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RFC 9128
YANG Data Model for Protocol Independent Multicast (PIM)

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 is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9128.

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Authors' Addresses

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 the Network Configuration Protocol (NETCONF) [RFC6241] or RESTCONF [RFC8040]. YANG is now also being used as a component of other management interfaces, such as command-line interfaces (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; see 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]
BIDIR-PIM:	Protocol Independent Multicast - Bidirectional Mode [RFC5015]
BSR:	Bootstrap Router [RFC5059]
DF:	Designated Forwarder [RFC5015]
DR:	Designated Router [RFC7761]
IGMP:	Internet Group Management Protocol [RFC3376]
MLD:	Multicast Listener Discovery [RFC3810]
mLDP:	Multipoint extensions for LDP [RFC6388]
MRIB:	Multicast Routing Information Base [RFC3973] [RFC5015] [RFC7761]
MSDP:	Multicast Source Discovery Protocol [RFC3618]
mVPN:	Multicast VPN
PIM:	Protocol Independent Multicast [RFC3973] [RFC5015] [RFC7761]
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 the context clearly indicates the YANG module in which 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	[RFC9314]

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 Bidirectional PIM [RFC5015].

The PIM extensions represented in the model include BSRs [RFC5059] and Anycast-RPs [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 signaling. 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 currently 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' configurations 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 intrinsic support for a piece of operational state would be able to derive a suitable value for a state variable that is not intrinsically 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 implementations.

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 [RFC8407].

2.4. Module and Hierarchy Organization

This model defines several separate modules for modeling PIM configuration. 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, a 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: under both the interface list and 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 be expressed either (1) as a vendor augmentation of an address-family-independent parameter above the address-family level or (2) by a constraint on the base model objects of a form similar to the following:

```
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: The IPv6 DR priority must match the "
      + "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 data and operational state data cover 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

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 data and operational state data of PIM interfaces are modeled as shown 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
```

Support for BFD client configuration is achieved by using a grouping provided by an external module, "ietf-bfd-types", as defined in [RFC9314].

3.1.5. Neighbor Modeling

For each PIM interface, there can be a list of neighbors that contains operational state data for each neighbor. 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 PIM-SM and BIDIR-PIM mode but is not shared by PIM-DM. The PIM-SM module and the BIDIR-PIM 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 RPs

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. BSRs

Support for BSRs 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 Any-Source Multicast (PIM-ASM) and PIM Source-Specific Multicast (PIM-SSM). This module has dependencies on the PIM base module and the 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 PIM-SM 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 PIM-SM:

```
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. BIDIR-PIM Module

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

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

```
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 RPs for BIDIR-PIM 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 enabled?                           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)
         |              {single-minimum-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. BIDIR-PIM 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".

Table 2 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

YANG Node	PIM-STD-MIB Object
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.

Table 3 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 the "source-address" leaf is "ietf-routing-types:*" and the value of the "is-rpt" leaf is "false".

Table 4 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
	pimStarGRPAddress
rpf-neighbor	pimStarGUpstreamNeighborType
	pimStarGUpstreamNeighbor
incoming-interface	pimStarGRPFIfIndex

Table 4: YANG Nodes and pimStarGTable Objects

In addition, 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 the "source-address" leaf is not "ietf-routing-types:*" and the value of the "is-rpt" leaf is "false".

Table 5 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

YANG Node	PIM-STD-MIB Object
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 the "is-rpt" leaf is "true".

Table 6 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.

Table 7 lists the YANG data nodes with corresponding objects of pimBidirDFElectionTable in the PIM-STD-MIB.

YANG Node	PIM-STD-MIB Object
ipv4-rp	pimBidirDFElectionAddressType

YANG Node	PIM-STD-MIB Object
ipv6-rp	
rp-address	pimBidirDFElectionRPAddress
df-address	pimBidirDFElectionWinnerAddressType
	pimBidirDFElectionWinnerAddress
up-time	pimBidirDFElectionWinnerUpTime
winner-metric-preference	pimBidirDFElectionWinnerMetricPref
	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.

Table 8 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.

Table 9 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.

