?                        yang:counter64
          |  |     +--ro graft-ack?                    yang:counter64
          |  |     +--ro hello?                        yang:counter64
          |  |     +--ro join-prune?                   yang:counter64
```

```
|  |     +--ro register?                    yang:counter64
|  |     +--ro register-stop?               yang:counter64
|  |     +--ro state-refresh?               yang:counter64
|  +--ro topology-tree-info
|     +--ro ipv4-route* [group source-address is-rpt]
|     |  +--ro group
|     |  |       rt-types:ipv4-multicast-group-address
|     |  +--ro source-address
|     |  |       rt-types:ipv4-multicast-source-address
|     |  +--ro is-rpt               boolean
|     |  +--ro expiration?
|     |  |       rt-types:timer-value-seconds16
|     |  +--ro incoming-interface?   if:interface-ref
|     |  +--ro is-spt?               boolean
|     |  +--ro mode?                 identityref
|     |  +--ro msdp-learned?         boolean
|     |  +--ro rp-address?           inet:ip-address
|     |  +--ro rpf-neighbor?         inet:ip-address
|     |  +--ro up-time?              rt-types:timeticks64
|     |  +--ro outgoing-interface* [name]
|     |     +--ro name          if:interface-ref
|     |     +--ro expiration?   rt-types:timer-value-seconds16
|     |     +--ro up-time?      rt-types:timeticks64
|     |     +--ro jp-state?     enumeration
|     +--ro ipv6-route* [group source-address is-rpt]
|        +--ro group
|        |       rt-types:ipv6-multicast-group-address
|        +--ro source-address
|        |       rt-types:ipv6-multicast-source-address
|        +--ro is-rpt               boolean
|        +--ro expiration?
|        |       rt-types:timer-value-seconds16
|        +--ro incoming-interface?   if:interface-ref
|        +--ro is-spt?               boolean
|        +--ro mode?                 identityref
|        +--ro msdp-learned?         boolean
|        +--ro rp-address?           inet:ip-address
|        +--ro rpf-neighbor?         inet:ip-address
|        +--ro up-time?              rt-types:timeticks64
|        +--ro outgoing-interface* [name]
|           +--ro name          if:interface-ref
|           +--ro expiration?   rt-types:timer-value-seconds16
|           +--ro up-time?      rt-types:timeticks64
|           +--ro jp-state?     enumeration
+--rw interfaces
   +--rw interface* [name]
      +--rw name              if:interface-ref
      +--rw address-family* [address-family]
```

```
+--rw address-family           identityref
+--rw bfd {bfd}?
|  +--rw enable?                            boolean
|  +--rw local-multiplier?                  multiplier
|  +--rw (interval-config-type)?
|     +--:(tx-rx-intervals)
|     |  +--rw desired-min-tx-interval      uint32
|     |  +--rw required-min-rx-interval     uint32
|     +--:(single-interval)
|        +--rw min-interval                 uint32
+--rw dr-priority?              uint32
|       {intf-dr-priority}?
+--rw hello-interval?
|       rt-types:timer-value-seconds16
|       {intf-hello-interval}?
+--rw (hello-holdtime-or-multiplier)?
|  +--:(holdtime) {intf-hello-holdtime}?
|  |  +--rw hello-holdtime?
|  |          rt-types:timer-value-seconds16
|  +--:(multiplier) {intf-hello-multiplier}?
|     +--rw hello-multiplier?
|             rt-types:timer-multiplier
+--rw jp-interval?
|       rt-types:timer-value-seconds16
|       {intf-jp-interval}?
+--rw (jp-holdtime-or-multiplier)?
|  +--:(holdtime) {intf-jp-holdtime}?
|  |  +--rw jp-holdtime?
|  |          rt-types:timer-value-seconds16
|  +--:(multiplier) {intf-jp-multiplier}?
|     +--rw jp-multiplier?
|             rt-types:timer-multiplier
+--rw override-interval?        uint16
|       {intf-override-interval}?
+--rw propagation-delay?        uint16
|       {intf-propagation-delay}?
+--ro oper-status?              enumeration
+--ro gen-id?                   uint32
+--ro hello-expiration?
|       rt-types:timer-value-seconds16
+--ro ipv4
|  +--ro address*      inet:ipv4-address
|  +--ro dr-address?   inet:ipv4-address
+--ro ipv6
|  +--ro address*      inet:ipv6-address
|  +--ro dr-address?   inet:ipv6-address
+--ro neighbors
   +--ro ipv4-neighbor* [address]
```

```
                     |  +--ro address            inet:ipv4-address
                     |  +--ro bfd-state?         bfd-types:state
                     |  +--ro expiration?
                     |  |       rt-types:timer-value-seconds16
                     |  +--ro dr-priority?       uint32
                     |  +--ro gen-id?            uint32
                     |  +--ro lan-prune-delay
                     |  |  +--ro present?             boolean
                     |  |  +--ro override-interval?   uint16
                     |  |  +--ro propagation-delay?   uint16
                     |  |  +--ro t-bit?               boolean
                     |  +--ro up-time?           rt-types:timeticks64
                     +--ro ipv6-neighbor* [address]
                        +--ro address            inet:ipv6-address
                        +--ro bfd-state?         bfd-types:state
                        +--ro expiration?
                        |       rt-types:timer-value-seconds16
                        +--ro dr-priority?       uint32
                        +--ro gen-id?            uint32
                        +--ro lan-prune-delay
                        |  +--ro present?             boolean
                        |  +--ro override-interval?   uint16
                        |  +--ro propagation-delay?   uint16
                        |  +--ro t-bit?               boolean
                        +--ro up-time?           rt-types:timeticks64

   notifications:
     +---n pim-neighbor-event
     |  +--ro event-type?          neighbor-event-type
     |  +--ro interface-ref?       leafref
     |  +--ro interface-af-ref?    leafref
     |  +--ro neighbor-ipv4-ref?   leafref
     |  +--ro neighbor-ipv6-ref?   leafref
     |  +--ro up-time?             rt-types:timeticks64
     +---n pim-interface-event
        +--ro event-type?      interface-event-type
        +--ro interface-ref?   leafref
        +--ro ipv4
        |  +--ro address*      inet:ipv4-address
        |  +--ro dr-address?   inet:ipv4-address
        +--ro ipv6
           +--ro address*      inet:ipv6-address
           +--ro dr-address?   inet:ipv6-address
```

4.2. PIM RP Module

```
module: ietf-pim-rp
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family:
    +--rw rp
       +--rw static-rp
       |  +--rw ipv4-rp* [rp-address]
       |  |  +--rw rp-address    inet:ipv4-address
       |  +--rw ipv6-rp* [rp-address]
       |     +--rw rp-address    inet:ipv6-address
       +--rw bsr {bsr}?
       |  +--rw bsr-candidate!
       |  |  +--rw (interface-or-address)?
       |  |  |  +--:(interface) {candidate-interface}?
       |  |  |  |  +--rw interface       if:interface-ref
       |  |  |  +--:(ipv4-address) {candidate-ipv4}?
       |  |  |  |  +--rw ipv4-address    inet:ipv4-address
       |  |  |  +--:(ipv6-address) {candidate-ipv6}?
       |  |  |     +--rw ipv6-address    inet:ipv6-address
       |  |  +--rw hash-mask-length      uint8
       |  |  +--rw priority?             uint8
       |  +--rw rp-candidate
       |  |  +--rw interface* [name] {candidate-interface}?
       |  |  |  +--rw name           if:interface-ref
       |  |  |  +--rw policy-name?   string
       |  |  |  +--rw mode?          identityref
       |  |  +--rw ipv4-address* [address] {candidate-ipv4}?
       |  |  |  +--rw address        inet:ipv4-address
       |  |  |  +--rw policy-name?   string
       |  |  |  +--rw mode?          identityref
       |  |  +--rw ipv6-address* [address] {candidate-ipv6}?
       |  |     +--rw address        inet:ipv6-address
       |  |     +--rw policy-name?   string
       |  |     +--rw mode?          identityref
       |  +--ro bsr
       |  |  +--ro address?            inet:ip-address
       |  |  +--ro hash-mask-length?   uint8
       |  |  +--ro priority?           uint8
       |  |  +--ro up-time?            rt-types:timeticks64
       |  +--ro (election-state)? {bsr-election-state}?
       |  |  +--:(candidate)
       |  |  |  +--ro candidate-bsr-state?         enumeration
       |  |  +--:(non-candidate)
       |  |     +--ro non-candidate-bsr-state?     enumeration
       |  +--ro bsr-next-bootstrap?                uint16
       |  +--ro rp
```

```
          |  |  +--ro rp-address?    inet:ip-address
          |  |  +--ro policy-name?   string
          |  |  +--ro up-time?       rt-types:timeticks64
          |  +--ro rp-candidate-next-advertisement?   uint16
          +--ro rp-list
          |  +--ro ipv4-rp* [rp-address mode]
          |  |  +--ro rp-address             inet:ipv4-address
          |  |  +--ro mode                   identityref
          |  |  +--ro info-source-address?   inet:ipv4-address
          |  |  +--ro info-source-type?      identityref
          |  |  +--ro up-time?               rt-types:timeticks64
          |  |  +--ro expiration?
          |  |          rt-types:timer-value-seconds16
          |  +--ro ipv6-rp* [rp-address mode]
          |     +--ro rp-address             inet:ipv6-address
          |     +--ro mode                   identityref
          |     +--ro info-source-address?   inet:ipv6-address
          |     +--ro info-source-type?      identityref
          |     +--ro up-time?               rt-types:timeticks64
          |     +--ro expiration?
          |             rt-types:timer-value-seconds16
          +--ro rp-mappings
             +--ro ipv4-rp* [group-range rp-address]
             |  +--ro group-range    inet:ipv4-prefix
             |  +--ro rp-address     inet:ipv4-address
             |  +--ro up-time?       rt-types:timeticks64
             |  +--ro expiration?    rt-types:timer-value-seconds16
             +--ro ipv6-rp* [group-range rp-address]
                +--ro group-range    inet:ipv6-prefix
                +--ro rp-address     inet:ipv6-address
                +--ro up-time?       rt-types:timeticks64
                +--ro expiration?    rt-types:timer-value-seconds16

    notifications:
      +---n pim-rp-event
         +--ro event-type?        rp-event-type
         +--ro instance-af-ref?   leafref
         +--ro group?             rt-types:ip-multicast-group-address
         +--ro rp-address?        inet:ip-address
         +--ro is-rpt?            boolean
         +--ro mode?              identityref
         +--ro message-origin?    inet:ip-address
```

4.3. PIM-SM Module

```
module: ietf-pim-sm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family:
    +--rw sm
       +--rw asm
       |  +--rw anycast-rp!
       |  |  +--rw ipv4-anycast-rp* [anycast-address rp-address]
       |  |  |  +--rw anycast-address    inet:ipv4-address
       |  |  |  +--rw rp-address         inet:ipv4-address
       |  |  +--rw ipv6-anycast-rp* [anycast-address rp-address]
       |  |     +--rw anycast-address    inet:ipv6-address
       |  |     +--rw rp-address         inet:ipv6-address
       |  +--rw spt-switch
       |     +--rw infinity! {spt-switch-infinity}?
       |        +--rw policy-name?   string {spt-switch-policy}?
       +--rw ssm!
          +--rw range-policy?   string
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:interfaces/pim-base:interface
            /pim-base:address-family:
    +--rw sm!
       +--rw passive?   empty
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family/pim-rp:rp/pim-rp:static-rp
            /pim-rp:ipv4-rp:
    +--rw sm!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family/pim-rp:rp/pim-rp:static-rp
            /pim-rp:ipv6-rp:
    +--rw sm!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
```

4.4. PIM-DM Module

```
module: ietf-pim-dm
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family:
    +--rw dm!
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:interfaces/pim-base:interface
            /pim-base:address-family:
    +--rw dm!
```

4.5. PIM-BIDIR Module

