

Internet Engineering Task Force (IETF)  
Request for Comments: 8347  
Category: Standards Track  
ISSN: 2070-1721

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March 2018

A YANG Data Model for the Virtual Router Redundancy Protocol (VRRP)

## Abstract

This document describes a data model for the Virtual Router Redundancy Protocol (VRRP). Both versions 2 and 3 of VRRP are covered.

## 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/rfc8347>.

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## 1. Introduction

This document introduces a YANG data model [RFC6020] [RFC7950] for the Virtual Router Redundancy Protocol (VRRP) [RFC3768] [RFC5798]. VRRP provides higher resiliency by specifying an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRP routers on a LAN.

The YANG module specified in this document supports both versions 2 and 3 of VRRP. VRRP version 2 (defined in [RFC3768]) supports IPv4. VRRP version 3 (defined in [RFC5798]) supports both IPv4 and IPv6.

## 1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

The following terms are defined in [RFC7950] and are not redefined here:

- o augment
- o data model
- o data node

## 1.2. Tree Diagrams

A simplified graphical representation of the data model is used in this document. The meaning of the symbols in these diagrams is defined in [RFC8340].

## 1.3. Prefixes in Data Node Names

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

Prefix	YANG module	Reference
yang	ietf-yang-types	[RFC6991]
inet	ietf-inet-types	[RFC6991]
if	ietf-interfaces	[RFC8343]
ip	ietf-ip	[RFC8344]

Table 1: Prefixes and Corresponding YANG Modules

## 2. Design of the Data Model

### 2.1. Scope of the Model

The model covers VRRP version 2 [RFC3768] and VRRP version 3 [RFC5798]. The model is designed to be implemented on a device where VRRP version 2 or 3 is implemented. With the help of a proper management protocol, the defined model can be used to:

- o Configure VRRP version 2 or 3.
- o Manage the protocol operational behavior.

- o Retrieve the protocol operational status.
- o Receive the protocol notifications.

## 2.2. Relationships with the Interface Model and IP Model

This model augments the interface data model "ietf-interfaces" [RFC8343] and the IP management model "ietf-ip" [RFC8344]. The augmentation relationships are shown as follows:

```

module: ietf-interfaces
  +--rw interfaces
    +--rw interface* [name]
      ...
      +--rw ip:ipv4!
        | +--rw ip:address* [ip]
        |   ...
        |   +--rw vrrp:vrrp
        |     +--rw vrrp:vrrp-instance* [vrid]
        |       +--rw vrrp:vrid                               uint8
        |       +--rw vrrp:virtual-ipv4-addresses
        |         ...
      +--rw ip:ipv6!
        +--rw ip:address* [ip]
        |   ...
        |   +--rw vrrp:vrrp
        |     +--rw vrrp:vrrp-instance* [vrid]
        |       +--rw vrrp:vrid                               uint8
        |       +--rw vrrp:virtual-ipv6-addresses
        |         ...

```

In the above figure, a tree node without a prefix is from the model "ietf-interfaces". A tree node with prefix "ip:" is from the model "ietf-ip". A tree node with prefix "vrrp:" is from the VRRP model specified in this document.

The "vrrp" container contains a list of vrrp-instance nodes, which are instantiated under an interface for a specified address family (IPv4 or IPv6).

Each vrrp-instance node represents a VRRP router state machine, as described in Section 6.4 of [RFC5798], providing the configuration and state information for the election process of a virtual router. The IP addresses on the augmented interface are the real addresses through which the VRRP router operates. The IPv4 or IPv6 address or addresses associated with a virtual router (described in Section 1 of [RFC5798]) are modeled as a list of IPv4 or IPv6 addresses under the vrrp-instance.

### 2.3. Protocol Configuration

The model structure for the protocol configuration is as shown below:

```

augment /if:interfaces/if:interface/ip:ipv4:
  +--rw vrrp
    +--rw vrrp-instance* [vrid]
      +--rw vrid                               uint8
      |
      | ...
      +--rw track
        +--rw interfaces
          +--rw interface* [interface]
            +--rw interface                   if:interface-ref
            |
            | ...
            +--rw networks
              +--rw network* [prefix]
                +--rw prefix                   inet:ipv4-prefix
                |
                | ...
        +--rw virtual-ipv4-addresses
          +--rw virtual-ipv4-address* [ipv4-address]
            +--rw ipv4-address                 inet:ipv4-address

augment /if:interfaces/if:interface/ip:ipv6:
  +--rw vrrp
    +--rw vrrp-instance* [vrid]
      +--rw vrid                               uint8
      |
      | ...
      +--rw track
        +--rw interfaces
          +--rw interface* [interface]
            +--rw interface                   if:interface-ref
            |
            | ...
            +--rw networks
              +--rw network* [prefix]
                +--rw prefix                   inet:ipv6-prefix
                |
                | ...
        +--rw virtual-ipv6-addresses
          +--rw virtual-ipv6-address* [ipv6-address]
            +--rw ipv6-address                 inet:ipv6-address

```

The model allows the following protocol entities to be configured:

- o VRRP instance (version 2 or 3), representing a VRRP router.
- o Virtual IPv4 or IPv6 address associated with a virtual router.
- o Tracking interface, to detect interface connectivity failures.
- o Tracking network, to detect network connectivity failures.

#### 2.4. Protocol States

The model structure for the protocol states is as shown below:

```

module: ietf-vrrp
  +--ro vrrp
  |   // global operational states
  +--ro virtual-routers?   uint32
  +--ro interfaces?       uint32
  +--ro statistics         // global statistics
  |   +--ro discontinuity-datetime?   yang:date-and-time
  |   +--ro checksum-errors?         yang:counter64
  |   +--ro version-errors?         yang:counter64
  |   +--ro vrid-errors?            yang:counter64
  |   +--ro ip-ttl-errors?          yang:counter64
  |
  augment /if:interfaces/if:interface/ip:ipv4:
    +--rw vrrp
    |   +--rw vrrp-instance* [vrid]
    |   |   +--rw vrid                               uint8
    |   |   |   ...
    |   +--rw track
    |   |   +--rw interfaces
    |   |   |   +--rw interface* [interface]
    |   |   |   |   +--rw interface                 if:interface-ref
    |   |   |   |   |   ...
    |   |   +--rw networks
    |   |   |   +--rw network* [prefix]
    |   |   |   |   +--rw prefix                     inet:ipv4-prefix
    |   |   |   |   |   ...
    |   |   |   ...
  