Table 10 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 addition, 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], [RFC5880], [RFC6991], [RFC7761], [RFC8294], [RFC8343], [RFC8349], [RFC8706], and [RFC9314].

```
<CODE BEGINS> file "ietf-pim-base@2022-10-19.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;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-yang-types {
    prefix yang;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-interfaces {
    prefix if;
    reference
      "RFC 8343: A YANG Data Model for Interface Management";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-bfd-types {
    prefix bfd-types;
    reference
      "RFC 9314: YANG Data Model for Bidirectional Forwarding
       Detection (BFD)";
  }

  organization
    "IETF PIM Working Group";
  contact
    "WG Web:   <https://datatracker.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@chinamobile.com>

     Editor:   Fangwei Hu
               <mailto:hufwei@gmail.com>";
   description
     "This module defines a collection of YANG definitions common for
      all PIM (Protocol Independent Multicast) modes.

      Copyright (c) 2022 IETF Trust and the persons identified as
      authors of the code.  All rights reserved.

      Redistribution and use in source and binary forms, with or
      without modification, is permitted pursuant to, and subject to
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      Relating to IETF Documents
      (https://trustee.ietf.org/license-info).

      This version of this YANG module is part of RFC 9128; see the
      RFC itself for full legal notices.";

   revision 2022-10-19 {
     description
       "Initial revision.";
     reference
       "RFC 9128: A YANG Data Model for Protocol Independent
        Multicast (PIM)";
   }

   /*
    * Features
    */

   feature bfd {
     description
       "Supports BFD (Bidirectional Forwarding Detection).";
     reference
       "RFC 5880: Bidirectional Forwarding Detection (BFD)";
   }

   feature global-graceful-restart {
     description
       "Global configuration for graceful restart support as per
        RFC 8706.";
     reference
       "RFC 8706: Restart Signaling for IS-IS";
```

```
  }

  feature intf-dr-priority {
    description
      "Supports configuration of an interface DR (Designated Router)
       priority.";
    reference
      "RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.3.2";
  }

  feature intf-hello-holdtime {
    description
      "Supports configuration of the interface Hello Holdtime.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.3.3
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-hello-interval {
    description
      "Supports configuration of the interface Hello interval.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.8
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-hello-multiplier {
    description
      "Supports configuration of the interface Hello multiplier
       (the number by which the Hello interval is multiplied to
       obtain the Hello Holdtime).";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.8
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-jp-interval {
    description
      "Supports configuration of the interface Join/Prune interval.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.8
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-jp-holdtime {
    description
      "Supports configuration of the interface Join/Prune Holdtime.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
```

```
       (PIM-DM): Protocol Specification (Revised), Section 4.8
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-jp-multiplier {
    description
      "Supports configuration of the interface Join/Prune
       multiplier (the number by which the Join/Prune interval is
       multiplied to obtain the Join/Prune Holdtime).";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.8
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature intf-propagation-delay {
    description
      "Supports configuration of interface propagation delay.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.3.5
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.3.3";
  }

  feature intf-override-interval {
    description
      "Supports configuration of the interface override interval.";
    reference
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised),
       Sections 4.1.1 and 4.8
       RFC 5015: Bidirectional Protocol Independent Multicast
       (BIDIR-PIM), Section 3.6
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.11";
  }

  feature per-af-graceful-restart {
    description
      "Per address family configuration for graceful restart support
       as per RFC 8706.";
    reference
      "RFC 8706: Restart Signaling for IS-IS";
  }

  /*
   * 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 is operating in Bidirectional Mode.";
  }

  identity pim-dm {
    base pim-mode;
    description
```

```
      "PIM is operating in Dense Mode (DM).";
  }

  identity pim-sm {
    base pim-mode;
    description
      "PIM is operating in Sparse Mode (SM).";
  }

  identity pim-asm {
    base pim-sm;
    description
      "PIM is operating in Sparse Mode with Any-Source Multicast
       (ASM).";
  }

  identity pim-ssm {
    base pim-sm;
    description
      "PIM is operating in 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
          "Enables or disables 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 the SPTbit (Shortest Path Tree bit) is set to
           indicate that forwarding is taking place on the
           (S,G) SPT.";
        reference
          "RFC 7761: Protocol Independent Multicast - Sparse Mode
           (PIM-SM): Protocol Specification (Revised), Section 4.1.3";
      }
      leaf mode {
        type identityref {
          base pim-mode;
        }
        description
          "PIM mode.";
      }
      leaf msdp-learned {
        type boolean;
        description
          "'true' if the route is learned from MSDP (the 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
            "Expiration time.";
        }
```

```
      leaf up-time {
        type rt-types:timeticks64;
        description
          "The number of time ticks (hundredths of a second) since
           the 'oper-status' setting 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 expiration 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 '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 '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 '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 ability 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 being 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
      "RFC 3973: Protocol Independent Multicast - Dense Mode
       (PIM-DM): Protocol Specification (Revised), Section 4.7.1
       RFC 5015: Bidirectional Protocol Independent Multicast
       (BIDIR-PIM), Section 3.7
       RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 4.9";
    leaf assert {
      type yang:counter64;
      description
        "The number of Assert messages, with the message Type
         of 5 (RFCs 3973 and 7761).";
      reference
        "RFC 3973: Protocol Independent Multicast - Dense Mode
         (PIM-DM): Protocol Specification (Revised)
         RFC 7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised)";