```
module: ietf-pim-bidir
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family:
    +--rw bidir!
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:interfaces/pim-base:interface
            /pim-base:address-family:
    +--rw bidir!
       +--rw df-election {intf-df-election}?
          +--rw offer-interval?     uint16
          +--rw backoff-interval?   uint16
          +--rw offer-multiplier?   uint8
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family/pim-rp:rp/pim-rp:static-rp
            /pim-rp:ipv4-rp:
    +--rw bidir!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family/pim-rp:rp/pim-rp:static-rp
            /pim-rp:ipv6-rp:
    +--rw bidir!
       +--rw policy-name?   string
       +--rw override?      boolean {static-rp-override}?
  augment /rt:routing/rt:control-plane-protocols/pim-base:pim
            /pim-base:address-family/pim-rp:rp:
    +--ro bidir
       +--ro df-election
       |  +--ro ipv4-rp* [rp-address]
       |  |  +--ro rp-address    inet:ipv4-address
       |  +--ro ipv6-rp* [rp-address]
       |     +--ro rp-address    inet:ipv6-address
       +--ro interface-df-election
          +--ro ipv4-rp* [rp-address interface-name]
          |  +--ro rp-address                 inet:ipv4-address
          |  +--ro interface-name             if:interface-ref
          |  +--ro df-address?                inet:ipv4-address
          |  +--ro interface-state?           identityref
          |  +--ro up-time?                   rt-types:timeticks64
          |  +--ro winner-metric?             uint32
          |  +--ro winner-metric-preference?  uint32
          +--ro ipv6-rp* [rp-address interface-name]
             +--ro rp-address                 inet:ipv6-address
             +--ro interface-name             if:interface-ref
             +--ro df-address?                inet:ipv6-address
```

```
             +--ro interface-state?           identityref
             +--ro up-time?                   rt-types:timeticks64
             +--ro winner-metric?             uint32
             +--ro winner-metric-preference?  uint32
   augment /rt:routing/rt:control-plane-protocols/pim-base:pim
             /pim-base:interfaces/pim-base:interface
             /pim-base:address-family/pim-base:neighbors
             /pim-base:ipv4-neighbor:
     +--ro bidir-capable?   boolean
   augment /rt:routing/rt:control-plane-protocols/pim-base:pim
             /pim-base:interfaces/pim-base:interface
             /pim-base:address-family/pim-base:neighbors
             /pim-base:ipv6-neighbor:
     +--ro bidir-capable?   boolean
```

5. Relationship to the PIM-STD-MIB

The following sections describe the mappings between the objects in the PIM-STD-MIB defined in [RFC5060] and the YANG data nodes defined in this document.

5.1. pimInterfaceTable

pimInterfaceTable is mapped to pim/interfaces/interface. The key of pimInterfaceTable is pimInterfaceIfIndex and pimInterfaceIPVersion, while the key of the "interface" list in YANG is the node "name". For each value of pimInterfaceIPVersion, the "interface" list contains a corresponding sublist whose key is the node "address-family".

The following table lists the YANG data nodes with corresponding objects of pimInterfaceTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
address-family	pimInterfaceAddressType
ipv4/address	pimInterfaceAddress
ipv6/address	
gen-id	pimInterfaceGenerationIDValue
ipv4/dr-address	pimInterfaceDR
ipv6/dr-address	
dr-priority	pimInterfaceDRPriority
hello-interval	pimInterfaceHelloInterval
hello-holdtime	pimInterfaceHelloHoldtime
jp-interval	pimInterfaceJoinPruneInterval
jp-holdtime	pimInterfaceJoinPruneHoldtime
bidir/offer-multiplier	pimInterfaceDFElectionRobustness
propagation-delay	pimInterfacePropagationDelay
override-interval	pimInterfaceOverrideInterval

Table 2: YANG Nodes and pimInterfaceTable Objects

5.2. pimNeighborTable

pimNeighborTable is mapped to pim/interfaces/interface/neighbors/ipv4-neighbor and pim/interfaces/interface/neighbors/ipv6-neighbor.

The following table lists the YANG data nodes with corresponding objects of pimNeighborTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-neighbor	pimNeighborAddressType
ipv6-neighbor	
address	pimNeighborAddress
gen-id	pimNeighborGenerationIDValue
up-time	pimNeighborUpTime
expiration	pimNeighborExpiryTime
dr-priority	pimNeighborDRPriority
lan-prune-delay/present	pimNeighborLanPruneDelayPresent
lan-prune-delay/t-bit	pimNeighborTBit
lan-prune-delay/ propagation-delay	pimNeighborPropagationDelay
lan-prune-delay/ override-interval	pimNeighborOverrideInterval
ietf-pim-bidir:bidir-capable	pimNeighborBidirCapable

Table 3: YANG Nodes and pimNeighborTable Objects

5.3. pimStarGTable

pimStarGTable is mapped to pim/address-family/topology-tree-info/ipv4-route and pim/address-family/topology-tree-info/ipv6-route, when the value of source-address leaf is "ietf-routing-types:*" and the value of is-rpt leaf is "false".

The following table lists the YANG data nodes with corresponding objects of pimStarGTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-route	pimStarGAddressType
ipv6-route	
group	pimStarGGrpAddress
up-time	pimStarGUpTime
mode	pimStarGPimMode
rp-address	pimStarGRPAddressType
rp-address	pimStarGRPAddress
rpf-neighbor	pimStarGUpstreamNeighborType
rpf-neighbor	pimStarGUpstreamNeighbor
incoming-interface	pimStarGRPFIfIndex

Table 4: YANG Nodes and pimStarGTable Objects

In addtion, the object pimStarGPimModeOrigin in pimStarGTable is mapped to the node rp/rp-list/ipv4-rp/info-source-type or the node rp/rp-list/ipv6-rp/info-source-type in the YANG module ietf-pim-rp.

5.4. pimSGTable

pimSGTable is mapped to pim/address-family/topology-tree-info/ipv4-route and pim/address-family/topology-tree-info/ipv6-route, when the value of source-address leaf is not "ietf-routing-types:*" and the value of is-rpt leaf is "false".

The following table lists the YANG data nodes with corresponding objects of pimSGTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-route	pimSGAddressType
ipv6-route	
group	pimSGGrpAddress
source-address	pimSGSrcAddress
up-time	pimSGUpTime
mode	pimSGPimMode
rpf-neighbor	pimStarGUpstreamNeighbor
incoming-interface	pimStarGRPFIfIndex
is-spt	pimSGSPTBit
expiration	pimSGKeepaliveTimer

Table 5: YANG Nodes and pimSGTable Objects

5.5. pimSGRptTable

pimSGRptTable is mapped to pim/address-family/topology-tree-info/ipv4-route and pim/address-family/topology-tree-info/ipv6-route, when the value of is-rpt leaf is "true".

The following table lists the YANG data nodes with corresponding objects of pimSGRptTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-route	pimStarGAddressType
ipv6-route	
group	pimStarGGrpAddress
source-address	pimSGRptSrcAddress
up-time	pimSGRptUpTime

Table 6: YANG Nodes and pimSGRptTable Objects

5.6. pimBidirDFElectionTable

pimBidirDFElectionTable is mapped to pim/address-family/rp/bidir/interface-df-election/ipv4-rp and pim/address-family/rp/bidir/interface-df-election/ipv6-rp. The key of pimBidirDFElectionTable includes pimBidirDFElectionIfIndex whose type is InterfaceIndex, while the YANG lists use a node "name" with the type string instead.

The following table lists the YANG data nodes with corresponding objects of pimBidirDFElectionTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-rp	pimBidirDFElectionAddressType
ipv6-rp	
rp-address	pimBidirDFElectionRPAddress
df-address	pimBidirDFElectionWinnerAddressType
	pimBidirDFElectionWinnerAddress
up-time	pimBidirDFElectionWinnerUpTime
winner-metric-preference	pimBidirDFElectionWinnerMetricPref
winner-metric-preference	pimBidirDFElectionWinnerMetric
interface-state	pimBidirDFElectionState

Table 7: YANG Nodes and pimBidirDFElectionTable Objects

5.7. pimStaticRPTable

pimStaticRPTable is mapped to pim/address-family/rp/static-rp/ipv4-rp and pim/address-family/rp/static-rp/ipv6-rp.

The following table lists the YANG data nodes with corresponding objects of pimStaticRPTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-rp	pimStaticRPAddressType
ipv6-rp	
rp-address	pimStaticRPRPAddress
bidir	pimStaticRPPimMode
sm	
bidir/override	pimStaticRPOverrideDynamic
sm/override	

Table 8: YANG Nodes and pimStaticRPTable Objects

5.8. pimAnycastRPSetTable

pimAnycastRPSetTable is mapped to pim/address-family/sm/asm/anycast-rp/ipv4-anycast-rp and pim/address-family/sm/asm/anycast-rp/ipv6-anycast-rp.

The following table lists the YANG data nodes with corresponding objects of pimAnycastRPSetTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-anycast-rp	pimAnycastRPSetAddressType
ipv6-anycast-rp	
anycast-address	pimAnycastRPSetAnycastAddress
rp-address	pimAnycastRPSetRouterAddress

Table 9: YANG Nodes and pimAnycastRPSetTable Objects

5.9. pimGroupMappingTable

pimGroupMappingTable is mapped to pim/address-family/rp/rp-mappings/ipv4-rp and pim/address-family/rp/rp-mappings/ipv6-rp.

The following table lists the YANG data nodes with corresponding objects of pimGroupMappingTable in the PIM-STD-MIB.

YANG node	PIM-STD-MIB object
ipv4-rp	pimGroupMappingAddressType
ipv6-rp	
group	pimGroupMappingGrpAddress
	pimGroupMappingGrpPrefixLength
ipv4-rp	pimGroupMappingRPAddressType
ipv6-rp	
rp-address	pimGroupMappingRPAddress
	pimGroupMappingPimMode

Table 10: YANG Nodes and pimGroupMappingTable Objects

In addtion, the object pimGroupMappingPimMode in pimGroupMappingTable is mapped to the node rp/rp-list/ipv4-rp/mode or the node rp/rp-list/ipv6-rp/mode in the YANG module ietf-pim-rp.

6. PIM YANG Modules

6.1. PIM base module

This module references [RFC3973], [RFC5015], [RFC5306], [RFC5880], and [RFC7761].

```
<CODE BEGINS> file "ietf-pim-base@2018-04-16.yang"
module ietf-pim-base {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-pim-base";
  prefix pim-base;

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

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

  import ietf-routing-types {
    prefix "rt-types";
  }

  import ietf-interfaces {
    prefix "if";
  }
```

```
  import ietf-routing {
    prefix "rt";
  }

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

  organization
    "IETF PIM Working Group";

  contact
    "WG Web:   <http://tools.ietf.org/wg/pim/>
     WG List:  <mailto:pim@ietf.org>

     Editor:   Xufeng Liu
               <mailto:xufeng.liu.ietf@gmail.com>

     Editor:   Pete McAllister
               <mailto:pete.mcallister@metaswitch.com>

     Editor:   Anish Peter
               <mailto:anish.ietf@gmail.com>

     Editor:   Mahesh Sivakumar
               <mailto:sivakumar.mahesh@gmail.com>

     Editor:   Yisong Liu
               <mailto:liuyisong@huawei.com>

     Editor:   Fangwei Hu
               <mailto:hu.fangwei@zte.com.cn>";

  description
    "The module defines a collection of YANG definitions common for
     all PIM (Protocol Independent Multicast) modes.

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     authors of the code.  All rights reserved.

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     forth in Section 4.c of the IETF Trust's Legal Provisions
     Relating to IETF Documents
     (http://trustee.ietf.org/license-info).