```

```

+--rw virtual-ipv4-addresses
|   +--rw virtual-ipv4-address* [ipv4-address]
|       +--rw ipv4-address      inet:ipv4-address
|
|       // per-instance operational states
+--ro state?                      identityref
+--ro is-owner?                    boolean
+--ro last-adv-source?              inet:ip-address
+--ro up-datetime?                  yang:date-and-time
+--ro master-down-interval?         uint32
+--ro skew-time?                    uint32
+--ro last-event?                   identityref
+--ro new-master-reason?            new-master-reason-type
+--ro statistics                    // per-instance statistics
    +--ro discontinuity-datetime?    yang:date-and-time
    +--ro master-transitions?        yang:counter32
    +--ro advertisement-rcvd?        yang:counter64
    +--ro advertisement-sent?        yang:counter64
    +--ro interval-errors?           yang:counter64
    |   {validate-interval-errors}?
    +--ro priority-zero-pkts-rcvd?   yang:counter64
    +--ro priority-zero-pkts-sent?   yang:counter64
    +--ro invalid-type-pkts-rcvd?    yang:counter64
    +--ro address-list-errors?        yang:counter64
    |   {validate-address-list-errors}?
    +--ro packet-length-errors?      yang:counter64

```

```
augment /if:interfaces/if:interface/ip:ipv6:
```

```

+--rw vrrp
  +--rw vrrp-instance* [vrid]
  +--rw vrid                      uint8
  +
  +--rw track
  |   +--rw interfaces
  |   |   +--rw interface* [interface]
  |   |       +--rw interface      if:interface-ref
  |   |       ...
  |   +--rw networks
  |   |   +--rw network* [prefix]
  |   |       +--rw prefix          inet:ipv6-prefix
  |   |       ...
  +--rw virtual-ipv6-addresses
  |   +--rw virtual-ipv6-address* [ipv6-address]
  |       +--rw ipv6-address      inet:ipv6-address

```

```

|      // per-instance operational states
+--ro state?                identityref
+--ro is-owner?             boolean
+--ro last-adv-source?     inet:ip-address
+--ro up-datetime?         yang:date-and-time
+--ro master-down-interval? uint32
+--ro skew-time?           uint32
+--ro last-event?          identityref
+--ro new-master-reason?   new-master-reason-type
+--ro statistics           // per-instance statistics
  +--ro discontinuity-datetime? yang:date-and-time
  +--ro master-transitions?    yang:counter32
  +--ro advertisement-rcvd?    yang:counter64
  +--ro advertisement-sent?    yang:counter64
  +--ro interval-errors?      yang:counter64
  |      {validate-interval-errors}?
  +--ro priority-zero-pkts-rcvd? yang:counter64
  +--ro priority-zero-pkts-sent? yang:counter64
  +--ro invalid-type-pkts-rcvd? yang:counter64
  +--ro address-list-errors?    yang:counter64
  |      {validate-address-list-errors}?
  +--ro packet-length-errors?  yang:counter64

```

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 [YANG-Guidelines]. When protocol states are retrieved from the NMDA operational state datastore, the returned states cover all "config true" (rw) and "config false" (ro) nodes defined in the schema.

The model allows the retrieval of protocol states at the following levels:

- o VRRP instance (version 2 or 3), representing a VRRP router.
- o Virtual IPv4 or IPv6 address associated with a virtual router.
- o Tracking interface, to detect interface connectivity failures.
- o Tracking network, to detect network connectivity failures.
- o Global states and statistics summarizing all instances.



## 2.5. Notifications

This model defines the following VRRP-specific notifications:

```

notifications:
  +---n vrrp-new-master-event
  |   +--ro master-ip-address      inet:ip-address
  |   +--ro new-master-reason      new-master-reason-type
  +---n vrrp-protocol-error-event
  |   +--ro protocol-error-reason  identityref
  +---n vrrp-virtual-router-error-event
  |   +--ro interface                if:interface-ref
  |   +--ro (ip-version)
  |   |   +---:(ipv4)
  |   |   |   +--ro ipv4
  |   |   |   |   +--ro vrid      leafref
  |   |   |   +---:(ipv6)
  |   |   |   |   +--ro ipv6
  |   |   |   |   |   +--ro vrid      leafref
  |   +--ro virtual-router-error-reason  identityref

```

Each notification type is used to indicate a type of VRRP state change or error occurrence:

### vrrp-new-master-event

VRRP new master event, indicating that a new master has been elected.

### vrrp-protocol-error-event

VRRP protocol error event for a message that fails to reach a VRRP instance to be processed.

### vrrp-virtual-router-error-event

VRRP virtual router error event for a message processed on a VRRP instance.

In addition to the notifications specified above, the mechanisms defined in [Subscribed-Notifications] and [YANG-Push] can be used for other general notifications. These mechanisms currently allow the user to:

- o Subscribe notifications on a per-client basis.
- o Specify subtree filters or XML Path Language (XPath) filters so that only contents of interest will be sent.
- o Specify either periodic or on-demand notifications.

### 3. Tree Structure

The VRRP YANG data model defined in this document has the following tree structure:

```

module: ietf-vrrp
  +--ro vrrp
    +--ro virtual-routers?   uint32
    +--ro interfaces?       uint32
    +--ro statistics
      +--ro discontinuity-datetime?  yang:date-and-time
      +--ro checksum-errors?        yang:counter64
      +--ro version-errors?         yang:counter64
      +--ro vrid-errors?            yang:counter64
      +--ro ip-ttl-errors?          yang:counter64
  augment /if:interfaces/if:interface/ip:ipv4:
    +--rw vrrp
      +--rw vrrp-instance* [vrid]
        +--rw vrid                               uint8
        +--rw version                           identityref
        +--rw log-state-change?                 boolean
        +--rw preempt
          | +--rw enabled?      boolean
          | +--rw hold-time?   uint16
        +--rw priority?                               uint8
        +--rw accept-mode?                           boolean
        +--rw (advertise-interval-choice)?
          | +--:(v2)
          | | +--rw advertise-interval-sec?          uint8
          | +--:(v3)
          | +--rw advertise-interval-centi-sec?     uint16
        +--rw track
          | +--rw interfaces
          | | +--rw interface* [interface]
          | | | +--rw interface           if:interface-ref
          | | | +--rw priority-decrement? uint8
          | +--rw networks
          | | +--rw network* [prefix]
          | | | +--rw prefix             inet:ipv4-prefix
          | | | +--rw priority-decrement? uint8
        +--rw virtual-ipv4-addresses
          | +--rw virtual-ipv4-address* [ipv4-address]
          | | +--rw ipv4-address       inet:ipv4-address
        +--ro state?                               identityref
        +--ro is-owner?                           boolean
        +--ro last-adv-source?                    inet:ip-address
        +--ro up-datetime?                        yang:date-and-time
        +--ro master-down-interval?              uint32