    }
    leaf bsr {
      type yang:counter64;
      description
        "The number of Bootstrap messages, with the message Type
         of 4 (RFCs 3973 and 7761).";
    }
    leaf candidate-rp-advertisement {
```

```
        type yang:counter64;
        description
          "The number of Candidate RP Advertisement messages, with the
           message Type of 8 (RFCs 3973 and 7761).";
      }
      leaf df-election {
        type yang:counter64;
        description
          "The number of DF (Designated Forwarder) election messages,
           with the message Type of 10 (RFC 5015).";
        reference
          "RFC 5015: Bidirectional Protocol Independent Multicast
           (BIDIR-PIM)";
      }
      leaf graft {
        type yang:counter64;
        description
          "The number of Graft messages, with the message Type
           of 6 (RFCs 3973 and 7761).";
      }
      leaf graft-ack {
        type yang:counter64;
        description
          "The number of Graft-Ack messages, with the message Type
           of 7 (RFCs 3973 and 7761).";
      }
      leaf hello {
        type yang:counter64;
        description
          "The number of Hello messages, with the message Type
           of 0 (RFCs 3973 and 7761).";
      }
      leaf join-prune {
        type yang:counter64;
        description
          "The number of Join/Prune messages, with the message Type
           of 3 (RFCs 3973 and 7761).";
      }
      leaf register {
        type yang:counter64;
        description
          "The number of Register messages, with the message Type
           of 1 (RFCs 3973 and 7761).";
      }
      leaf register-stop {
        type yang:counter64;
        description
          "The number of Register-Stop messages, with the message Type
           of 2 (RFCs 3973 and 7761).";
      }
      leaf state-refresh {
        type yang:counter64;
        description
          "The number of State Refresh messages, with the message Type
           of 9 (RFC 3973).";
      }
    } // 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 data and operational state 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 of the most recent occasion at which any one
               or more of the statistics counters suffered a
               discontinuity.  If no such discontinuities have
               occurred since the last reinitialization of the local
               management subsystem, then this node contains the time
               the local management subsystem reinitialized
               itself.";
          }
          container error {
            description
              "Contains error statistics.";
            uses statistics-sent-received {
              description
                "Statistics 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
                 errors related to PIM Version, Type, and message
                 length.";
            }
          }
          container queue {
            description
              "Contains queue statistics.";
            leaf size {
              type uint32;
              description
                "The size of the input queue.";
            }
            leaf overflow {
              type yang:counter32;
              description
                "The number of input queue overflows.";
            }
          }
          container received {
            description
              "Contains statistics of received messages.";
            uses statistics-sent-received;
          }
          container sent {
            description
              "Contains statistics of sent messages.";
            uses statistics-sent-received;
          }
        }
        container topology-tree-info {
          config false;
          description
            "Contains topology tree information.";
          list ipv4-route {
            when "../../address-family = 'rt:ipv4'" {
              description
                "Only applicable to an 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 an RPT
               (Rendezvous Point Tree).";
          }
          uses multicast-route-attributes;
        } // ipv4-route
        list ipv6-route {
          when "../../address-family = 'rt:ipv6'" {
            description
              "Only applicable to an 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 an RPT.";
          }
          uses multicast-route-attributes;
        } // ipv6-route
      } // topology-tree-info
    } // address-family
    container interfaces {
      description
        "Contains 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
              "RFC 3973: Protocol Independent Multicast -
               Dense Mode (PIM-DM): Protocol Specification
               (Revised), Section 4.8
               RFC 7761: Protocol Independent Multicast - Sparse
               Mode (PIM-SM): Protocol Specification (Revised),
               Section 4.11";
          }
          choice hello-holdtime-or-multiplier {
            description
              "The Holdtime is the timer value to time out the
               neighbor state when the timer expires.
               The Holdtime value can be specified by either
               (1) the given Holdtime value or (2) 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
                  "The 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
                  "The Hello multiplier is the number by which the
                   Hello interval is multiplied 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
                "The Join/Prune Holdtime is the amount of time a
                 receiver must keep the Join/Prune state alive.
                 The Holdtime value can be specified by either
                 (1) the given Holdtime value or (2) the calculation
                 of '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
                    "The 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
                    "The Join/Prune multiplier is the number
                     by which the Join/Prune interval is multiplied
                     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 into 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 an 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 an 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 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 an 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 an 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 a 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 an 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 an 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 being timed out.";
    }
  }

  notification pim-interface-event {
    description
      "Notification event for an interface.";
    leaf event-type {
      type interface-event-type;
      description
        "Event type.";
    }
    uses pim-interface-state-ref;
    container ipv4 {
      description
        "Contains 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
        "Contains IPv6 information.";
      leaf-list address {
        type inet:ipv6-address;
        description
          "List of addresses.";
      }
      leaf dr-address {
        type inet:ipv6-address;
        description
          "DR address.";
      }
    }
  }
}

<CODE ENDS>
```