     This version of this YANG module is part of RFC XXXX; see the
```

```
        RFC itself for full legal notices.";

    revision 2018-04-16 {
      description
        "Initial revision.";
      reference
        "RFC XXXX: A YANG Data Model for PIM";
    }

    /*
     * Features
     */
    feature bfd {
      description
        "Support BFD (Bidirectional Forwarding Detection).";
      reference
        "RFC5880: Bidirectional Forwarding Detection (BFD)";
    }

    feature global-graceful-restart {
      description
        "Global configuration for graceful restart support as per
         RFC5306.";
    }

    feature intf-dr-priority {
      description
        "Support configuration of interface DR (Designated Router)
         priority.";
      reference
        "RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.3.2.";
    }

    feature intf-hello-holdtime {
      description
        "Support configuration of interface hello holdtime.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.3.3.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-hello-interval {
      description
        "Support configuration of interface hello interval.";
      reference
```

```
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.8.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-hello-multiplier {
      description
        "Support configuration of interface hello multiplier.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.8.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-jp-interval {
      description
        "Support configuration of interface join prune interval.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.8.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-jp-holdtime {
      description
        "Support configuration of interface join prune holdtime.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.8.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-jp-multiplier {
      description
        "Support configuration of interface join prune multiplier.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.8.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature intf-propagation-delay {
      description
```

```
        "Support configuration of interface propagation delay.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.3.5.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.3.3.";
    }

    feature intf-override-interval {
      description
        "Support configuration of interface override interval.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.3.3.
         RFC5015: Bidirectional Protocol Independent Multicast
         (BIDIR-PIM). Sec. 3.6.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.11.";
    }

    feature per-af-graceful-restart {
      description
        "Per address family configuration for graceful restart support
         as per RFC5306.";
    }

    /*
     * Typedefs
     */
    typedef interface-event-type {
      type enumeration {
        enum up {
          description
            "Neighbor status changed to up.";
        }
        enum down {
          description
            "Neighbor status changed to down.";
        }
        enum new-dr {
          description
            "A new DR (Designated Router) was elected on the connected
             network.";
        }
        enum new-df {
          description
            "A new DF (Designated Forwarder) was elected on the
             connected network.";
```

```
        }
      }
      description "Operational status event type for notifications.";
    }

    typedef neighbor-event-type {
      type enumeration {
        enum up {
          description
            "Neighbor status changed to up.";
        }
        enum down {
          description
            "Neighbor status changed to down.";
        }
      }
      description "Operational status event type for notifications.";
    }

    /*
     * Identities
     */
    identity pim-mode {
      description
        "The PIM mode in which a group is operating.";
    }
    identity pim-none {
      base pim-mode;
      description
        "PIM is not operating.";
    }
    identity pim-bidir {
      base pim-mode;
      description
        "PIM operates in the Bidirectional Mode.";
    }
    identity pim-dm {
      base pim-mode;
      description
        "PIM operates in the Dense Mode (DM).";
    }
    identity pim-sm {
      base pim-mode;
      description
        "PIM operates in the Sparse Mode (SM).";
    }
    identity pim-asm {
      base pim-sm;
```

```
      description
        "PIM operates in the Sparse Mode with Any Source Multicast
         (ASM).";
    }
    identity pim-ssm {
      base pim-sm;
      description
        "PIM operates in the Sparse Mode with Source-Specific
         Multicast (SSM).";
    }

    /*
     * Groupings
     */
    grouping graceful-restart-container {
      description
        "A grouping defining a container of graceful restart
        attributes.";
      container graceful-restart {
        leaf enabled {
          type boolean;
          default false;
          description
            "Enable or disable graceful restart.";
        }
        leaf duration {
          type uint16;
          units seconds;
          default 60;
          description
            "Maximum time for graceful restart to finish.";
        }
        description
          "Container of graceful restart attributes.";
      }
    } // graceful-restart-container

    grouping multicast-route-attributes {
      description
        "A grouping defining multicast route attributes.";

      leaf expiration {
        type rt-types:timer-value-seconds16;
        description "When the route will expire.";
      }
      leaf incoming-interface {
        type if:interface-ref;
        description
```

```
          "Reference to an entry in the global interface
           list.";
        }
        leaf is-spt {
          type boolean;
          description
            "'true' if SPT (Shortest Path Tree) bit is set to indicate
             forwarding is taking place on the (S,G) Shortest Path Tree
             (SPT).";
          reference
            "RFC7761: Protocol Independent Multicast - Sparse Mode
            (PIM-SM): Protocol Specification (Revised). Sec. 4.1.3.";
        }
        leaf mode {
          type identityref {
            base pim-mode;
          }
          description "PIM mode.";
        }
        leaf msdp-learned {
          type boolean;
          description
            "'true' if route is learned from MSDP (Multicast Source
              Discovery Protocol).";
        }
        leaf rp-address {
          type inet:ip-address;
          description "RP (Rendezvous Point) address.";
        }
        leaf rpf-neighbor {
          type inet:ip-address;
          description "RPF (Reverse Path Forwarding) neighbor address.";
        }
        leaf up-time {
          type rt-types:timeticks64;
          description
            "The number of time ticks (hundredths of a second) since the
             route last transitioned into the active state.";
        }
        list outgoing-interface {
          key "name";
          description
            "A list of outgoing interfaces.";

          leaf name {
            type if:interface-ref;
            description
              "Interface name.";
```

```
        }

        leaf expiration {
          type rt-types:timer-value-seconds16;
          description "Expiring time.";
        }

        leaf up-time {
          type rt-types:timeticks64;
          description
            "The number of time ticks (hundredths of a second) since
             the oper-status of the interface was last changed to
             'up'.";
        }

        leaf jp-state {
          type enumeration {
            enum "no-info" {
              description
                "The interface has no (*,G) Join state and no timers
                 running.";
            }
            enum "join" {
              description
                "The interface has Join state.";
            }
            enum "prune-pending" {
              description
                "The router has received a Prune on this interface from
                 a downstream neighbor and is waiting to see whether
                 the prune will be overridden by another downstream
                 router.  For forwarding purposes, the Prune-Pending
                 state functions exactly like the Join state.";
            }
          }
          description "Join-prune state.";
        }
      }
    } // multicast-route-attributes

    grouping neighbor-state-af-attributes {
      description
        "A grouping defining neighbor per address family attributes.";
      leaf bfd-state {
        type bfd-types:state;
        description "BFD (Bidirectional Forwarding Detection) status.";
      }
      leaf expiration {
```

```
          type rt-types:timer-value-seconds16;
          description "Neighbor expiring time.";
        }
        leaf dr-priority {
          type uint32;
          description
            "DR (Designated Router) priority as the preference in the DR
             election process.";
        }
        leaf gen-id {
          type uint32;
          description
            "The value of the Generation ID in the last Hello message
             from the neighbor.";
        }
        container lan-prune-delay {
          description
            "The information of the LAN Prune Delay option in the Hello
             message from the neighbor.";
          leaf present {
            type boolean;
            description
              "'true' if the LAN Prune Delay option is present in the
               last Hello message from the neighbor.";
          }
          leaf override-interval {
            when "../present = 'true'" {
              description
                "Available only when the leaf present is 'true'.";
            }
            type uint16;
            units milliseconds;
            description
              "The value of the Override_Interval field of the LAN Prune
               Delay option in the last Hello message from the neighbor.
               The neighbor uses this value to indicate a short period
               after a Join or Prune to allow other routers on the LAN
               to override the Join or Prune.";
          }
          leaf propagation-delay {
            when "../present = 'true'" {
              description
                "Available only when the leaf present is 'true'.";
            }
            type uint16;
            units milliseconds;
            description
              "The value of the Propagation_Delay field of the LAN Prune
```

```
            Delay option in the last Hello message from the neighbor.
            The value is the propagation delay over the local link
            expected by the neighbor.";
        }
        leaf t-bit {
          when "../present = 'true'" {
            description
              "Available only when the leaf present is 'true'.";
          }
          type boolean;
          description
            "'true' if the T bit is set in the LAN Prune Delay option
             in the last Hello message from the neighbor. This flag
             indicates the neighbor's capability to disable Join
             message suppression.";
        }
      }
      leaf up-time {
        type rt-types:timeticks64;
        description
          "The number of time ticks (hundredths of a second) since
           the neighbor relationship has been formed as reachable
           without beeing timed out.";
      }
    } // neighbor-state-af-attributes

    grouping pim-instance-af-state-ref {
      description
        "An absolute reference to a PIM instance address family.";
      leaf instance-af-ref {
        type leafref {
          path "/rt:routing/rt:control-plane-protocols/"
            + "pim-base:pim/pim-base:address-family/"
            + "pim-base:address-family";
        }
        description
          "Reference to a PIM instance address family.";
      }
    } // pim-instance-af-state-ref

    grouping pim-interface-state-ref {
      description
        "An absolute reference to a PIM interface state.";
      leaf interface-ref {
        type leafref {
          path "/rt:routing/rt:control-plane-protocols/"
            + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
            + "pim-base:name";
```

```
        }
        description
          "Reference to a PIM interface.";
      }
    } // pim-interface-state-ref

    grouping statistics-sent-received {
      description
        "A grouping defining sent and received statistics
         on PIM messages.";
      reference
        "RFC3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised). Sec. 4.7.1.
         RFC5015: Bidirectional Protocol Independent Multicast
         (BIDIR-PIM). Sec. 3.7.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.9.";
      leaf assert {
        type yang:counter64;
        description
          "The number of Assert messages, with the message Type
           of 5 in RFC3973 and RFC7761.";
      }
      leaf bsr {
        type yang:counter64;
        description
          "The number of Bootstrap messages, with the message Type
           of 4 in RFC3973 and RFC7761.";
      }
      leaf candidate-rp-advertisement {
        type yang:counter64;
        description
          "The number of Candidate RP Advertisement messages, with the
           message Type of 8 in RFC3973 and RFC7761.";
      }
      leaf df-election {
        type yang:counter64;
        description
          "The number of DF (Designated Forwarder) Election messages,
           with the message Type of 10 in RFC5015.";
      }
      leaf graft {
        type yang:counter64;
        description
          "The number of Graft messages, with the message Type
           of 6 in RFC3973 and RFC7761.";
      }
      leaf graft-ack {
```

```
          type yang:counter64;
          description
            "The number of Graft-Ack messages, with the message Type
             of 7 in RFC3973 and RFC7761.";
        }
        leaf hello {
          type yang:counter64;
          description
            "The number of Hello messages, with the message Type
             of 0 in RFC3973 and RFC7761.";
        }
        leaf join-prune {
          type yang:counter64;
          description
            "The number of Join/Prune messages, with the message Type
             of 3 in RFC3973 and RFC7761.";
        }
        leaf register {
          type yang:counter64;
          description
            "The number of Register messages, with the message Type
             of 1 in RFC3973 and RFC7761.";
        }
        leaf register-stop {
          type yang:counter64;
          description
            "The number of Register Stop messages, with the message Type
             of 2 in RFC3973 and RFC7761.";
        }
        leaf state-refresh {
          type yang:counter64;
          description
            "The number of State Refresh messages, with the message Type
             of 9 in RFC3973.";
        }
      } // statistics-sent-received

      /*
       * Data nodes
       */

      augment "/rt:routing/rt:control-plane-protocols" {
        description
          "PIM augmentation to the routing instance model.";

        container pim {
          presence
            "Enables the PIM protocol.";
```

```
        description
          "PIM configuration and operational data.";

        uses graceful-restart-container {
          if-feature global-graceful-restart;
        }

        list address-family {
          key "address-family";
          description
            "Each list entry for one address family.";
          uses rt:address-family;
          uses graceful-restart-container {
            if-feature per-af-graceful-restart;
          }

          container statistics {
            config false;
            description "A container defining statistics attributes.";
            leaf discontinuity-time {
              type yang:date-and-time;
              description
                "The time on the most recent occasion at which any one
                 or more of the statistic counters suffered a
                 discontinuity. If no such discontinuities have
                 occurred since the last re-initialization of the local
                 management subsystem, then this node contains the time
                 the local management subsystem re-initialized
                 itself.";
            }
            container error {
              description "Containing error statistics.";
              uses statistics-sent-received {
                description
                  "Statistic counters on the PIM messages per PIM
                   message Type. Each leaf attribute counts the number
                   of PIM messages that were of a particular Type (such
                   as Hello) and contained errors preventing them from
                   being processed by PIM.