```

```

    +--ro skew-time?                uint32
    +--ro last-event?               identityref
    +--ro new-master-reason?
new-master-reason-type
    +--ro statistics
      +--ro discontinuity-datettime? yang:date-and-time
      +--ro master-transitions?     yang:counter32
      +--ro advertisement-rcvd?     yang:counter64
      +--ro advertisement-sent?     yang:counter64
      +--ro interval-errors?        yang:counter64
      | {validate-interval-errors}?
      +--ro priority-zero-pkts-rcvd? yang:counter64
      +--ro priority-zero-pkts-sent? yang:counter64
      +--ro invalid-type-pkts-rcvd? yang:counter64
      +--ro address-list-errors?     yang:counter64
      | {validate-address-list-errors}?
      +--ro packet-length-errors?    yang:counter64
augment /if:interfaces/if:interface/ip:ipv6:
  +--rw vrrp
    +--rw vrrp-instance* [vrid]
      +--rw vrid                uint8
      +--rw version              identityref
      +--rw log-state-change?    boolean
      +--rw preempt
      | +--rw enabled?          boolean
      | +--rw hold-time?        uint16
      +--rw priority?            uint8
      +--rw accept-mode?         boolean
      +--rw advertise-interval-centi-sec? uint16
      +--rw track
      | +--rw interfaces
      | | +--rw interface* [interface]
      | | | +--rw interface      if:interface-ref
      | | | +--rw priority-decrement? uint8
      | +--rw networks
      | | +--rw network* [prefix]
      | | | +--rw prefix          inet:ipv6-prefix
      | | | +--rw priority-decrement? uint8
      +--rw virtual-ipv6-addresses
      | +--rw virtual-ipv6-address* [ipv6-address]
      | +--rw ipv6-address        inet:ipv6-address
      +--ro state?                identityref
      +--ro is-owner?              boolean
      +--ro last-adv-source?       inet:ip-address
      +--ro up-datetime?           yang:date-and-time
      +--ro master-down-interval?  uint32

```

```

    +--ro skew-time?                uint32
    +--ro last-event?               identityref
    +--ro new-master-reason?
new-master-reason-type
  +--ro statistics
    +--ro discontinuity-datetime?  yang:date-and-time
    +--ro master-transitions?     yang:counter32
    +--ro advertisement-rcvd?     yang:counter64
    +--ro advertisement-sent?     yang:counter64
    +--ro interval-errors?        yang:counter64
    |   {validate-interval-errors}?
    +--ro priority-zero-pkts-rcvd? yang:counter64
    +--ro priority-zero-pkts-sent? yang:counter64
    +--ro invalid-type-pkts-rcvd? yang:counter64
    +--ro address-list-errors?    yang:counter64
    |   {validate-address-list-errors}?
    +--ro packet-length-errors?   yang:counter64

notifications:
  +---n vrrp-new-master-event
  |   +--ro master-ip-address      inet:ip-address
  |   +--ro new-master-reason     new-master-reason-type
  +---n vrrp-protocol-error-event
  |   +--ro protocol-error-reason identityref
  +---n vrrp-virtual-router-error-event
  |   +--ro interface              if:interface-ref
  |   +--ro (ip-version)
  |   |   +--:(ipv4)
  |   |   |   +--ro ipv4
  |   |   |   |   +--ro vrid      leafref
  |   |   +--:(ipv6)
  |   |   |   +--ro ipv6
  |   |   |   |   +--ro vrid      leafref
  |   +--ro virtual-router-error-reason identityref

```

#### 4. YANG Module

This module references [RFC2787], [RFC3768], [RFC5798], and [RFC6527].

```
<CODE BEGINS> file "ietf-vrrp@2018-03-13.yang"

module ietf-vrrp {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-vrrp";
  prefix "vrrp";

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

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

  import ietf-interfaces {
    prefix "if";
  }

  import ietf-ip {
    prefix "ip";
  }

  organization
    "IETF Routing Area Working Group (RTGWG)";
  contact
    "WG Web: <https://datatracker.ietf.org/wg/rtgwg/>
    WG List: <mailto:rtgwg@ietf.org>

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```

## description

"This YANG module defines a model for managing Virtual Router Redundancy Protocol (VRRP) versions 2 and 3.

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This version of this YANG module is part of RFC 8347; see the RFC itself for full legal notices.";

## revision 2018-03-13 {

## description

"Initial revision.";

## reference

"RFC 8347: A YANG Data Model for the Virtual Router Redundancy Protocol (VRRP)  
 RFC 2787: Definitions of Managed Objects for the Virtual Router Redundancy Protocol  
 RFC 3768: Virtual Router Redundancy Protocol (VRRP)  
 RFC 5798: Virtual Router Redundancy Protocol (VRRP) Version 3 for IPv4 and IPv6  
 RFC 6527: Definitions of Managed Objects for the Virtual Router Redundancy Protocol Version 3 (VRRPv3)";

}

/\*

\* Features

\*/

## feature validate-interval-errors {

## description

"This feature indicates that the system validates that the advertisement interval from advertisement packets received is the same as the interval configured for the local VRRP router.";

}

## feature validate-address-list-errors {

## description

"This feature indicates that the system validates that the address list from received packets matches the