6.2. PIM RP Module

This module references [RFC5059], [RFC6991], [RFC7761], [RFC8294], [RFC8343], and [RFC8349].

```
<CODE BEGINS> file "ietf-pim-rp@2022-10-19.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;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-interfaces {
    prefix if;
    reference
      "RFC 8343: A YANG Data Model for Interface Management";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-pim-base {
    prefix pim-base;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  organization
    "IETF PIM Working Group";
  contact
    "WG Web:   <https://datatracker.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@chinamobile.com>

     Editor:   Fangwei Hu
               <mailto:hufwei@gmail.com>";
  description
    "This 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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      without modification, is permitted pursuant to, and subject to
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      Relating to IETF Documents
      (https://trustee.ietf.org/license-info).

      This version of this YANG module is part of RFC 9128; see the
      RFC itself for full legal notices.";

  revision 2022-10-19 {
    description
      "Initial revision.";
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  /*
   * Features
   */

  feature bsr {
    description
      "This feature indicates that the system supports BSRs
       (Bootstrap Routers).";
    reference
      "RFC 5059: 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
      "RFC 5059: Bootstrap Router (BSR) Mechanism for Protocol
       Independent Multicast (PIM)";
  }

  feature static-rp-override {
    description
      "This feature indicates that the system supports configuration
       of the static RP (Rendezvous Point) that overrides the RP
       discoveries from other mechanisms.";
    reference
      "RFC 7761: Protocol Independent Multicast - Sparse Mode
       (PIM-SM): Protocol Specification (Revised), Section 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 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 (Bidirectional).";
  }

  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 a 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 RPs and dynamic RPs,
         setting this attribute to 'true' will ask the system to use
         static RPs.";
    }
  } // 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
         (Bidirectional).  Each of these modes is defined in a
         separate YANG 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 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
          "Contains static RP attributes.";
        list ipv4-rp {
          when "../../../pim-base:address-family = 'rt:ipv4'" {
            description
              "Only applicable to an 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 an 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
          "Contains 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 an interface or an IP address.";
            case interface {
              if-feature "candidate-interface";
              leaf interface {
                type if:interface-ref;
                mandatory true;
                description
                  "Interface to be used by a BSR.";
              }
```

```
            }
            case ipv4-address {
              when "../../../pim-base:address-family = 'rt:ipv4'" {
                description
                  "Only applicable to an IPv4 address family.";
              }
              if-feature "candidate-ipv4";
              leaf ipv4-address {
                type inet:ipv4-address;
                mandatory true;
                description
                  "IP address to be used by a BSR.";
              }
            }
            case ipv6-address {
              when "../../../pim-base:address-family = 'rt:ipv6'" {
                description
                  "Only applicable to an IPv6 address family.";
              }
              if-feature "candidate-ipv6";
              leaf ipv6-address {
                type inet:ipv6-address;
                mandatory true;
                description
                  "IP address to be used by a 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
            "Contains 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 an 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 an 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 came 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 of the
                     BSR functions.";
                }
              }
              description
                "Candidate-BSR (C-BSR) state.";
              reference
                "RFC 5059: Bootstrap Router (BSR) Mechanism for
                 Protocol Independent Multicast (PIM),
                 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
                   that provides 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
              "RFC 5059: Bootstrap Router (BSR) Mechanism for
               Protocol Independent Multicast (PIM),
               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
          "Contains a list of RPs.";
        list ipv4-rp {
          when "../../../pim-base:address-family = 'rt:ipv4'" {
            description
              "Only applicable to an 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 an 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
          "Contains a list of group-to-RP mappings.";
        list ipv4-rp {
          when "../../../pim-base:address-family = 'rt:ipv4'" {
            description
              "Only applicable to an 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 a 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 an 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 a 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 an 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 an RPT (Rendezvous Point Tree).";
    }
    leaf mode {
      type identityref {
        base pim-base:pim-mode;
      }
      description
        "PIM mode.";
    }
    leaf message-origin {
      type inet:ip-address;
      description
        "Where the message originated.";
    }
  }
}

<CODE ENDS>
```