                   Such messages are also counted by the corresponding
                   counter of the same Type (such as Hello) in the
                   'received' container.";
              }
              leaf checksum {
                type yang:counter64;
                description
                  "The number of PIM messages that were passed to PIM
```

```
                and contained checksum errors.";
            }
            leaf format {
              type yang:counter64;
              description
                "The number of PIM messages that passed checksum
                 validation but contained format errors, including
                 the errors such as PIM Version, Type, and message
                 length.";
            }
          }
          container queue {
            description "Containing queue statistics.";
            leaf size {
              type uint32;
              description
                "The size of the input queue.";
            }
            leaf overflow {
              type yang:counter32;
              description
                "The number of the input queue overflows.";
            }
          }
          container received {
            description
              "Containing statistics of received messages.";
            uses statistics-sent-received;
          }
          container sent {
            description
              "Containing statistics of sent messages.";
            uses statistics-sent-received;
          }
        }

        container topology-tree-info {
          config false;
          description "Containing topology tree information.";
          list ipv4-route {
            when "../../address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            key "group source-address is-rpt";
            description "A list of IPv4 routes.";
            leaf group {
              type rt-types:ipv4-multicast-group-address;
```

```
            description "Group address.";
          }
          leaf source-address {
            type rt-types:ipv4-multicast-source-address;
            description "Source address.";
          }
          leaf is-rpt {
            type boolean;
            description
              "'true' if the tree is RPT (Rendezvous-Point Tree).";
          }

          uses multicast-route-attributes;
        } // ipv4-route

        list ipv6-route {
          when "../../address-family = 'rt:ipv6'" {
            description
              "Only applicable to IPv6 address family.";
          }
          key "group source-address is-rpt";
          description "A list of IPv6 routes.";
          leaf group {
            type rt-types:ipv6-multicast-group-address;
            description "Group address.";
          }
          leaf source-address {
            type rt-types:ipv6-multicast-source-address;
            description "Source address.";
          }
          leaf is-rpt {
            type boolean;
            description
              "'true' if the tree is RPT (Rendezvous-Point Tree).";
          }

          uses multicast-route-attributes;
        } // ipv6-route
      } // topology-tree-info
    } // address-family

    container interfaces {
      description
        "Containing a list of interfaces.";
      list interface {
        key "name";
        description
          "List of pim interfaces.";
```

```
            leaf name {
              type if:interface-ref;
              description
                "Reference to an entry in the global interface
                list.";
            }
            list address-family {
              key "address-family";
              description
                "Each list entry for one address family.";
              uses rt:address-family;

              container bfd {
                if-feature bfd;
                description
                  "BFD (Bidirectional Forwarding Detection)
                   operation.";
                uses bfd-types:client-cfg-parms;
              }
              leaf dr-priority {
                if-feature intf-dr-priority;
                type uint32;
                default 1;
                description
                  "DR (Designated Router) priority as the preference in
                   the DR election process.";
              }
              leaf hello-interval {
                if-feature intf-hello-interval;
                type rt-types:timer-value-seconds16;
                default 30;
                description
                  "Periodic interval for Hello messages.
                   If 'infinity' or 'not-set' is used, no periodic
                   Hello messages are sent.";
                reference
                  "RFC3973: Protocol Independent Multicast - Dense Mode
                   (PIM-DM): Protocol Specification (Revised).
                   Sec. 4.8.
                   RFC7761: Protocol Independent Multicast - Sparse
                   Mode (PIM-SM): Protocol Specification (Revised).
                   Sec. 4.11.";
              }
              choice hello-holdtime-or-multiplier {
                description
                  "Holdtime is timer value to time out the neighbor
                   state when the timer expires.
                   The holdtime value can be specified either by the
```

```
           given holdtime value or by the calculation of the
           hello-interval multiplied by the given value of the
           multiplier.";
        case holdtime {
          if-feature intf-hello-holdtime;
          leaf hello-holdtime {
            type rt-types:timer-value-seconds16;
            default 105;
            description
              "Hello holdtime is the amount of time to keep
               the neighbor reachable until a new Hello message
               is received.";
          }
        }
        case multiplier {
          if-feature intf-hello-multiplier;
          leaf hello-multiplier {
            type rt-types:timer-multiplier;
            default 3;
            description
              "Hello multiplier is the number by which the
               hello interval is multplied to obtain the Hello
               holdtime.
               The value of the Hello holdtime is calculated
               as:
               hello-holdtime =
               (multiplier + 0.5) * (hello-interval)";
          }
        }
      }
      leaf jp-interval {
        if-feature intf-jp-interval;
        type rt-types:timer-value-seconds16;
        default 60;
        description
          "Periodic interval between Join/Prune messages.
           If 'infinity' or 'not-set' is used, no periodic
           Join/Prune messages are sent.";
      }
      choice jp-holdtime-or-multiplier {
        description
          "Join/Prune holdtime is the amount of time a receiver
           must keep the Join/Prune state alive.
           The holdtime value can be specified either by the
           given holdtime value or by the calculation of the
           jp-interval multiplied by the given value of the
           multiplier.";
        case holdtime {
```

```
            if-feature intf-jp-holdtime;
            leaf jp-holdtime {
              type rt-types:timer-value-seconds16;
              default 210;
              description
                "Join/Prune holdtime is the amount of time a
                 receiver must keep the Join/Prune state alive.";
            }
          }
          case multiplier {
            if-feature intf-jp-multiplier;
            leaf jp-multiplier {
              type rt-types:timer-multiplier;
              default 3;
              description
                "Join prune multiplier is the number by which the
                 join prune interval is multplied to obtain the
                 Join/Prune holdtime.
                 The value of the Join/Prune holdtime is
                 calculated as:
                 jp-holdtime =
                 (multiplier + 0.5) * (jp-interval)";
            }
          }
        }
        leaf override-interval {
          if-feature intf-override-interval;
          type uint16;
          units milliseconds;
          default 2500;
          description
            "A short period after a Join or Prune to allow other
             routers on the LAN to override the Join or Prune.";
        }
        leaf propagation-delay {
          if-feature intf-propagation-delay;
          type uint16;
          units milliseconds;
          default 500;
          description
            "Expected propagation delay over the local link.";
        }

        // Interface state attributes
        leaf oper-status {
          type enumeration {
            enum up {
              description
```

```
            "The interface is ready to pass PIM messages.";
          }
          enum down {
            description
            "The interface does not pass PIM messages.";
          }
        }
        config false;
        description
          "PIM operational status on the interface.
           This status is PIM specific and separate from the
           operational status of the underlying interface.";
      }
      leaf gen-id {
        type uint32;
        config false;
        description
          "The value of the Generation ID this router uses to
           insert in the PIM Hello message sent on this
           interface.";
      }
      leaf hello-expiration {
        type rt-types:timer-value-seconds16;
        config false;
        description "Hello interval expiration time.";
      }
      container ipv4 {
        when "../address-family = 'rt:ipv4'" {
          description
            "Only applicable to IPv4 address family.";
        }
        config false;
        description "Interface state attributes for IPv4.";
        leaf-list address {
          type inet:ipv4-address;
          description
            "List of addresses on which PIM is operating.";
        }
        leaf dr-address {
          type inet:ipv4-address;
          description "DR (Designated Router) address.";
        }
      }
      container ipv6 {
        when "../address-family = 'rt:ipv6'" {
          description
            "Only applicable to IPv6 address family.";
        }
```

```
            config false;
            description "Interface state attributes for IPv6.";
            leaf-list address {
              type inet:ipv6-address;
              description
                "List of addresses on which PIM is operating.";
            }
            leaf dr-address {
              type inet:ipv6-address;
              description "DR (Designated Router) address.";
            }
          }
          container neighbors {
            config false;
            description
              "Information learned from neighbors through this
               interface.";
            list ipv4-neighbor {
              when "../../address-family = 'rt:ipv4'" {
                description
                  "Only applicable to IPv4 address family.";
              }
              key "address";
              description "Neighbor state information.";
              leaf address {
                type inet:ipv4-address;
                description "Neighbor address.";
              }
              uses neighbor-state-af-attributes;
            } // list ipv4-neighbor
            list ipv6-neighbor {
              when "../../address-family = 'rt:ipv6'" {
                description
                  "Only applicable to IPv6 address family.";
              }
              key "address";
              description "Neighbor state information.";
              leaf address {
                type inet:ipv6-address;
                description "Neighbor address.";
              }
              uses neighbor-state-af-attributes;
            } // list ipv6-neighbor
          } // neighbors
        } // address-family
      } // interface
    } // interfaces
  } // pim
```

```
    } // augment

    /*
     * Notifications
     */
    notification pim-neighbor-event {
      description "Notification event for neighbor.";
      leaf event-type {
        type neighbor-event-type;
        description "Event type.";
      }
      uses pim-interface-state-ref;
      leaf interface-af-ref {
        type leafref {
          path "/rt:routing/rt:control-plane-protocols/"
            + "pim-base:pim/pim-base:interfaces/pim-base:interface"
            + "[pim-base:name = current()/../interface-ref]/"
            + "pim-base:address-family/pim-base:address-family";
        }
        description
          "Reference to a PIM interface address family.";
      }
      leaf neighbor-ipv4-ref {
        when "../interface-af-ref = 'rt:ipv4'" {
          description "Only applicable to IPv4 address family.";
        }
        type leafref {
          path "/rt:routing/rt:control-plane-protocols/"
            + "pim-base:pim/pim-base:interfaces/pim-base:interface"
            + "[pim-base:name = current()/../interface-ref]/"
            + "pim-base:address-family"
            + "[pim-base:address-family = "
            + "current()/../interface-af-ref]/"
            + "pim-base:neighbors/pim-base:ipv4-neighbor/"
            + "pim-base:address";
        }
        description
          "Reference to a PIM IPv4 neighbor.";
      }
      leaf neighbor-ipv6-ref {
        when "../interface-af-ref = 'rt:ipv6'" {
          description "Only applicable to IPv6 address family.";
        }
        type leafref {
          path "/rt:routing/rt:control-plane-protocols/"
            + "pim-base:pim/pim-base:interfaces/pim-base:interface"
            + "[pim-base:name = current()/../interface-ref]/"
            + "pim-base:address-family"
```

```
             + "[pim-base:address-family = "
             + "current()/../interface-af-ref]/"
             + "pim-base:neighbors/pim-base:ipv6-neighbor/"
             + "pim-base:address";
         }
         description
           "Reference to a PIM IPv6 neighbor.";
       }
       leaf up-time {
         type rt-types:timeticks64;
         description
           "The number of time ticks (hundredths of a second) since
            the neighbor relationship has been formed as reachable
            without beeing timed out.";
       }
     }
     notification pim-interface-event {
       description "Notification event for interface.";
       leaf event-type {
         type interface-event-type;
         description "Event type.";
       }
       uses pim-interface-state-ref;
       container ipv4 {
         description "Containing IPv4 information.";
         leaf-list address {
           type inet:ipv4-address;
           description "List of addresses.";
         }
         leaf dr-address {
           type inet:ipv4-address;
           description "DR (Designated Router) address.";
         }
       }
       container ipv6 {
         description "Containing IPv6 information.";
         leaf-list address {
           type inet:ipv6-address;
           description "List of addresses.";
         }
         leaf dr-address {
           type inet:ipv6-address;
           description "DR (Designated Router) address.";
         }
       }
     }
   }
   <CODE ENDS>
```

6.2. PIM RP Module

This module references [RFC5059] and [RFC7761].

```
<CODE BEGINS> file "ietf-pim-rp@2018-04-16.yang"
module ietf-pim-rp {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-pim-rp";
  prefix pim-rp;

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

  import ietf-routing-types {
    prefix "rt-types";
  }

  import ietf-interfaces {
    prefix "if";
  }

  import ietf-routing {
    prefix "rt";
  }

  import ietf-pim-base {
    prefix "pim-base";
  }

  organization
    "IETF PIM Working Group";

  contact
    "WG Web:   <http://tools.ietf.org/wg/pim/>
     WG List:  <mailto:pim@ietf.org>

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      Editor:   Yisong Liu
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      Editor:   Fangwei Hu
                <mailto:hu.fangwei@zte.com.cn>";

    description
      "The YANG module defines a PIM (Protocol Independent Multicast)
       RP (Rendezvous Point) model.