```
        locally configured list for the VRRP router.";
    }

/*
 * Typedefs
 */

typedef new-master-reason-type {
    type enumeration {
        enum not-master {
            description
                "The virtual router has never transitioned to master
                state.";
        }
        enum priority {
            description
                "Priority was higher.";
        }
        enum preempted {
            description
                "The master was preempted.";
        }
        enum no-response {
            description
                "Previous master did not respond.";
        }
    }
    description
        "Indicates why the virtual router has transitioned to
        master state.";
} // new-master-reason-type

/*
 * Identities
 */

/* vrrp-event-type identity and its derivatives. */
identity vrrp-event-type {
    description
        "Indicates the type of a VRRP protocol event.";
}
identity vrrp-event-none {
    base vrrp-event-type;
    description
        "Indicates a non-meaningful event.";
}
identity vrrp-event-startup {
    base vrrp-event-type;
```

```
    description
      "Indicates that a VRRP router has initiated the protocol.";
  }
  identity vrrp-event-shutdown {
    base vrrp-event-type;
    description
      "Indicates that a VRRP router has closed down the protocol.";
  }
  identity vrrp-event-higher-priority-backup {
    base vrrp-event-type;
    description
      "Indicates that a backup router has a higher priority than
      the current master.";
  }
  identity vrrp-event-master-timeout {
    base vrrp-event-type;
    description
      "Indicates that the current master has not sent an
      advertisement within the limit of master-down-interval.";
  }
  identity vrrp-event-interface-up {
    base vrrp-event-type;
    description
      "Indicates that the VRRP-enabled interface has become
      'operational up'.";
  }
  identity vrrp-event-interface-down {
    base vrrp-event-type;
    description
      "Indicates that the VRRP-enabled interface has become
      'operational down'.";
  }
  identity vrrp-event-no-primary-ip-address {
    base vrrp-event-type;
    description
      "Indicates that the primary IP address on the VRRP-enabled
      interface has become unavailable.";
  }
  identity vrrp-event-primary-ip-address {
    base vrrp-event-type;
    description
      "Indicates that the primary IP address on the VRRP-enabled
      interface has become available.";
  }
  identity vrrp-event-no-virtual-ip-addresses {
    base vrrp-event-type;
    description
      "Indicates that there are no virtual IP addresses on the
```



```
        virtual router.";
    }
    identity vrrp-event-virtual-ip-addresses {
        base vrrp-event-type;
        description
            "Indicates that there are virtual IP addresses on the
            virtual router.";
    }
    identity vrrp-event-preempt-hold-timeout {
        base vrrp-event-type;
        description
            "Indicates that the configured preemption hold time has
            passed.";
    }
    identity vrrp-event-lower-priority-master {
        base vrrp-event-type;
        description
            "Indicates that there is a lower-priority VRRP master.";
    }
    identity vrrp-event-owner-preempt {
        base vrrp-event-type;
        description
            "Indicates that the owner has preempted another router to
            become the master.";
    }
}

/* vrrp-error-global identity and its derivatives. */
identity vrrp-error-global {
    description
        "Indicates the type of a VRRP error that occurred
        for a packet before it reaches a VRRP router.";
}
identity checksum-error {
    base vrrp-error-global;
    description
        "A packet has been received with an invalid VRRP checksum
        value.";
}
identity ip-ttl-error {
    base vrrp-error-global;
    description
        "A packet has been received with IP TTL (Time-To-Live)
        not equal to 255.";
}
identity version-error {
    base vrrp-error-global;
    description
        "A packet has been received with an unknown or unsupported
```

```
        version number.";
    }
    identity vrid-error {
        base vrrp-error-global;
        description
            "A packet has been received with a Virtual Router Identifier
            (VRID) that is not valid for any virtual router on this
            router.";
    }
}

/* vrrp-error-virtual-router identity and its derivatives. */
identity vrrp-error-virtual-router {
    description
        "Indicates the type of a VRRP error that occurred
        after a packet reaches a VRRP router.";
}
identity address-list-error {
    base vrrp-error-virtual-router;
    description
        "A packet has been received with an address list that
        does not match the locally configured address list for
        the virtual router.";
}
identity interval-error {
    base vrrp-error-virtual-router;
    description
        "A packet has been received with an advertisement interval
        different than the interval configured for the local
        virtual router.";
}
identity packet-length-error {
    base vrrp-error-virtual-router;
    description
        "A packet has been received with a packet length less
        than the length of the VRRP header.";
}
}

/* vrrp-state-type identity and its derivatives. */
identity vrrp-state-type {
    description
        "Indicates the state of a virtual router.";
}
identity initialize {
    base vrrp-state-type;
    description
        "Indicates that the virtual router is waiting
        for a startup event.";
}
}
```

```
identity backup {
  base vrrp-state-type;
  description
    "Indicates that the virtual router is monitoring the
     availability of the master router.";
}
identity master {
  base vrrp-state-type;
  description
    "Indicates that the virtual router is forwarding
     packets for IP addresses that are associated with
     this virtual router.";
}

/* vrrp-version identity and its derivatives. */
identity vrrp-version {
  description
    "The version of VRRP.";
}
identity vrrp-v2 {
  base vrrp-version;
  description
    "Indicates version 2 of VRRP.";
}
identity vrrp-v3 {
  base vrrp-version;
  description
    "Indicates version 3 of VRRP.";
}

/*
 * Groupings
 */

grouping vrrp-common-attributes {
  description
    "Group of VRRP attributes common to versions 2 and 3.";

  leaf vrid {
    type uint8 {
      range "1..255";
    }
    description
      "Virtual Router ID (i.e., VRID).";
  }

  leaf version {
    type identityref {
```

```
    base vrrp:vrrp-version;
  }
  mandatory true;
  description
    "Version 2 or 3 of VRRP.";
}

leaf log-state-change {
  type boolean;
  default "false";
  description
    "Generates VRRP state change messages each time the
    VRRP instance changes state (from 'up' to 'down'
    or 'down' to 'up').";
}

container preempt {
  description
    "Enables a higher-priority VRRP backup router to preempt a
    lower-priority VRRP master.";
  leaf enabled {
    type boolean;
    default "true";
    description
      "'true' if preemption is enabled.";
  }
  leaf hold-time {
    type uint16;
    units seconds;
    default 0;
    description
      "Hold time, in seconds, for which a higher-priority VRRP
      backup router must wait before preempting a lower-priority
      VRRP master.";
  }
}

leaf priority {
  type uint8 {
    range "1..254";
  }
  default 100;
  description
    "Configures the VRRP election priority for the backup
    virtual router.";
}

leaf accept-mode {
```

```

when "derived-from-or-self(current()/../version, 'vrrp-v3')" {
  description
    "Applicable only to version 3.";
}
type boolean;
default "false";
description
  "Controls whether a virtual router in master state will
  accept packets addressed to the address owner's IPvX address
  as its own if it is not the IPvX address owner. The default
  is 'false'. Deployments that rely on, for example, pinging
  the address owner's IPvX address may wish to configure
  accept-mode to 'true'.