6.3. PIM-SM Module

This module references [RFC4607], [RFC6991], [RFC7761], and [RFC8349].

```
<CODE BEGINS> file "ietf-pim-sm@2022-10-19.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;
    reference
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-pim-base {
    prefix pim-base;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }
  import ietf-pim-rp {
    prefix pim-rp;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  organization
    "IETF PIM Working Group";
  contact
    "WG Web:   <https://datatracker.ietf.org/wg/pim/>
     WG List:  <mailto:pim@ietf.org>

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

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

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

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

     Editor:   Fangwei Hu
               <mailto:hufwei@gmail.com>";
  description
    "This YANG module defines a PIM (Protocol Independent Multicast)
     SM (Sparse Mode) model.

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```

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

      This version of this YANG module is part of RFC 9128; see the
      RFC itself for full legal notices.";

    revision 2022-10-19 {
      description
        "Initial revision.";
      reference
        "RFC 9128: A YANG Data Model for Protocol Independent
         Multicast (PIM)";
    }

    /*
     * Features
     */

    feature spt-switch-infinity {
      description
        "This feature indicates that the system supports the
         configuration choice of whether to trigger switchover from
         the RPT (Rendezvous Point Tree) to the SPT (Shortest Path
         Tree).";
      reference
        "RFC 7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised), Section 4.2";
    }

    feature spt-switch-policy {
      description
        "This feature indicates that the system supports configuring
         the policy for switchover from the RPT to the SPT.";
      reference
        "RFC 7761: Protocol Independent Multicast - Sparse Mode
         (PIM-SM): Protocol Specification (Revised), Section 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 RPs.";
      container sm {
        presence "Indicates support for PIM-SM.";
```

```
      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 an Anycast-RP
                    (Rendezvous Point).";
          description
            "Anycast-RP attributes.";
          list ipv4-anycast-rp {
            when "../../../../pim-base:address-family = 'rt:ipv4'" {
              description
                "Only applicable to an 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 an
                 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 an 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 an
                 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 the SPT switchover threshold is set
                      to infinity, according to the policy specified
                      below.";
            description
              "The receiver's DR (Designated Router) never triggers
               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 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 range used by SSM.
```

```
              If a policy is not specified, the default SSM multicast
              group range is used.
              The default SSM multicast group range is 232.0.0.0/8
              for IPv4 and ff3x::/96 for IPv6, where x represents any
              valid scope identifier.
              The definition of such a policy is outside the scope
              of this document.";
            reference
              "RFC 4607: 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 PIM-SM.";
        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] and [RFC8349].