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       authors of the code.  All rights reserved.

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       Relating to IETF Documents
       (http://trustee.ietf.org/license-info).

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

    revision 2018-04-16 {
      description
        "Initial revision.";
      reference
        "RFC XXXX: A YANG Data Model for PIM";
    }

    /*
     * Features
     */
    feature bsr {
      description
        "This feature indicates that the system supports BSR
         (Bootstrap Router).";
      reference
        "RFC5059: Bootstrap Router (BSR) Mechanism for Protocol
         Independent Multicast (PIM).";
    }

    feature bsr-election-state {
      if-feature bsr;
      description
        "This feature indicates that the system supports providing
```

```
          BSR election state.";
      reference
        "RFC5059: Bootstrap Router (BSR) Mechanism for Protocol
         Independent Multicast (PIM).";
    }

    feature static-rp-override {
      description
        "This feature indicates that the system supports configuration
         of static RP (Rendezvous Point) override.";
      reference
        "RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 3.7.";
    }

    feature candidate-interface {
      description
        "This feature indicates that the system supports using
         an interface to configure a BSR or RP candidate.";
    }

    feature candidate-ipv4 {
      description
        "This feature indicates that the system supports using
         an IPv4 address to configure a BSR or RP candidate.";
    }

    feature candidate-ipv6 {
      description
        "This feature indicates that the system supports using
         an IPv6 address to configure a BSR or RP candidate.";
    }


    /*
     * Typedefs
     */
    typedef rp-event-type {
      type enumeration {
        enum invalid-jp {
          description
            "An invalid JP (Join/Prune) message has been received.";
        }
        enum invalid-register {
          description
            "An invalid register message has been received.";
        }
        enum mapping-created {
```

```
          description
            "A new mapping has been created.";
        }
        enum mapping-deleted {
          description
            "A mapping has been deleted.";
        }
      }
      description "Operational status event type for notifications.";
    }

    /*
     * Identities
     */
    identity rp-mode {
      description
        "The mode of an RP, which can be SM (Sparse Mode) or
         BIDIR (bi-directional).";
    }

    identity rp-info-source-type {
      description
        "The information source of an RP.";
    }
    identity static {
      base rp-info-source-type;
      description
        "The RP is statically configured.";
    }
    identity bootstrap {
      base rp-info-source-type;
      description
        "The RP is learned from bootstrap.";
    }

    /*
     * Groupings
     */
    grouping rp-mapping-state-attributes {
      description
        "Grouping of RP mapping attributes.";
      leaf up-time {
        type rt-types:timeticks64;
        description
          "The number of time ticks (hundredths of a second) since
           the RP mapping or the RP became actively available.";
      }
      leaf expiration {
```

```
        type rt-types:timer-value-seconds16;
        description "Expiration time.";
      }
    } // rp-mapping-state-attributes

    grouping rp-state-attributes {
      description
        "Grouping of RP state attributes.";
      leaf info-source-type {
        type identityref {
          base rp-info-source-type;
        }
        description "The information source of an RP.";
      } // info-source-type
      leaf up-time {
        type rt-types:timeticks64;
        description
            "The number of time ticks (hundredths of a second) since
             the RP became actively available.";
      }
      leaf expiration {
        type rt-types:timer-value-seconds16;
        description "Expiration time.";
      }
    } // rp-state-attributes

    grouping static-rp-attributes {
      description
        "Grouping of static RP attributes, used in augmenting
         modules.";
      leaf policy-name {
        type string;
        description
          "The string value is the name to uniquely identify a
           policy that contains one or more policy rules used to
           determine which multicast group addresses are mapped
           to this statically configured RP address.
           If a policy is not specified, the entire multicast address
           space is mapped.
           The definition of such a policy is outside the scope
           of this document.";
      }
      leaf override {
        if-feature static-rp-override;
        type boolean;
        default false;
        description
          "When there is a conflict between static RP and dynamic
```

```
            RP, setting this attribute to 'true' will ask the
            system to use static RP.";
        }
      } // static-rp-attributes

      grouping rp-candidate-attributes {
        description
          "Grouping of RP candidate attributes.";
        leaf policy-name {
          type string;
          description
            "The string value is the name to uniquely identify a
             policy that contains one or more policy rules used to
             accept or reject certain multicast groups.
             If a policy is not specified, the entire multicast address
             space is accepted.
             The definition of such a policy is outside the scope
             of this document.";
        }
        leaf mode {
          type identityref {
            base rp-mode;
          }
          description
            "The mode of an RP, which can be SM (Sparse Mode) or BIDIR
             (bi-directional), each of them is defined in a saparate YNAG
             module. If a system supports an RP mode, the corresponding
             YANG module is implemented.
             When the value of this leaf is not specified, the default
             value is the supported mode if only one mode is implemented,
             or the default value is SM (Sparce Mode) if both SM and
             BIDIR are implemented.";
        }
      } // rp-candidate-attributes

      /*
       * Configuration data nodes
       */

      augment "/rt:routing/rt:control-plane-protocols/pim-base:pim/"
        + "pim-base:address-family" {
        description "PIM RP augmentation.";

        container rp {
          description
            "PIM RP configuration data.";

          container static-rp {
```

```
          description
            "Containing static RP attributes.";
          list ipv4-rp {
            when "../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            key "rp-address";
            description
              "A list of IPv4 RP addresses.";
            leaf rp-address {
              type inet:ipv4-address;
              description
                "Specifies a static RP address.";
            }
          }

          list ipv6-rp {
            when "../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            key "rp-address";
            description
              "A list of IPv6 RP addresses.";
            leaf rp-address {
              type inet:ipv6-address;
              description
                "Specifies a static RP address.";
            }
          }
        } // static-rp

        container bsr {
          if-feature bsr;
          description
            "Containing BSR (BootStrap Router) attributes.";
          container bsr-candidate {
            presence
              "Present to serve as a BSR candidate";
            description
              "BSR candidate attributes.";

            choice interface-or-address {
              description
                "Use either interface or ip-address.";
              case interface {
                if-feature candidate-interface;
```

```
            leaf interface {
              type if:interface-ref;
              mandatory true;
              description
                "Interface to be used by BSR.";
            }
          }
          case ipv4-address {
            when "../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            if-feature candidate-ipv4;
            leaf ipv4-address {
              type inet:ipv4-address;
              mandatory true;
              description
                "IP address to be used by BSR.";
            }
          }
          case ipv6-address {
            when "../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            if-feature candidate-ipv6;
            leaf ipv6-address {
              type inet:ipv6-address;
              mandatory true;
              description
                "IP address to be used by BSR.";
            }
          }
        }

        leaf hash-mask-length{
          type uint8 {
            range "0..128";
          }
          mandatory true;
          description
            "Value contained in BSR messages used by all routers to
             hash (map) to an RP.";
        }

        leaf priority {
          type uint8 {
            range "0..255";
```

```
            }
            default 64;
            description
              "BSR election priority among different candidate BSRs.
               A larger value has a higher priority over a smaller
               value.";
          }
        } // bsr-candidate

        container rp-candidate {
          description
            "Containing RP candidate attributes.";
          list interface {
            if-feature candidate-interface;
            key "name";
            description
              "A list of RP candidates";
            leaf name {
              type if:interface-ref;
              description
                "Interface that the RP candidate uses.";
            }
            uses rp-candidate-attributes;
          }

          list ipv4-address {
            when "../../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            if-feature candidate-ipv4;
            key "address";
            description
              "A list of RP candidate addresses.";
            leaf address {
              type inet:ipv4-address;
              description
                "IPv4 address that the RP candidate uses.";
            }
            uses rp-candidate-attributes;
          }

          list ipv6-address {
            when "../../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            if-feature candidate-ipv6;
```

```
            key "address";
            description
              "A list of RP candidate addresses.";
            leaf address {
              type inet:ipv6-address;
              description
                "IPv6 address that the RP candidate uses.";
            }
            uses rp-candidate-attributes;
          }
        }

        // BSR state attributes.
        container bsr {
          config false;
          description
            "BSR information.";
          leaf address {
            type inet:ip-address;
            description "BSR address";
          }
          leaf hash-mask-length {
            type uint8 {
              range "0..128";
            }
            description "Hash mask length.";
          }
          leaf priority {
            type uint8 {
              range "0..255";
            }
            description "Priority.";
          }
          leaf up-time {
            type rt-types:timeticks64;
            description
              "The number of time ticks (hundredths of a second)
               since the BSR became up.";
          }
        }
        choice election-state {
          if-feature bsr-election-state;
          config false;
          description "BSR election state.";
          case candidate {
            leaf candidate-bsr-state {
              type enumeration {
                enum "candidate" {
```

```
                description
                  "The router is a candidate to be the BSR for the
                   scope zone, but currently another router is the
                   preferred BSR.";
                }
                enum "pending" {
                  description
                    "The router is a candidate to be the BSR for the
                     scope zone. Currently, no other router is the
                     preferred BSR, but this router is not yet the
                     elected BSR.  This is a temporary state that
                     prevents rapid thrashing of the choice of BSR
                     during BSR election.";
                }
                enum "elected" {
                  description
                    "The router is the elected BSR for the scope zone
                     and it must perform all the BSR functions.";
                }
              }
              description
                "Candidate-BSR state.";
              reference
                "RFC5059, Section 3.1.1.";
            }
          }
          case "non-candidate" {
            leaf non-candidate-bsr-state {
              type enumeration {
                enum "no-info" {
                  description
                    "The router has no information about this scope
                     zone.";
                }
                enum "accept-any" {
                  description
                    "The router does not know of an active BSR, and
                     will accept the first Bootstrap message it sees
                     as giving the new BSR's identity and the
                     RP-Set.";
                }
                enum "accept" {
                  description
                    "The router knows the identity of the current
                     BSR, and is using the RP-Set provided by that
                     BSR. Only Bootstrap messages from that BSR or
                     from a Candidate-BSR (C-BSR) with higher weight
                     than the current BSR will be accepted.";
```

```
            }
          }
          description
            "Non-candidate-BSR state.";
          reference
            "RFC5059, Section 3.1.2.";
        }
      }
    } // election-state
    leaf bsr-next-bootstrap {
      type uint16;
      units seconds;
      config false;
      description
        "The remaining time interval in seconds until the next
         bootstrap will be sent.";
    }

    container rp {
      config false;
      description
        "State information of the RP.";
      leaf rp-address {
        type inet:ip-address;
        description "RP address.";
      }
      leaf policy-name {
        type string;
        description
          "The string value is the name to uniquely identify a
           policy that contains one or more policy rules used to
           accept or reject certain multicast groups.
           If a policy is not specified, the entire multicast
           address space is accepted.
           The definition of such a policy is outside the scope
           of this document.";
      }
      leaf up-time {
        type rt-types:timeticks64;
        description
          "The number of time ticks (hundredths of a second)
           since the RP became actively available.";
      }
    }
    leaf rp-candidate-next-advertisement {
      type uint16;
      units seconds;
      config false;
```

```
            description
              "The remaining time interval in seconds until the next
               RP candidate advertisement will be sent.";
          }
        } // bsr

        container rp-list {
          config false;
          description
            "Containing a list of RPs.";
          list ipv4-rp {
            when "../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            key "rp-address mode";
            description
              "A list of IPv4 RP addresses.";
            leaf rp-address {
              type inet:ipv4-address;
              description
                "RP address.";
            }
            leaf mode {
              type identityref {
                base rp-mode;
              }
              description
                "RP mode.";
            }
            leaf info-source-address {
              type inet:ipv4-address;
              description
                "The address where RP information is learned.";
            }
            uses rp-state-attributes;
          }

          list ipv6-rp {
            when "../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            key "rp-address mode";
            description
              "A list of IPv6 RP addresses.";
            leaf rp-address {
              type inet:ipv6-address;
```