  Note: IPv6 Neighbor Solicitations and Neighbor
  Advertisements MUST NOT be dropped when accept-mode
  is 'false'.";
}
} // vrrp-common-attributes

grouping vrrp-ipv4-attributes {
  description
    "Group of VRRP attributes for IPv4.";

  uses vrrp-common-attributes;

  choice advertise-interval-choice {
    description
      "The options for the advertisement interval at which VRRPv2
      or VRRPv3 advertisements are sent from the specified
      interface.";

    case v2 {
      when "derived-from-or-self(version, 'vrrp-v2')" {
        description
          "Applicable only to version 2.";
      }
      leaf advertise-interval-sec {
        type uint8 {
          range "1..254";
        }
        units seconds;
        default 1;
        description
          "Configures the interval that VRRPv2 advertisements
          are sent from the specified interface.";
      }
    }
  }
}

```

```
case v3 {
  when "derived-from-or-self(version, 'vrrp-v3')" {
    description
      "Applicable only to version 3.";
  }
  leaf advertise-interval-centi-sec {
    type uint16 {
      range "1..4095";
    }
    units centiseconds;
    default 100;
    description
      "Configures the interval that VRRPv3 advertisements
       are sent from the specified interface.";
  }
}
} // advertise-interval-choice

container track {
  description
    "Enables the specified VRRP instance to track interfaces
     or networks.";
  container interfaces {
    description
      "Enables the specified VRRPv2 or VRRPv3 instance to track
       interfaces. Interface tracking prevents traffic loss by
       detecting the availability of interfaces. The operational
       states of other interfaces are associated with the
       priority of a VRRP router. When a tracked interface
       becomes unavailable (or 'operational down'), the priority
       of the VRRP router decrements. When an unavailable
       interface becomes available again, the priority of the
       VRRP router is incremented by the same amount.";
  }

  list interface {
    key "interface";
    description
      "Interface to track.";
    leaf interface {
      type if:interface-ref;
      must "/if:interfaces/if:interface[if:name=current()]/"
        + "ip:ipv4" {
        description
          "Interface is IPv4.";
      }
      description
        "Interface to track.";
    }
  }
}
```

```

leaf priority-decrement {
  type uint8 {
    range "1..254";
  }
  default 10;
  description
    "Specifies how much to decrement the priority of the
    VRRP instance if the interface goes down.";
}
} // interface
} // interfaces

container networks {
  description
    "Enables the VRRPv2 or VRRPv3 router instance to track the
    specified networks through their IPv4 network prefixes.
    Network tracking prevents traffic loss by detecting
    network connectivity failure. The states of
    connectivity to some networks are associated with the
    priority of a VRRP router. When connectivity to a
    tracked network represented by its prefix is lost, the
    priority of the VRRP router decrements. When an
    unavailable network is again reachable, the priority of
    the VRRP router is incremented by the same amount.";
  list network {
    key "prefix";
    description
      "Enables the specified VRRPv2 or VRRPv3 instance to
      track an IPv4 network by specifying the prefix of the
      IPv4 network.";

    leaf prefix {
      type inet:ipv4-prefix;
      description
        "The IPv4 prefix of the network to track.";
    }

    leaf priority-decrement {
      type uint8 {
        range "1..254";
      }
      default 10;
      description
        "Specifies how much to decrement the priority of the
        VRRP router if there is a failure in the IPv4
        network.";
    }
  } // network
}

```

```

    } // networks
  } // track

  container virtual-ipv4-addresses {
    description
      "Configures the virtual IPv4 address for the
       VRRP interface.";

    list virtual-ipv4-address {
      key "ipv4-address";
      max-elements 16;
      description
        "Virtual IPv4 addresses for a single VRRP instance. For a
         VRRP owner router, the virtual address must match one
         of the IPv4 addresses configured on the interface
         corresponding to the virtual router.";

      leaf ipv4-address {
        type inet:ipv4-address;
        description
          "An IPv4 address associated with a virtual router.";
        reference
          "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
           Version 3 for IPv4 and IPv6. Section 1.2";
      }
    } // virtual-ipv4-address
  } // virtual-ipv4-addresses
} // vrrp-ipv4-attributes

grouping vrrp-ipv6-attributes {
  description
    "Group of VRRP attributes for IPv6.";

  uses vrrp-common-attributes;

  leaf advertise-interval-centi-sec {
    type uint16 {
      range "1..4095";
    }
    units centiseconds;
    default 100;
    description
      "Configures the interval that VRRPv3 advertisements
       are sent from the specified interface.";
  }

  container track {
    description

```



```

"Enables the specified VRRP instance to track interfaces
or networks.";
container interfaces {
  description
    "Enables the specified VRRPv2 or VRRPv3 instance to track
    interfaces. Interface tracking prevents traffic loss by
    detecting the availability of interfaces. The operational
    states of other interfaces are associated with the
    priority of a VRRP router. When a tracked interface
    becomes unavailable (or 'operational down'), the priority
    of the VRRP router decrements. When an unavailable
    interface becomes available again, the priority of the
    VRRP router is incremented by the same amount.";
  list interface {
    key "interface";
    description
      "Interface to track.";

    leaf interface {
      type if:interface-ref;
      must "/if:interfaces/if:interface[if:name=current()]/"
        + "ip:ipv6" {
        description
          "Interface is IPv6.";
      }
      description
        "Interface to track.";
    }

    leaf priority-decrement {
      type uint8 {
        range "1..254";
      }
      default 10;
      description
        "Specifies how much to decrement the priority of the
        VRRP instance if the interface goes down.";
    }
  } // interface
} // interfaces

```