```
<CODE BEGINS> file "ietf-pim-dm@2022-10-19.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;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-pim-base {
    prefix pim-base;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  organization
    "IETF PIM Working Group";
  contact
    "WG Web:   <https://datatracker.ietf.org/wg/pim/>
     WG List:  <mailto:pim@ietf.org>

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

     Editor:   Pete McAllister
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     Editor:   Anish Peter
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     Editor:   Mahesh Sivakumar
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     Editor:   Yisong Liu
               <mailto:liuyisong@chinamobile.com>

     Editor:   Fangwei Hu
               <mailto:hufwei@gmail.com>";
  description
    "This YANG module defines a PIM (Protocol Independent Multicast)
     DM (Dense Mode) model.

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```

```
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  revision 2022-10-19 {
    description
      "Initial revision.";
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  /*
   * Configuration data nodes
   */

  augment "/rt:routing/rt:control-plane-protocols/"
        + "pim-base:pim/pim-base:address-family" {
    description
      "PIM-DM augmentation.";
    container dm {
      presence "Present to enable PIM-DM.";
      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 PIM-DM.";
      description
        "PIM-DM configuration data.";
    } // dm
  } // augment

}

<CODE ENDS>
```

6.5. BIDIR-PIM Module

This module references [RFC5015], [RFC6991], [RFC8294], [RFC8343], and [RFC8349].

```
<CODE BEGINS> file "ietf-pim-bidir@2022-10-19.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;
    reference
```

```
      "RFC 6991: Common YANG Data Types";
  }
  import ietf-routing-types {
    prefix rt-types;
    reference
      "RFC 8294: Common YANG Data Types for the Routing Area";
  }
  import ietf-interfaces {
    prefix if;
    reference
      "RFC 8343: A YANG Data Model for Interface Management";
  }
  import ietf-routing {
    prefix rt;
    reference
      "RFC 8349: A YANG Data Model for Routing Management (NMDA
       Version)";
  }
  import ietf-pim-base {
    prefix pim-base;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }
  import ietf-pim-rp {
    prefix pim-rp;
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  organization
    "IETF PIM Working Group";
  contact
    "WG Web:   <https://datatracker.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@chinamobile.com>

     Editor:   Fangwei Hu
               <mailto:hufwei@gmail.com>";
  description
    "This YANG module defines a PIM (Protocol Independent Multicast)
     BIDIR (Bidirectional) mode model.
```

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

  revision 2022-10-19 {
    description
      "Initial revision.";
    reference
      "RFC 9128: A YANG Data Model for Protocol Independent
       Multicast (PIM)";
  }

  /*
   * Features
   */

  feature intf-df-election {
    description
      "Supports configuration of interface DF election.";
    reference
      "RFC 5015: Bidirectional Protocol Independent Multicast
       (BIDIR-PIM), Section 3.5";
  }

  /*
   * Identities
   */

  identity rp-bidir {
    base pim-rp:rp-mode;
    description
      "BIDIR mode.";
  }

  identity df-state {
    description
      "DF (Designated Forwarder) election state type.";
    reference
      "RFC 5015: 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
      "Either (1) there is a different election winner or
       (2) 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 attributes for a static RP
       (Rendezvous Point).";
    container bidir {
      presence "Indicates support for 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 data nodes
   */

  augment "/rt:routing/rt:control-plane-protocols/"
        + "pim-base:pim/pim-base:address-family" {
    description
      "PIM-BIDIR 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 the number of transmission attempts for
             DF election messages.
             When a DF election Offer or Winner message fails to be
             received, the message is retransmitted.
             '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 an 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 an 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 an 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 an 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 name of the interface for which the DF state is
               being maintained.";
          }
          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. Security Considerations

The YANG modules specified in this document define a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] 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 these YANG modules 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 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 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 PIM Sparse Mode (PIM-SM) on a device. Modifying the configuration can cause multicast traffic to be disabled or rerouted in PIM-SM.

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

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

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 under "/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 these YANG modules 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.

8. IANA Considerations

IANA has registered 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.