```
            description
              "RP address.";
          }
          leaf mode {
            type identityref {
              base rp-mode;
            }
            description
              "RP mode.";
          }
          leaf info-source-address {
            type inet:ipv6-address;
            description
              "The address where RP information is learned.";
          }
          uses rp-state-attributes;
        }
      } // rp-list

      container rp-mappings {
        config false;
        description
          "Containing a list of group-to-RP mappings.";
        list ipv4-rp {
          when "../../../pim-base:address-family = 'rt:ipv4'" {
            description
              "Only applicable to IPv4 address family.";
          }
          key "group-range rp-address";
          description
            "A list of group-to-RP mappings.";
          leaf group-range {
            type inet:ipv4-prefix;
            description
              "Group range presented in the format of prefix.";
          }
          leaf rp-address {
            type inet:ipv4-address;
            description
              "RP address.";
          }
          uses rp-mapping-state-attributes;
        }

        list ipv6-rp {
          when "../../../pim-base:address-family = 'rt:ipv6'" {
            description
              "Only applicable to IPv6 address family.";
```

```
            }
            key "group-range rp-address";
            description
              "A list of IPv6 RP addresses.";
            leaf group-range {
              type inet:ipv6-prefix;
              description
                "Group range presented in the format of prefix.";
            }
            leaf rp-address {
              type inet:ipv6-address;
              description
                "RP address.";
            }
            uses rp-mapping-state-attributes;
          }
        } // rp-mappings
      } // rp
    } // augment

    /*
     * Notifications
     */
    notification pim-rp-event {
      description "Notification event for RP.";
      leaf event-type {
        type rp-event-type;
        description "Event type.";
      }
      uses pim-base:pim-instance-af-state-ref;
      leaf group {
        type rt-types:ip-multicast-group-address;
        description "Group address.";
      }
      leaf rp-address {
        type inet:ip-address;
        description "RP address.";
      }
      leaf is-rpt {
        type boolean;
        description "'true' if the tree is RPT (RP-Tree).";
      }
      leaf mode {
        type identityref {
          base pim-base:pim-mode;
        }
        description "PIM mode.";
      }
```

```
      leaf message-origin {
        type inet:ip-address;
        description "Where the message is originated.";
      }
    }
  }
  <CODE ENDS>
```

6.3. PIM-SM Module

This module references [RFC4607] and [RFC7761].

```
  <CODE BEGINS> file "ietf-pim-sm@2018-04-16.yang"
  module ietf-pim-sm {
    yang-version 1.1;
    namespace "urn:ietf:params:xml:ns:yang:ietf-pim-sm";
    prefix pim-sm;

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

    import ietf-routing {
      prefix "rt";
    }

    import ietf-pim-base {
      prefix "pim-base";
    }

    import ietf-pim-rp {
      prefix "pim-rp";
    }

    organization
      "IETF PIM Working Group";

    contact
      "WG Web:   <http://tools.ietf.org/wg/pim/>
       WG List:  <mailto:pim@ietf.org>

       Editor:   Xufeng Liu
                 <mailto:xufeng.liu.ietf@gmail.com>

       Editor:   Pete McAllister
                 <mailto:pete.mcallister@metaswitch.com>
```

```
        Editor:   Anish Peter
                  <mailto:anish.ietf@gmail.com>

        Editor:   Mahesh Sivakumar
                  <mailto:sivakumar.mahesh@gmail.com>

        Editor:   Yisong Liu
                  <mailto:liuyisong@huawei.com>

        Editor:   Fangwei Hu
                  <mailto:hu.fangwei@zte.com.cn>";

    description
      "The YANG module defines a PIM (Protocol Independent Multicast)
       SM (Sparse Mode) model.

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       authors of the code.  All rights reserved.

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       Relating to IETF Documents
       (http://trustee.ietf.org/license-info).

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       RFC itself for full legal notices.";

    revision 2018-04-16 {
      description
        "Initial revision.";
      reference
        "RFC XXXX: A YANG Data Model for PIM.
         RFC7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised). Sec. 4.2.";
    }

    /*
     * Features
     */
    feature spt-switch-infinity {
      description
        "This feature indicates that the system supports configuration
         choice whether to trigger the switchover from the RPT
         (Rendezvous Point Tree) to the SPT (Shortest Path Tree).";
      reference
        "RFC7761: Protocol Independent Multicast - Sparse Mode
```

```
          (PIM-SM): Protocol Specification (Revised). Sec. 4.2.";
      }

      feature spt-switch-policy {
        description
          "This feature indicates that the system supports configuring
           policy for the switchover from the RPT to the SPT.";
        reference
          "RFC7761: Protocol Independent Multicast - Sparse Mode
           (PIM-SM): Protocol Specification (Revised). Sec. 4.2.";
      }

      /*
       * Identities
       */
      identity rp-sm {
        base pim-rp:rp-mode;
        description
          "SM (Sparse Mode).";
      }

      /*
       * Groupings
       */
      grouping static-rp-sm-container {
        description
          "Grouping that contains SM attributes for static RP.";
        container sm {
          presence
            "Indicate the support of sparse mode.";
          description
            "PIM SM configuration data.";

          uses pim-rp:static-rp-attributes;
        } // sm
      } // static-rp-sm-container

      /*
       * Configuration data nodes
       */
      augment "/rt:routing/rt:control-plane-protocols/pim-base:pim/"
        + "pim-base:address-family" {
        description "PIM SM augmentation.";

        container sm {
          description
            "PIM SM configuration data.";
```

```
        container asm {
          description
            "ASM (Any Source Multicast) attributes.";

          container anycast-rp {
            presence
              "Present to enable anycast RP (Rendezvous Point).";
            description
              "Anycast RP attributes.";

            list ipv4-anycast-rp {
              when "../../../../pim-base:address-family = 'rt:ipv4'" {
                description
                  "Only applicable to IPv4 address family.";
              }
              key "anycast-address rp-address";
              description
                "A list of IPv4 anycast RP settings, only applicable
                 when pim-base:address-family is IPv4.";
              leaf anycast-address {
                type inet:ipv4-address;
                description
                  "IP address of the anycast RP set. This IP address
                   is used by the multicast groups or sources to join
                   or register.";
              }

              leaf rp-address {
                type inet:ipv4-address;
                description
                  "IP address of the router configured with anycast
                   RP. This is the IP address where the Register
                   messages are forwarded.";
              }
            }
            list ipv6-anycast-rp {
              when "../../../../pim-base:address-family = 'rt:ipv6'" {
                description
                  "Only applicable to IPv6 address family.";
              }
              key "anycast-address rp-address";
              description
                "A list of IPv6 anycast RP settings, only applicable
                 when pim-base:address-family is IPv6.";
              leaf anycast-address {
                type inet:ipv6-address;
                description
                  "IP address of the anycast RP set. This IP address
```

```
                is used by the multicast groups or sources to join
                or register.";
            }

            leaf rp-address {
              type inet:ipv6-address;
              description
                "IP address of the router configured with anycast
                 RP. This is the IP address where the Register
                 messages are forwarded.";
            }
          }
        }

        container spt-switch {
          description
            "SPT (Shortest Path Tree) switching attributes.";
          container infinity {
            if-feature spt-switch-infinity;
            presence
              "Present if SPT switchover threshold is set to
               infinity, according to the policy specified below.";
            description
              "The receiver's DR (Designated Router) never triggers
               the switchover from the RPT to the SPT.";
            leaf policy-name {
              if-feature spt-switch-policy;
              type string;
              description
                "The string value is the name to uniquely identify a
                 policy that contains one or more policy rules used
                 to accept or reject certain multicast groups.
                 The groups accepted by this policy have the SPT
                 switchover threshold set to infinity, meaning that
                 they will stay on the shared tree forever.
                 If a policy is not specified, the entire multicast
                 address space is accepted.
                 The definition of such a policy is outside the scope
                 of this document.";
            }
          } // infinity
        }
      } // asm

      container ssm {
        presence
          "Present to enable SSM (Source-Specific Multicast).";
        description
```

```
            "SSM (Source-Specific Multicast) attributes.";

          leaf range-policy {
            type string;
            description
              "The string value is the name to uniquely identify a
               policy that contains one or more policy rules used
               to accept or reject certain multicast groups.
               The groups accepted by this policy define the multicast
               group rang used by SSM.
               If a policy is not specified, the default SSM multicast
               group rang is used.
               The default SSM multicast group range is 232.0.0.0/8 for
               IPv4 and ff3x::/96 for IPv6 where x reprents any valid
               scope identifier.
               The definition of such a policy is outside the scope
               of this document.";
            reference
              "RFC4607: Source-Specific Multicast for IP.";
          }
        } // ssm
      } // sm
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/pim-base:pim/"
      + "pim-base:interfaces/pim-base:interface/"
      + "pim-base:address-family" {
      description "PIM SM augmentation.";

      container sm {
        presence "Present to enable sparse-mode.";
        description
          "PIM SM configuration data.";

        leaf passive {
          type empty;
          description
            "Specifies that no PIM messages are sent or accepted on
             this PIM interface, but the interface can be included in a
             multicast forwarding entry.";
        }
      } // sm
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/pim-base:pim/"
      + "pim-base:address-family/pim-rp:rp/"
      + "pim-rp:static-rp/pim-rp:ipv4-rp" {
      description "PIM SM augmentation.";
```

```
      uses static-rp-sm-container;
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/pim-base:pim/"
      + "pim-base:address-family/pim-rp:rp/"
      + "pim-rp:static-rp/pim-rp:ipv6-rp" {
      description "PIM SM augmentation.";

      uses static-rp-sm-container;
    } // augment
  }
  <CODE ENDS>
```

6.4. PIM-DM Module

This module references [RFC3973].

```
  <CODE BEGINS> file "ietf-pim-dm@2018-04-16.yang"
  module ietf-pim-dm {
    yang-version 1.1;
    namespace "urn:ietf:params:xml:ns:yang:ietf-pim-dm";
    prefix pim-dm;

    import ietf-routing {
      prefix "rt";
    }

    import ietf-pim-base {
      prefix "pim-base";
    }

    organization
      "IETF PIM Working Group";

    contact
      "WG Web:   <http://tools.ietf.org/wg/pim/>
       WG List:  <mailto:pim@ietf.org>

       Editor:   Xufeng Liu
                 <mailto:xufeng.liu.ietf@gmail.com>

       Editor:   Pete McAllister
                 <mailto:pete.mcallister@metaswitch.com>

       Editor:   Anish Peter
                 <mailto:anish.ietf@gmail.com>
```

```
        Editor:   Mahesh Sivakumar
                  <mailto:sivakumar.mahesh@gmail.com>

        Editor:   Yisong Liu
                  <mailto:liuyisong@huawei.com>

        Editor:   Fangwei Hu
                  <mailto:hu.fangwei@zte.com.cn>";

    description
      "The YANG module defines a PIM (Protocol Independent Multicast)
       DM (Dense Mode) model.

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       (http://trustee.ietf.org/license-info).

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

    revision 2018-04-16 {
      description
        "Initial revision.";
      reference
        "RFC XXXX: A YANG Data Model for PIM.
         RFC 3973: Protocol Independent Multicast - Dense Mode
        (PIM-DM): Protocol Specification (Revised).";
    }

    /*
     * Configuration data nodes
     */

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:address-family" {
      description "PIM DM (Dense Mode) augmentation.";

      container dm {
        presence "Present to enable dense-mode.";
        description
          "PIM DM configuration data.";
      } // Dm
```

```
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
      + "pim-base:address-family" {
      description "PIM DM augmentation to PIM base interface.";

      container dm {
        presence "Present to enable dense-mode.";
        description
          "PIM DM configuration data.";
      } // sm
    } // augment
  }
  <CODE ENDS>
```

6.5. PIM-BIDIR Module

This module references [RFC5015].