```

container networks {
  description
    "Enables the VRRPv2 or VRRPv3 router instance to track the
    specified networks through their IPv6 network prefixes.
    Network tracking prevents traffic loss by detecting
    network connectivity failure. The states of
    connectivity to some networks are associated with the

```

```

    priority of a VRRP router.  When connectivity to a
    tracked network represented by its prefix is lost, the
    priority of the VRRP router decrements.  When an
    unavailable network is again reachable, the priority of
    the VRRP router is incremented by the same amount.";
list network {
  key "prefix";
  description
    "Enables the specified VRRPv2 or VRRPv3 instance to
    track an IPv6 network by specifying the prefix of the
    IPv6 network.";

  leaf prefix {
    type inet:ipv6-prefix;
    description
      "The IPv6 prefix of the network to track.";
  }

  leaf priority-decrement {
    type uint8 {
      range "1..254";
    }
    default 10;
    description
      "Specifies how much to decrement the priority of the
      VRRP router if there is a failure in the IPv6
      network.";
  }
} // network
} // networks
} // track

container virtual-ipv6-addresses {
  description
    "Configures the virtual IPv6 address for the
    VRRP interface.";
  list virtual-ipv6-address {
    key "ipv6-address";
    max-elements 2;
    description
      "Two IPv6 addresses are allowed.  The first address must
      be a link-local address.  The second address can be a
      link-local or global address.";

    leaf ipv6-address {
      type inet:ipv6-address;
      description
        "An IPv6 address associated with a virtual router.";
    }
  }
}

```

```
        reference
          "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
           Version 3 for IPv4 and IPv6. Section 1.3";
      }
    } // virtual-ipv6-address
  } // virtual-ipv6-addresses
} // vrrp-ipv6-attributes

grouping vrrp-state-attributes {
  description
    "Group of VRRP state attributes.";

  leaf state {
    type identityref {
      base vrrp:vrrp-state-type;
    }
    config false;
    description
      "Operational state.";
  }

  leaf is-owner {
    type boolean;
    config false;
    description
      "Set to 'true' if this virtual router is the owner.";
  }

  leaf last-adv-source {
    type inet:ip-address;
    config false;
    description
      "Last advertised IPv4/IPv6 source address.";
  }

  leaf up-datetime {
    type yang:date-and-time;
    config false;
    description
      "The date and time when this virtual router
       transitioned out of 'init' state.";
  }

  leaf master-down-interval {
    type uint32;
    units centiseconds;
    config false;
    description

```

```
        "Time interval for the backup virtual router to declare
        'master down'.";
    }

leaf skew-time {
    type uint32;
    units microseconds;
    config false;
    description
        "Calculated based on the priority and advertisement
        interval configuration command parameters. See RFC 3768.";
}

leaf last-event {
    type identityref {
        base vrrp:vrrp-event-type;
    }
    config false;
    description
        "Last reported event.";
}

leaf new-master-reason {
    type new-master-reason-type;
    config false;
    description
        "Indicates why the virtual router has transitioned to
        master state.";
}

container statistics {
    config false;
    description
        "VRRP statistics.";

    leaf discontinuity-datetime {
        type yang:date-and-time;
        description
            "The time on the most recent occasion at which one or
            more of the VRRP statistics counters suffered a
            discontinuity. If no such discontinuities have occurred
            since the last re-initialization of the local management
            subsystem, then this node contains the time that the
            local management subsystem re-initialized itself.";
    }

    leaf master-transitions {
        type yang:counter32;
    }
}
```

```
    description
      "The total number of times that this virtual router's
       state has transitioned to 'master'.";
  }

  leaf advertisement-rcvd {
    type yang:counter64;
    description
      "The total number of VRRP advertisements received by
       this virtual router.";
  }

  leaf advertisement-sent {
    type yang:counter64;
    description
      "The total number of VRRP advertisements sent by
       this virtual router.";
  }

  leaf interval-errors {
    if-feature validate-interval-errors;
    type yang:counter64;
    description
      "The total number of VRRP advertisement packets received
       with an advertisement interval different than the
       interval configured for the local virtual router.";
  }

  leaf priority-zero-pkts-rcvd {
    type yang:counter64;
    description
      "The total number of VRRP packets received by the
       virtual router with a priority of 0.";
  }

  leaf priority-zero-pkts-sent {
    type yang:counter64;
    description
      "The total number of VRRP packets sent by the
       virtual router with a priority of 0.";
  }

  leaf invalid-type-pkts-rcvd {
    type yang:counter64;
    description
      "The number of VRRP packets received by the virtual
       router with an invalid value in the 'type' field.";
  }
}
```

```
leaf address-list-errors {
  if-feature validate-address-list-errors;
  type yang:counter64;
  description
    "The total number of packets received with an
    address list that does not match the locally
    configured address list for the virtual router.";
}

leaf packet-length-errors {
  type yang:counter64;
  description
    "The total number of packets received with a packet
    length less than the length of the VRRP header.";
}
} // statistics
} // vrrp-state-attributes

grouping vrrp-global-state-attributes {
  description
    "Group of VRRP global state attributes.";

  leaf virtual-routers {
    type uint32;
    description
      "Number of configured virtual routers.";
  }

  leaf interfaces {
    type uint32;
    description
      "Number of interfaces with VRRP configured.";
  }

  container statistics {
    description
      "VRRP global statistics.";

    leaf discontinuity-datetime {
      type yang:date-and-time;
      description
        "The time on the most recent occasion at which any
        one or more of checksum-errors, version-errors,
        vrid-errors, or ip-ttl-errors suffered a
        discontinuity.