IANA has registered the following YANG modules in the "YANG Module Names" registry [RFC6020]:

Name: ietf-pim-base
Namespace: urn:ietf:params:xml:ns:yang:ietf-pim-base
Prefix: pim-base
Reference: RFC 9128

Name: ietf-pim-bidir
Namespace: urn:ietf:params:xml:ns:yang:ietf-pim-bidir
Prefix: pim-bidir
Reference: RFC 9128

Name: ietf-pim-dm
Namespace: urn:ietf:params:xml:ns:yang:ietf-pim-dm
Prefix: pim-dm
Reference: RFC 9128

Name: ietf-pim-rp
Namespace: urn:ietf:params:xml:ns:yang:ietf-pim-rp
Prefix: pim-rp
Reference: RFC 9128

Name: ietf-pim-sm
Namespace: urn:ietf:params:xml:ns:yang:ietf-pim-sm
Prefix: pim-sm
Reference: RFC 9128

9. References

9.1. Normative References

[RFC3569] Bhattacharyya, S., Ed., "An Overview of Source-Specific Multicast (SSM)", RFC 3569, DOI 10.17487/RFC3569, July 2003, <https://www.rfc-editor.org/info/rfc3569>.

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

[RFC3973] Adams, A., Nicholas, J., and W. Siadak, "Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification (Revised)", RFC 3973, DOI 10.17487/RFC3973, January 2005, <https://www.rfc-editor.org/info/rfc3973>.

[RFC4607] Holbrook, H. and B. Cain, "Source-Specific Multicast for IP", RFC 4607, DOI 10.17487/RFC4607, August 2006, <https://www.rfc-editor.org/info/rfc4607>.

[RFC4610] Farinacci, D. and Y. Cai, "Anycast-RP Using Protocol Independent Multicast (PIM)", RFC 4610, DOI 10.17487/RFC4610, August 2006, <https://www.rfc-editor.org/info/rfc4610>.

[RFC5015] Handley, M., Kouvelas, I., Speakman, T., and L. Vicisano, "Bidirectional Protocol Independent Multicast (BIDIR-PIM)", RFC 5015, DOI 10.17487/RFC5015, October 2007, <https://www.rfc-editor.org/info/rfc5015>.

[RFC5059] Bhaskar, N., Gall, A., Lingard, J., and S. Venaas, "Bootstrap Router (BSR) Mechanism for Protocol Independent Multicast (PIM)", RFC 5059, DOI 10.17487/RFC5059, January 2008, <https://www.rfc-editor.org/info/rfc5059>.

[RFC5060] Sivaramu, R., Lingard, J., McWalter, D., Joshi, B., and A. Kessler, "Protocol Independent Multicast MIB", RFC 5060, DOI 10.17487/RFC5060, January 2008, <https://www.rfc-editor.org/info/rfc5060>.

[RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", RFC 6020, DOI 10.17487/RFC6020, October 2010, <https://www.rfc-editor.org/info/rfc6020>.

[RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/info/rfc6241>.

[RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <https://www.rfc-editor.org/info/rfc6242>.

[RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <https://www.rfc-editor.org/info/rfc6991>.

[RFC7761] Fenner, B., Handley, M., Holbrook, H., Kouvelas, I., Parekh, R., Zhang, Z., and L. Zheng, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", STD 83, RFC 7761, DOI 10.17487/RFC7761, March 2016, <https://www.rfc-editor.org/info/rfc7761>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/info/rfc7950>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[RFC8294] Liu, X., Qu, Y., Lindem, A., Hopps, C., and L. Berger, "Common YANG Data Types for the Routing Area", RFC 8294, DOI 10.17487/RFC8294, December 2017, <https://www.rfc-editor.org/info/rfc8294>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/info/rfc8342>.

[RFC8343] Bjorklund, M., "A YANG Data Model for Interface Management", RFC 8343, DOI 10.17487/RFC8343, March 2018, <https://www.rfc-editor.org/info/rfc8343>.

[RFC8349] Lhotka, L., Lindem, A., and Y. Qu, "A YANG Data Model for Routing Management (NMDA Version)", RFC 8349, DOI 10.17487/RFC8349, March 2018, <https://www.rfc-editor.org/info/rfc8349>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC9314] Jethanandani, M., Ed., Rahman, R., Ed., Zheng, L., Ed., Pallagatti, S., and G. Mirsky, "YANG Data Model for Bidirectional Forwarding Detection (BFD)", RFC 9314, DOI 10.17487/RFC9314, September 2022, <https://www.rfc-editor.org/info/rfc9314>.

9.2. Informative References

[RFC3376] Cain, B., Deering, S., Kouvelas, I., Fenner, B., and A. Thyagarajan, "Internet Group Management Protocol, Version 3", RFC 3376, DOI 10.17487/RFC3376, October 2002, <https://www.rfc-editor.org/info/rfc3376>.