```
  <CODE BEGINS> file "ietf-pim-bidir@2018-04-16.yang"
  module ietf-pim-bidir {
    yang-version 1.1;
    namespace "urn:ietf:params:xml:ns:yang:ietf-pim-bidir";
    prefix pim-bidir;

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

    import ietf-routing-types {
      prefix "rt-types";
    }

    import ietf-interfaces {
      prefix "if";
    }

    import ietf-routing {
      prefix "rt";
    }

    import ietf-pim-base {
      prefix "pim-base";
    }
```

```
     import ietf-pim-rp {
       prefix "pim-rp";
     }

     organization
       "IETF PIM Working Group";

     contact
       "WG Web:   <http://tools.ietf.org/wg/pim/>
        WG List:  <mailto:pim@ietf.org>

        Editor:   Xufeng Liu
                  <mailto:xufeng.liu.ietf@gmail.com>

        Editor:   Pete McAllister
                  <mailto:pete.mcallister@metaswitch.com>

        Editor:   Anish Peter
                  <mailto:anish.ietf@gmail.com>

        Editor:   Mahesh Sivakumar
                  <mailto:sivakumar.mahesh@gmail.com>

        Editor:   Yisong Liu
                  <mailto:liuyisong@huawei.com>

        Editor:   Fangwei Hu
                  <mailto:hu.fangwei@zte.com.cn>";

     description
       "The YANG module defines a PIM (Protocol Independent Multicast)
        BIDIR (Bidirectional) mode model.

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        (http://trustee.ietf.org/license-info).

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

     revision 2018-04-16 {
       description
```

```
        "Initial revision.";
      reference
        "RFC XXXX: A YANG Data Model for PIM.
         RFC5015: Bidirectional Protocol Independent Multicast
         (BIDIR-PIM).";

    }

    /*
     * Features
     */
    feature intf-df-election {
      description
        "Support configuration of interface DF election.";
      reference
        "RFC5015: Bidirectional Protocol Independent Multicast
         (BIDIR-PIM). Sec. 3.5.";
    }

    /*
     * Identities
     */
    identity rp-bidir {
      base pim-rp:rp-mode;
      description
        "BIDIR (Bidirectional) mode.";
    }

    identity df-state {
      description
        "DF (Designated Forwarder) election state type.";
      reference
        "RFC5015: Bidirectional Protocol Independent Multicast
         (BIDIR-PIM).";
    }

    identity df-state-offer {
      base df-state;
      description
        "Initial election state. When in the Offer state, a router
         thinks it can eventually become the winner and periodically
         generates Offer messages.";
    }

    identity df-state-lose {
      base df-state;
      description
        "There either is a different election winner or that no
```

```
          router on the link has a path to the RPA (Rendezvous-Point
          Address).";
      }

      identity df-state-win {
        base df-state;
        description
          "The router is the acting DF without any contest.";
      }

      identity df-state-backoff {
        base df-state;
        description
          "The router is the acting DF but another router has made a
           bid to take over.";
      }

      /*
       * Groupings
       */
      grouping static-rp-bidir-container {
        description
          "Grouping that contains BIDIR (Bidirectional) attributes for
           static RP (Rendezvous-Point).";
        container bidir {
          presence
            "Indicate the support of BIDIR mode.";
          description
            "PIM BIDIR configuration data.";

          uses pim-rp:static-rp-attributes;
        } // bidir
      } // static-rp-bidir-container

      grouping interface-df-election-state-attributes {
        description
          "Grouping that contains the state attributes of a DF election
           on an interface.";
        leaf interface-state {
          type identityref {
            base df-state;
          }
          description
            "Interface state with respect to the DF election.";
        }
        leaf up-time {
          type rt-types:timeticks64;
          description
```

```
          "The number of time ticks (hundredths of a second) since the
           current DF has been elected as the winner.";
      }
      leaf winner-metric {
        type uint32;
        description
          "The unicast routing metric used by the DF to reach the RP.
           The value is announced by the DF.";
      }
      leaf winner-metric-preference {
        type uint32;
        description
          "The preference value assigned to the unicast routing
           protocol that the DF used to obtain the route to the RP.
           The value is announced by the DF.";
      }
    } // interface-df-election-state-attributes

    /*
     * Configuration data and operational state date nodes
     */

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:address-family" {
      description "PIM BIDIR (Bidirectional) augmentation.";

      container bidir {
        presence "Present to enable BIDIR mode.";
        description
          "PIM BIDIR configuration data.";
      } // bidir
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
      + "pim-base:address-family" {
      description "PIM BIDIR augmentation.";

      container bidir {
        presence "Present to enable BIDIR mode.";
        description
          "PIM BIDIR configuration data.";
        container df-election {
          if-feature intf-df-election;
          description
            "DF election attributes.";
          leaf offer-interval {
            type uint16;
```

```
            units milliseconds;
            default 100;
            description
              "Offer interval specifies the interval between repeated
               DF election messages.";
          }
          leaf backoff-interval {
            type uint16;
            units milliseconds;
            default 1000;
            description
              "This is the interval that the acting DF waits between
               receiving a better DF Offer and sending the Pass message
               to transfer DF responsibility";
          }
          leaf offer-multiplier {
            type uint8;
            default 3;
            description
              "This is number of transmission attempts for DF election
               messages.
               When a DF election Offer or Winner message fails to be
               received, the message is retransmitted.
               The offer-multiplier sets the minimum number of DF
               election messages that must fail to be received for DF
               election to fail.
               If a router receives from a neighbor a better offer than
               its own, the router stops participating in the election
               for a period of offer-multiplier * offer-interval.
               Eventually, all routers except the best candidate stop
               sending Offer messages.";
          }
        } // df-election
      } // bidir
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:address-family/pim-rp:rp/"
      + "pim-rp:static-rp/pim-rp:ipv4-rp" {
      description "PIM BIDIR augmentation.";

      uses static-rp-bidir-container;
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:address-family/pim-rp:rp/"
      + "pim-rp:static-rp/pim-rp:ipv6-rp" {
      description "PIM BIDIR augmentation.";
```

```
      uses static-rp-bidir-container;
    } // augment

    /*
     * Operational state data nodes
     */

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:address-family/pim-rp:rp" {
      description "PIM BIDIR augmentation to RP state data.";

      container bidir {
        config false;
        description
          "PIM BIDIR state data.";
        container df-election {
          description
            "DF election data.";
          list ipv4-rp {
            when "../../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            key "rp-address";
            description
              "A list of IPv4 RP addresses.";
            leaf rp-address {
              type inet:ipv4-address;
              description
                "The address of the RP.";
            }
          } // ipv4-rp
          list ipv6-rp {
            when "../../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            key "rp-address";
            description
              "A list of IPv6 RP addresses.";
            leaf rp-address {
              type inet:ipv6-address;
              description
                "The address of the RP.";
            }
          } // ipv6-rp
        } // df-election
```

```
        container interface-df-election {
          description
            "Interface DF election data.";
          list ipv4-rp {
            when "../../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to IPv4 address family.";
            }
            key "rp-address interface-name";
            description
              "A list of IPv4 RP addresses.";
            leaf rp-address {
              type inet:ipv4-address;
              description
                "The address of the RP.";
            }
            leaf interface-name {
              type if:interface-ref;
              description
                "The name of the interface for which the DF state is
                 being maintained.";
            }
            leaf df-address {
              type inet:ipv4-address;
              description
                "The address of the elected DF, which is the winner of
                 the DF Election process.";
            }
            uses interface-df-election-state-attributes;
          } // ipv4-rp
          list ipv6-rp {
            when "../../../../pim-base:address-family = 'rt:ipv6'" {
              description
                "Only applicable to IPv6 address family.";
            }
            key "rp-address interface-name";
            description
              "A list of IPv6 RP addresses.";
            leaf rp-address {
              type inet:ipv6-address;
              description
                "The address of the RP.";
            }
            leaf interface-name {
              type if:interface-ref;
              description
                "The address of the RP.";
            }
```

```
            leaf df-address {
              type inet:ipv6-address;
              description
                "DF address.";
            }
            uses interface-df-election-state-attributes;
          } // ipv6-rp
        } // interface-df-election
      }
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
      + "pim-base:address-family/pim-base:neighbors/"
      + "pim-base:ipv4-neighbor" {
      description
        "PIM BIDIR augmentation to the IPv4 neighbor state data.";
      leaf bidir-capable {
        type boolean;
        description
          "'true' if the neighbor is using the Bidirectional Capable
           option in the last Hello message.";
      }
    } // augment

    augment "/rt:routing/rt:control-plane-protocols/"
      + "pim-base:pim/pim-base:interfaces/pim-base:interface/"
      + "pim-base:address-family/pim-base:neighbors/"
      + "pim-base:ipv6-neighbor" {
      description
        "PIM BIDIR augmentation to the IPv6 neighbor state data.";
      leaf bidir-capable {
        type boolean;
        description
          "'true' if the neighbor is using the Bidirectional Capable
           option in the last Hello message.";
      }
    } // augment
  }
  <CODE ENDS>
```

7. Implementation Status

This section to be removed by the RFC editor.

This section records the status of known implementations of the protocol defined by this specification at the time of posting of this

Internet-Draft, and is based on a proposal described in [RFC7942]. The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs. Please note that the listing of any individual implementation here does not imply endorsement by the IETF. Furthermore, no effort has been spent to verify the information presented here that was supplied by IETF contributors. This is not intended as, and must not be construed to be, a catalog of available implementations or their features. Readers are advised to note that other implementations may exist.

According to RFC 7942, "this will allow reviewers and working groups to assign due consideration to documents that have the benefit of running code, which may serve as evidence of valuable experimentation and feedback that have made the implemented protocols more mature. It is up to the individual working groups to use this information as they see fit".

This document is the work result of the PIM working group's YANG multicast design team. The following wiki page contains the information on the design team members, the meeting discussions, lists of modeled features, and which features are supported by which existing implementations:

https://trac.ietf.org/trac/pim/wiki/yang

8. Security Considerations

The YANG module specified in this document defines 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 [RFC6536] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in this 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. These are the subtrees and data nodes and their sensitivity/vulnerability:

pim-base:graceful-restart
This subtree specifies the configuration for the PIM graceful restart at the global level on a device. Modifying the configuration can cause temporary interruption to the multicast routing during restart.

pim-base:address-family/pim-base:graceful-restart
This subtree specifies the per address family configuration for the PIM graceful restart on a device. Modifying the configuration can cause temporary interruption to the multicast routing during restart.

pim-base:address-family/pim-rp:pim-rp:rp
This subtree specifies the configuration for the PIM Rendezvous Point (RP) on a device. Modifying the configuration can cause RP malfunctions.

pim-base:address-family/pim-sm:sm
This subtree specifies the configuration for the PIM Sparse Mode (PIM-SM) on a device. Modifying the configuration can cause multicast traffic disabled or rerouted in PIM-SM.

pim-base:address-family/pim-dm:dm
This subtree specifies the configuration for the PIM Dense Mode (PIM-DM) on a device. Modifying the configuration can cause multicast traffic disabled or rerouted in PIM-DM.

pim-base:address-family/pim-bidir:bidir
This subtree specifies the configuration for the PIM Bidirectional Mode (PIM-BIDIR) on a device. Modifying the configuration can cause multicast traffic disabled or rerouted in PIM-BIDIR.

pim-base:interfaces
This subtree specifies the configuration for the PIM interfaces on a device. Modifying the configuration can cause the PIM protocol to get insufficient or incorrect information.

These subtrees are all nnder /rt:routing/rt:control-plane-protocols/ pim-base:pim.

Unauthorized access to any data node of these subtrees can adversely affect the multicast routing subsystem of both the local device and the network. This may lead to network malfunctions, delivery of packets to inappropriate destinations, and other problems.

Some of the readable data nodes in this 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. These are the subtrees and data nodes and their sensitivity/vulnerability:

/rt:routing/rt:control-plane-protocols/pim-base:pim

Unauthorized access to any data node of the above subtree can disclose the operational state information of PIM on this device.

9. IANA Considerations

RFC Ed.: In this section, replace all occurrences of 'XXXX' with the actual RFC number (and remove this note).

This document registers the following namespace URIs in the IETF XML registry [RFC3688]:

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

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

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

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

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

This document registers the following YANG modules in the YANG Module Names registry [RFC7950]:

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

------------------------------------------------------------------
name:         ietf-pim-bidir
namespace:    urn:ietf:params:xml:ns:yang:ietf-pim-bidir
prefix:       pim-bidir
reference:    RFC XXXX
------------------------------------------------------------------

------------------------------------------------------------------
name:         ietf-pim-dm
namespace:    urn:ietf:params:xml:ns:yang:ietf-pim-dm
prefix:       pim-dm
reference:    RFC XXXX
------------------------------------------------------------------

------------------------------------------------------------------
name:         ietf-pim-rp
namespace:    urn:ietf:params:xml:ns:yang:ietf-pim-rp
prefix:       pim-rp
reference:    RFC XXXX
------------------------------------------------------------------

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

10. Acknowledgements

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11. References

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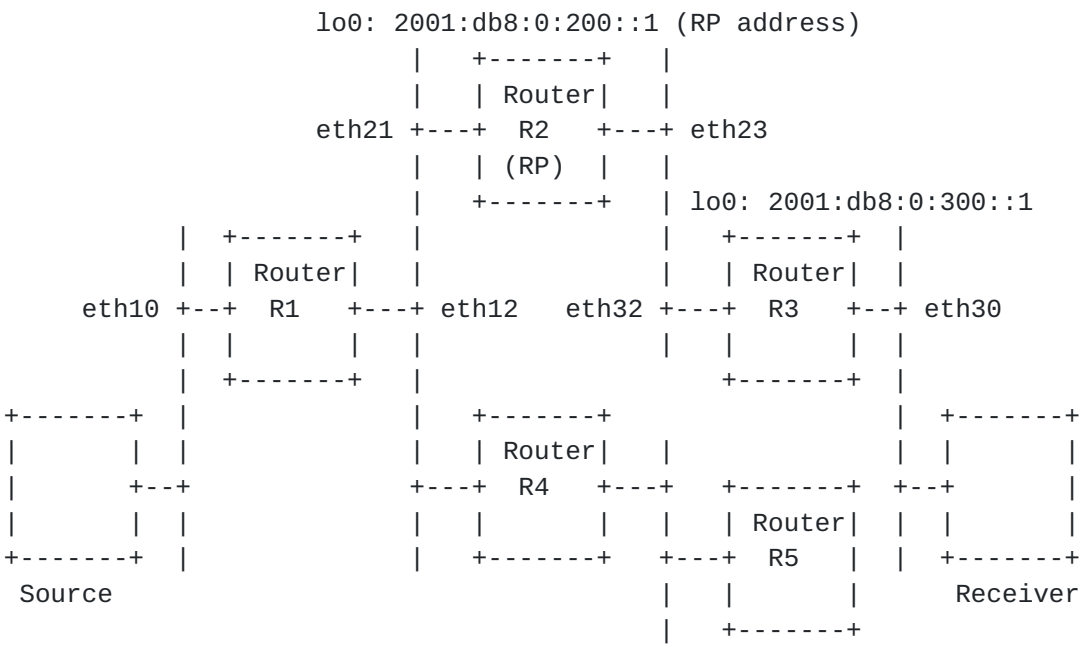
Appendix A. Data Tree Example

This section contains an example of an instance data tree in the JSON encoding [RFC7951], containing both configuration and state data.



The configuration instance data tree for Router R3 in the above figure could be as follows:

```
{
  "ietf-interfaces:interfaces": {
    "interface": [
      {
        "name": "lo0",
        "description": "R3 loopback interface.",
        "type": "iana-if-type:softwareLoopback",
        "ietf-ip:ipv6": {
          "address": [
            {
              "ip": "2001:db8:0:300::1",
              "prefix-length": 64
            }
          ]
        }
      },
      {
        "name": "eth30",
        "description": "An interface connected to the receiver.",
        "type": "iana-if-type:ethernetCsmacd",
        "ietf-ip:ipv6": {
```

```
            "forwarding": true
          }
        },
        {
          "name": "eth32",
          "description": "An interface connected to RP (R2).",
          "type": "iana-if-type:ethernetCsmacd",
          "ietf-ip:ipv6": {
            "forwarding": true
          }
        }
      ]
    },
    "ietf-routing:routing": {
      "router-id": "203.0.113.3",
      "control-plane-protocols": {
        "ietf-pim-base:pim": {
          "address-family": [
            {
              "address-family": "ietf-routing:ipv6",
              "ietf-pim-rp:rp": {
                "static-rp": {
                  "ipv6-rp": [
                    {
                      "rp-address": "2001:db8:0:200::1",
                      "ietf-pim-sm:sm": {
                      }
                    }
                  ]
                }
              }
            }
          ],
          "interfaces": {
            "interface": [
              {
                "name": "lo0",
                "address-family": [
                  {
                    "address-family": "ietf-routing:ipv6",
                    "hello-interval": "infinity",
                    "ietf-pim-sm:sm": {
                    }
                  }
                ]
              },
              {
                "name": "eth30",
```

```
                "address-family": [
                  {
                    "address-family": "ietf-routing:ipv6",
                    "ietf-pim-sm:sm": {
                    }
                  }
                ]
              },
              {
                "name": "eth32",
                "address-family": [
                  {
                    "address-family": "ietf-routing:ipv6",
                    "ietf-pim-sm:sm": {
                    }
                  }
                ]
              }
            ]
          }
        }
      }
    }
  }
```

The corresponding operational state data for Router R3 could be as follows:

```
{
  "ietf-interfaces:interfaces": {
    "interface": [
      {
        "name": "lo0",
        "description": "R3 loopback interface.",
        "type": "iana-if-type:softwareLoopback",
        "phys-address": "00:00:5e:00:53:03",
        "oper-status": "up",
        "statistics": {
          "discontinuity-time": "2018-01-23T12:34:56-05:00"
        },
        "ietf-ip:ipv6": {
          "mtu": 1500,
          "address": [
            {
              "ip": "2001:db8:0:300::1",
              "prefix-length": 64,
              "origin": "static",
              "status": "preferred"
```

```
            },
            {
              "ip": "fe80::200:5eff:fe00:5303",
              "prefix-length": 64,
              "origin": "link-layer",
              "status": "preferred"
            }
          ],
          "neighbor": [
          ]
        }
      },
      {
        "name": "eth30",
        "description": "An interface connected to the receiver.",
        "type": "iana-if-type:ethernetCsmacd",
        "phys-address": "00:00:5e:00:53:30",
        "oper-status": "up",
        "statistics": {
          "discontinuity-time": "2018-01-23T12:34:56-05:00"
        },
        "ietf-ip:ipv6": {
          "forwarding": true,
          "mtu": 1500,
          "address": [
            {
              "ip": "fe80::200:5eff:fe00:5330",
              "prefix-length": 64,
              "origin": "link-layer",
              "status": "preferred"
            }
          ],
          "neighbor": [
          ]
        }
      },
      {
        "name": "eth32",
        "description": "An interface connected to RP (R2).",
        "type": "iana-if-type:ethernetCsmacd",
        "phys-address": "00:00:5e:00:53:32",
        "oper-status": "up",
        "statistics": {
          "discontinuity-time": "2018-01-23T12:34:56-05:00"
        },
        "ietf-ip:ipv6": {
          "forwarding": true,
          "mtu": 1500,
```

```
            "address": [
              {
                "ip": "fe80::200:5eff:fe00:5332",
                "prefix-length": 64,
                "origin": "link-layer",
                "status": "preferred"
              }
            ],
            "neighbor": [
              {
                "ip": "fe80::200:5eff:fe00:5323",
                "link-layer-address": "00:00:5e:00:53:23",
                "origin": "dynamic",
                "is-router": [null],
                "state": "reachable"
              }
            ]
          }
        }
      ]
    },
    "ietf-routing:routing": {
      "router-id": "203.0.113.1",
      "interfaces": {
        "interface": [
          "lo0",
          "eth30",
          "eth32"
        ]
      },
      "control-plane-protocols": {
        "ietf-pim-base:pim": {
          "address-family": [
            {
              "address-family": "ietf-routing:ipv6",
              "statistics": {
                "discontinuity-time": "2018-01-23T12:34:56-05:00"
              },
              "topology-tree-info": {
                "ipv6-route": [
                  {
                    "group": "ff06::1",
                    "source-address": "*",
                    "is-rpt": true,
                    "expiration": 16,
                    "incoming-interface": "eth32",
                    "is-spt": false,
                    "mode": "pim-asm",
```

```
          "msdp-learned": false,
          "rp-address": "2001:db8:0:200::1",
          "rpf-neighbor": "fe80::200:5eff:fe00:5323",
          "up-time": 123400,
          "outgoing-interface": [
            {
              "name": "eth30",
              "expiration": 36,
              "up-time": 223400,
              "jp-state": "join"
            }
          ]
        },
        {
          "group": "ff06::1",
          "source-address": "2001:db8:1:1::100",
          "is-rpt": false,
          "expiration": 8,
          "incoming-interface": "eth32",
          "is-spt": true,
          "mode": "pim-asm",
          "msdp-learned": false,
          "rp-address": "2001:db8:0:200::1",
          "rpf-neighbor": "fe80::200:5eff:fe00:5323",
          "up-time": 5200,
          "outgoing-interface": [
            {
              "name": "eth30",
              "expiration": 6,
              "up-time": 5600,
              "jp-state": "join"
            }
          ]
        }
      ]
    },
    "ietf-pim-rp:rp": {
      "static-rp": {
        "ipv6-rp": [
          {
            "rp-address": "2001:db8:0:200::1",
            "ietf-pim-sm:sm": {
            }
          }
        ]
      },
      "rp-list": {
        "ipv6-rp": [
```

```
                    {
                      "rp-address": "2001:db8:0:200::1",
                      "mode": "ietf-pim-sm:rp-sm",
                      "info-source-type": "static",
                      "up-time": 323400,
                      "expiration": "not-set"
                    }
                  ]
                },
                "rp-mappings": {
                  "ipv6-rp": [
                    {
                      "group-range": "ff06::1/128",
                      "rp-address": "2001:db8:0:200::1",
                      "up-time": 123400,
                      "expiration": "36"
                    }
                  ]
                }
              }
            }
          ],
          "interfaces": {
            "interface": [
              {
                "name": "lo0",
                "address-family": [
                  {
                    "address-family": "ietf-routing:ipv6",
                    "hello-interval": "infinity",
                    "ietf-pim-sm:sm": {
                    },
                    "oper-status": "up",
                    "gen-id": 103689,
                    "hello-expiration": "infinity",
                    "ipv6": {
                      "address": [
                        "fe80::200:5eff:fe00:5303"
                      ],
                      "dr-address": "fe80::200:5eff:fe00:5303"
                    },
                    "neighbors": {
                      "ipv6-neighbor": [
                      ]
                    }
                  }
                ]
              },
```

```
                {
                  "name": "eth30",
                  "address-family": [
                    {
                      "address-family": "ietf-routing:ipv6",
                      "ietf-pim-sm:sm": {
                      },
                      "oper-status": "up",
                      "gen-id": 203689,
                      "hello-expiration": 18,
                      "ipv6": {
                        "address": [
                          "fe80::200:5eff:fe00:5330"
                        ],
                        "dr-address": "fe80::200:5eff:fe00:5330"
                      },
                      "neighbors": {
                        "ipv6-neighbor": [
                        ]
                      }
                    }
                  ]
                },
                {
                  "name": "eth32",
                  "address-family": [
                    {
                      "address-family": "ietf-routing:ipv6",
                      "ietf-pim-sm:sm": {
                      },
                      "oper-status": "up",
                      "gen-id": 303689,
                      "hello-expiration": 21,
                      "ipv6": {
                        "address": [
                          "fe80::200:5eff:fe00:5332"
                        ],
                        "dr-address": "fe80::200:5eff:fe00:5332"
                      },
                      "neighbors": {
                        "ipv6-neighbor": [
                          {
                            "address": "fe80::200:5eff:fe00:5323",
                            "expiration": 28,
                            "dr-priority": 1,
                            "gen-id": 102,
                            "lan-prune-delay": {
                              "present": false
```

```
                          },
                          "up-time": 323500
                        }
                      ]
                    }
                  }
                ]
              }
            ]
          }
        }
      }
    }
  }
```

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