        If no such discontinuities have occurred since the last
        re-initialization of the local management subsystem,
```

```

        then this node contains the time that the local management
        subsystem re-initialized itself.";
    }

leaf checksum-errors {
    type yang:counter64;
    description
        "The total number of VRRP packets received with an invalid
        VRRP checksum value.";
    reference
        "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
        Version 3 for IPv4 and IPv6. Section 5.2.8";
}

leaf version-errors {
    type yang:counter64;
    description
        "The total number of VRRP packets received with an unknown
        or unsupported version number.";
    reference
        "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
        Version 3 for IPv4 and IPv6. Section 5.2.1";
}

leaf vrid-errors {
    type yang:counter64;
    description
        "The total number of VRRP packets received with a VRID that
        is not valid for any virtual router on this router.";
    reference
        "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
        Version 3 for IPv4 and IPv6. Section 5.2.3";
}

leaf ip-ttl-errors {
    type yang:counter64;
    description
        "The total number of VRRP packets received by the
        virtual router with IP TTL (IPv4) or Hop Limit (IPv6)
        not equal to 255.";
    reference
        "RFC 5798: Virtual Router Redundancy Protocol (VRRP)
        Version 3 for IPv4 and IPv6.
        Sections 5.1.1.3 and 5.1.2.3";
}
} // statistics
} // vrrp-global-state-attributes

```

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

augment "/if:interfaces/if:interface/ip:ipv4" {
  description
    "Augments IPv4 interface.";

  container vrrp {
    description
      "Configures VRRP version 2 or 3 for IPv4.";

    list vrrp-instance {
      key "vrid";
      description
        "Defines a virtual router, identified by a VRID, within the
        IPv4 address space.";

      uses vrrp-ipv4-attributes;
      uses vrrp-state-attributes;
    }
  }
} // augments ipv4

augment "/if:interfaces/if:interface/ip:ipv6" {
  description
    "Augments IPv6 interface.";

  container vrrp {
    description
      "Configures VRRP version 3 for IPv6.";

    list vrrp-instance {
      must "derived-from-or-self(version, 'vrrp-v3')" {
        description
          "IPv6 is only supported by version 3.";
      }
      key "vrid";
      description
        "Defines a virtual router, identified by a VRID, within the
        IPv6 address space.";

      uses vrrp-ipv6-attributes;
      uses vrrp-state-attributes;
    }
  }
} // augments ipv6
```



```
container vrrp {
  config false;
  description
    "VRRP data at the global level.";

  uses vrrp-global-state-attributes;
}

/*
 * Notifications
 */

notification vrrp-new-master-event {
  description
    "Notification event for the election of a new VRRP master.";
  leaf master-ip-address {
    type inet:ip-address;
    mandatory true;
    description
      "IPv4 or IPv6 address of the new master.";
  }
  leaf new-master-reason {
    type new-master-reason-type;
    mandatory true;
    description
      "Indicates why the virtual router has transitioned to
      master state.";
  }
}

notification vrrp-protocol-error-event {
  description
    "Notification event for a VRRP protocol error.";
  leaf protocol-error-reason {
    type identityref {
      base vrrp:vrrp-error-global;
    }
    mandatory true;
    description
      "Indicates the reason for the protocol error.";
  }
}

notification vrrp-virtual-router-error-event {
  description
    "Notification event for an error that happened on a
    virtual router.";
  leaf interface {
```

```

type if:interface-ref;
mandatory true;
description
  "Indicates the interface on which the event has occurred.";
}

choice ip-version {
mandatory true;
description
  "The error may have happened on either an IPv4 virtual
  router or an IPv6 virtual router.  The information
  related to a specific IP version is provided by one of
  the following cases.";
case ipv4 {
description
  "IPv4.";
container ipv4 {
description
  "Error information for IPv4.";
leaf vrid {
type leafref {
path "/if:interfaces/if:interface"
+ "[if:name = current()/../../vrrp:interface]/"
+ "ip:ipv4/vrrp:vrrp/vrrp:vrrp-instance/vrrp:vrid";
}
mandatory true;
description
  "Indicates the virtual router on which the event has
  occurred.";
}
}
}
case ipv6 {
description
  "IPv6.";
container ipv6 {
description
  "Error information for IPv6.";
leaf vrid {
type leafref {
path "/if:interfaces/if:interface"
+ "[if:name = current()/../../vrrp:interface]/"
+ "ip:ipv6/vrrp:vrrp/vrrp:vrrp-instance/vrrp:vrid";
}
mandatory true;
description
  "Indicates the virtual router on which the event has
  occurred.";
}
}
}
}
}

```

```

    }
  }
}

leaf virtual-router-error-reason {
  type identityref {
    base vrrp:vrrp-error-virtual-router;
  }
  mandatory true;
  description
    "Indicates the reason for the virtual router error.";
}
}
}

```

<CODE ENDS>

## 5. IANA Considerations

This document registers the following namespace URI in the "IETF XML Registry" [RFC3688]:

```

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

```

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

```

-----
name:          ietf-vrrp
namespace:    urn:ietf:params:xml:ns:yang:ietf-vrrp
prefix:       vrrp
reference:    RFC 8347
-----

```

## 6. Security Considerations

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

The NETCONF access control model [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 this YANG module that are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

```
/if:interfaces/if:interface/ip:ipv4/vrrp:vrrp/vrrp:vrrp-instance  
  
/if:interfaces/if:interface/ip:ipv6/vrrp:vrrp/vrrp:vrrp-instance
```

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

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

```
/ietf-vrrp:vrrp  
  
/if:interfaces/if:interface/ip:ipv4/vrrp:vrrp/vrrp:vrrp-instance  
  
/if:interfaces/if:interface/ip:ipv6/vrrp:vrrp/vrrp:vrrp-instance
```

Unauthorized access to any data node of these subtrees can disclose the operational state information of VRRP on this device.

## 7. References

### 7.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC2787] Jewell, B. and D. Chuang, "Definitions of Managed Objects for the Virtual Router Redundancy Protocol", RFC 2787, DOI 10.17487/RFC2787, March 2000, <<https://www.rfc-editor.org/info/rfc2787>>.
- [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <<https://www.rfc-editor.org/info/rfc3688>>.
- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", RFC 5246, DOI 10.17487/RFC5246, August 2008, <<https://www.rfc-editor.org/info/rfc5246>>.
- [RFC5798] Nadas, S., Ed., "Virtual Router Redundancy Protocol (VRRP) Version 3 for IPv4 and IPv6", RFC 5798, DOI 10.17487/RFC5798, March 2010, <<https://www.rfc-editor.org/info/rfc5798>>.
- [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>>.
- [RFC6527] Tata, K., "Definitions of Managed Objects for Virtual Router Redundancy Protocol Version 3 (VRRPv3)", RFC 6527, DOI 10.17487/RFC6527, March 2012, <<https://www.rfc-editor.org/info/rfc6527>>.

- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", RFC 6991, DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [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>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.
- [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>>.
- [RFC8344] Bjorklund, M., "A YANG Data Model for IP Management", RFC 8344, DOI 10.17487/RFC8344, March 2018, <<https://www.rfc-editor.org/info/rfc8344>>.

## 7.2. Informative References

- [RFC3768] Hinden, R., Ed., "Virtual Router Redundancy Protocol (VRRP)", RFC 3768, DOI 10.17487/RFC3768, April 2004, <<https://www.rfc-editor.org/info/rfc3768>>.
- [RFC7224] Bjorklund, M., "IANA Interface Type YANG Module", RFC 7224, DOI 10.17487/RFC7224, May 2014, <<https://www.rfc-editor.org/info/rfc7224>>.
- [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>>.

[Subscribed-Notifications]

Voit, E., Clemm, A., Gonzalez Prieto, A., Nilsen-Nygaard, E., and A. Tripathy, "Custom Subscription to Event Streams", Work in Progress, draft-ietf-netconf-subscribed-notifications-10, February 2018.

[YANG-Push]

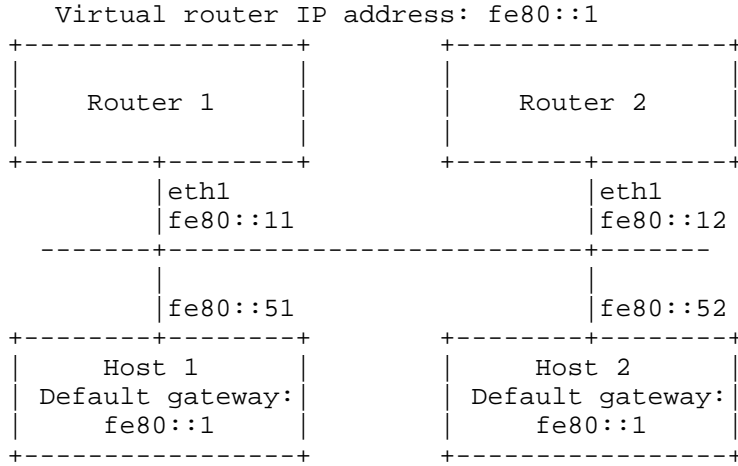
Clemm, A., Voit, E., Gonzalez Prieto, A., Tripathy, A., Nilsen-Nygaard, E., Bierman, A., and B. Lengyel, "YANG Datastore Subscription", Work in Progress, draft-ietf-netconf-yang-push-15, February 2018.

[YANG-Guidelines]

Bierman, A., "Guidelines for Authors and Reviewers of YANG Data Model Documents", Work in Progress, draft-ietf-netmod-rfc6087bis-20, March 2018.

## Appendix A. Data Tree Example

This section contains an example of an instance data tree in JSON encoding [RFC7951], containing both configuration and state data. (This example includes "iana-if-type", which is defined in [RFC7224].)





The configuration instance data for Router 1 in the above figure could be as follows:

```
{
  "ietf-interfaces:interfaces": {
    "interface": [
      {
        "name": "eth1",
        "description": "An interface with VRRP enabled.",
        "type": "iana-if-type:ethernetCsmacd",
        "ietf-ip:ipv6": {
          "address": [
            {
              "ip": "2001:db8:0:1::1",
              "prefix-length": 64
            },
            {
              "ip": "fe80::11",
              "prefix-length": 64
            }
          ],
          "forwarding": true,
          "ietf-vrrp:vrrp": {
            "vrrp-instance": [
              {
                "vrid": 1,
                "version": "vrrp-v3",
                "priority": 200,
                "advertise-interval-centi-sec": 50,
                "virtual-ipv6-addresses": {
                  "virtual-ipv6-address": [
                    {
                      "ipv6-address": "fe80::1"
                    }
                  ]
                }
              }
            ]
          }
        }
      }
    ]
  }
}
```

The corresponding operational state data for Router 1 could be as follows:

```
{
  "ietf-interfaces:interfaces": {
    "interface": [
      {
        "name": "eth1",
        "description": "An interface with VRRP enabled.",
        "type": "iana-if-type:ethernetCsmacd",
        "phys-address": "00:00:5e:00:53:01",
        "oper-status": "up",
        "statistics": {
          "discontinuity-time": "2016-10-24T17:11:27+02:00"
        },
        "ietf-ip:ipv6": {
          "forwarding": true,
          "mtu": 1500,
          "address": [
            {
              "ip": "2001:db8:0:1::1",
              "prefix-length": 64,
              "origin": "static",
              "status": "preferred"
            },
            {
              "ip": "fe80::11",
              "prefix-length": 64,
              "origin": "static",
              "status": "preferred"
            }
          ]
        }
      ]
    }
  }
}
```

```

"ietf-vrrp:vrrp": {
  "vrrp-instance": [
    {
      "vrid": 1,
      "version": "vrrp-v3",
      "log-state-change": false,
      "preempt": {
        "enabled": true,
        "hold-time": 0
      }
    },
    {
      "priority": 200,
      "accept-mode": false,
      "advertise-interval-centi-sec": 50,
      "virtual-ipv6-addresses": {
        "virtual-ipv6-address": [
          "ipv6-address": "fe80::1"
        ]
      },
      "state": "master",
      "is-owner": false,
      "last-adv-source": "fe80::11",
      "up-datetime": "2016-10-24T17:11:27+02:00",
      "master-down-interval": 161,
      "skew-time": 11,
      "last-event": "vrrp-event-interface-up",
      "new-master-reason": "priority",
      "statistics": {
        "discontinuity-datetime":
          "2016-10-24T17:11:27+02:00",
        "master-transitions": 2,
        "advertisement-rcvd": 20,
        "advertisement-sent": 12,
        "interval-errors": 0,
        "priority-zero-pkts-rcvd": 0,
        "priority-zero-pkts-sent": 0,
        "invalid-type-pkts-rcvd": 0,
        "address-list-errors": 0,
        "packet-length-errors": 1
      }
    }
  ]
}

```

```
{
  "ietf-vrrp:vrrp": {
    "virtual-routers": 3,
    "interfaces": 2,
    "statistics": {
      "discontinuity-datettime": "2016-10-24T17:11:27+02:00",
      "checksum-errors": 2,
      "version-errors": 0,
      "vrid-errors": 0,
      "ip-ttl-errors": 1
    }
  }
}
```

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