[RFC3618] Fenner, B., Ed. and D. Meyer, Ed., "Multicast Source Discovery Protocol (MSDP)", RFC 3618, DOI 10.17487/RFC3618, October 2003, <https://www.rfc-editor.org/info/rfc3618>.

[RFC3810] Vida, R., Ed. and L. Costa, Ed., "Multicast Listener Discovery Version 2 (MLDv2) for IPv6", RFC 3810, DOI 10.17487/RFC3810, June 2004, <https://www.rfc-editor.org/info/rfc3810>.

[RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", RFC 5880, DOI 10.17487/RFC5880, June 2010, <https://www.rfc-editor.org/info/rfc5880>.

[RFC6388] Wijnands, IJ., Ed., Minei, I., Ed., Kompella, K., and B. Thomas, "Label Distribution Protocol Extensions for Point-to-Multipoint and Multipoint-to-Multipoint Label Switched Paths", RFC 6388, DOI 10.17487/RFC6388, November 2011, <https://www.rfc-editor.org/info/rfc6388>.

[RFC7951] Lhotka, L., "JSON Encoding of Data Modeled with YANG", RFC 7951, DOI 10.17487/RFC7951, August 2016, <https://www.rfc-editor.org/info/rfc7951>.

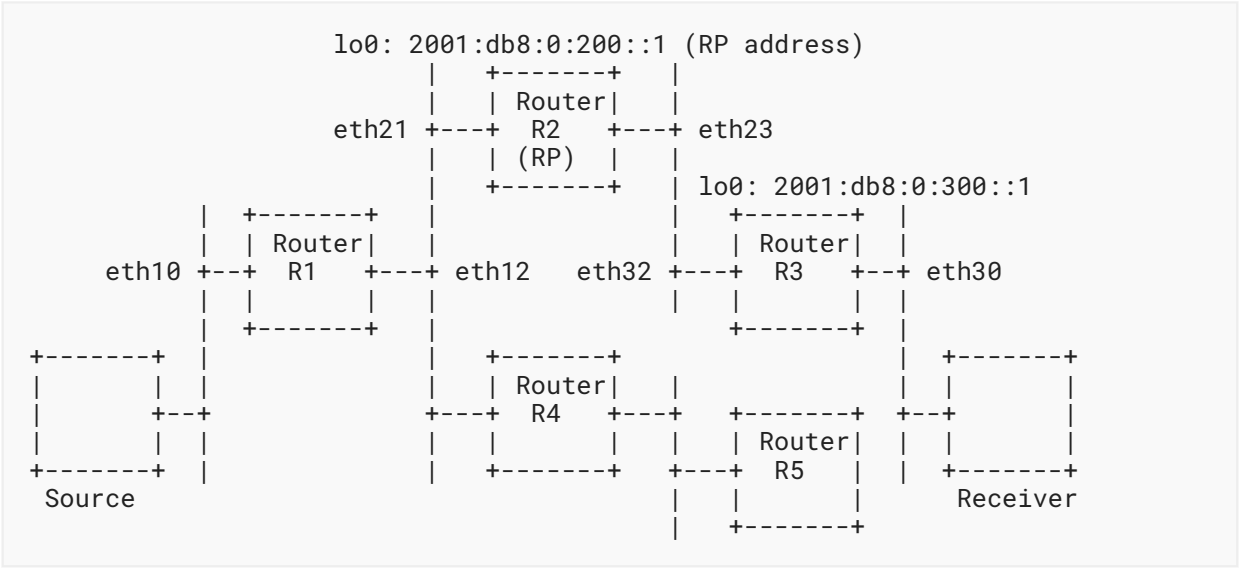
[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

[RFC8407] Bierman, A., "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", BCP 216, RFC 8407, DOI 10.17487/RFC8407, October 2018, <https://www.rfc-editor.org/info/rfc8407>.

[RFC8706] Ginsberg, L. and P. Wells, "Restart Signaling for IS-IS", RFC 8706, DOI 10.17487/RFC8706, February 2020, <https://www.rfc-editor.org/info/rfc8706>.

Appendix A. Data Tree Example

This appendix contains an example of an instance data tree, in JSON encoding [RFC7951], containing both configuration data 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 the 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 the 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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