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Definitions of Managed Objects for the Virtual Router Redundancy Protocol Version 3 (VRRPv3)

Abstract

This specification defines a portion of the Management Information Base (MIB) for use with network management based on the Simple Network Management Protocol (SNMP). In particular, it defines objects for configuring, monitoring, and controlling routers that employ the Virtual Router Redundancy Protocol Version 3 (VRRPv3) for both IPv4 and IPv6 as defined in RFC 5798. This memo obsoletes RFC 2787.

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 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6527.

Table of Contents

1. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

2. Introduction

This specification defines a portion of the MIB for use with SNMP-based network management. In particular, it defines objects for configuring, monitoring, and controlling routers that employ the Virtual Router Redundancy Protocol Version 3 (VRRPv3) for both IPv4 and IPv6 as defined in RFC 5798 [RFC5798].

3. 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 RFC 2119 [RFC2119].

4. Relationship to RFC 2787

This document obsoletes RFC 2787 [RFC2787]. The major changes in this document reflect changes in the VRRP protocol between RFC 2338 [RFC2338] and RFC 5798 [RFC5798]. This document is also updated to conform to current MIB conventions.

5. Relation to Interface Group (IF-MIB)

Since a router can be participating in VRRP on one or more interfaces, "ifIndex" is used as an index into the tables defined in the VRRP MIB. This MIB module imports ifIndex from the IF-MIB. At this time, the latest version of the IF-MIB is from RFC 2863 [RFC2863].

6. Multi-Stack Implementations

This MIB module is designed to support multi-stack implementations that run VRRP over IPv4 and IPv6. The IP version, Virtual Router Identifier (VRID), and ifIndex are used to uniquely identify rows in a multi-stack implementation.

7. Interpretation of RFC 5798

During the review of this document, it emerged that there are different possible interpretations of [RFC5798]. The authors of that document and the VRRP working group were unable to reach consensus as to which interpretation is correct. This document makes the following assumption:

IPv4 and IPv6 virtual routers are treated as two separate logical entities and represented as two separate entries in the vrrpv3OperationsTable. This is required due to the undefined behavior of the protocol in [RFC5798] in a multi-stack scenario.

8. VRRP MIB Structure and Design

This MIB module contains three tables:

(1) The vrrpv3OperationsTable contains objects that define the operational characteristics of a VRRP router. Rows in this table correspond to instances of virtual routers.

(2) The vrrpv3StatisticsTable contains the operating statistics for a VRRP router.

(3) The vrrpv3AssociatedIpAddrTable contains the addresses of the virtual router(s) that a given VRRP router is backing up.

Tables are indexed on ifIndex, VRID, and the IP version to uniquely identify a VRRP router.

Notifications in this MIB module are controlled using the mechanisms defined in [RFC3413].

9. VRRP Multi-Stack Scenario

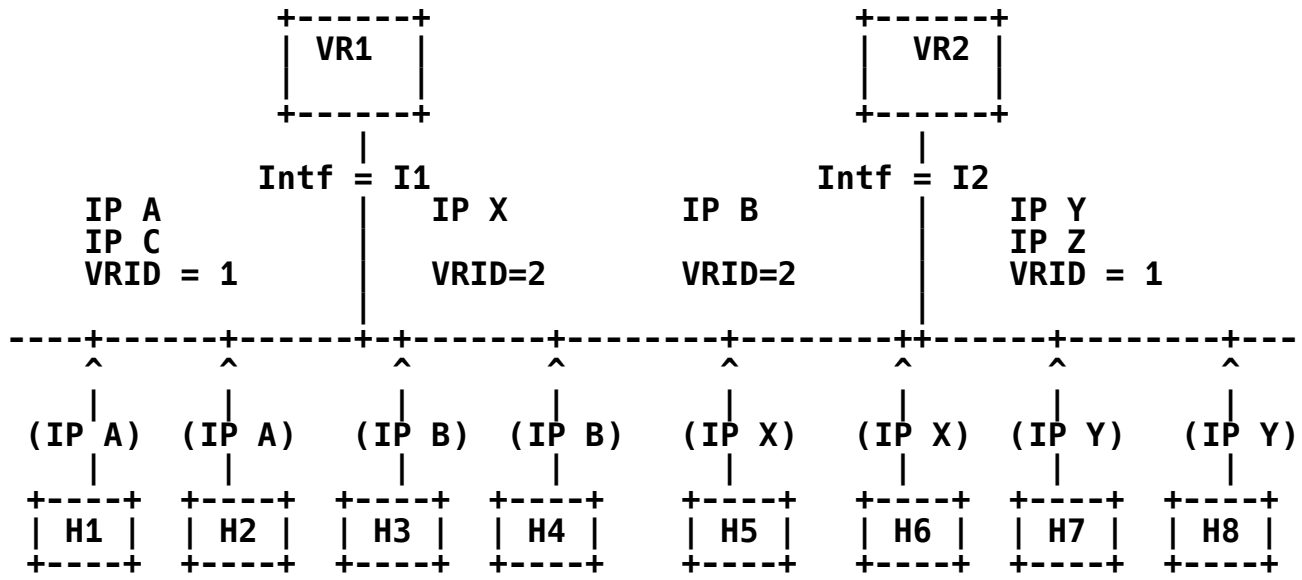
The following section provides examples of how some of the objects in this MIB are instantiated.

KEY:

The labels in the following tables and diagrams correspond to the actual MIB objects as follows:

```
if      = IfIndex
AddrType= vrrpv3OperationsInetAddrType
VrId    = vrrpv3OperationsVrId
State   = vrrpv3OperationsStatus
Prior   = vrrpv3OperationsPriority
IpAddr  = vrrpv3OperationsMasterIpAddr
```

The following figure shows a hypothetical network with two VRRP routers, VR1 & VR2, configured with two virtual routers. Addresses in '()' indicate the address of the default gateway for a given host; H1 to H4 are IPv4 hosts, and H5 to H8 are IPv6 hosts. A, B, and C are IPv4 addresses, and X, Y, and Z are IPv6 addresses. In the diagram, "Interface" is used in the context defined in IF-MIB.



----- MIB Tables For VRRP Router "VR1": -----

vrrpv3OperationsTable

if	VrId	AddrType	State	Prior	IpAddr	
I1	01	1	M	255	A	
I1	01	2	B	1-254	Y	
I1	02	1	B	1-254	B	
I1	02	2	M	255	X	

vrrpv3AssociatedIpAddrTable

if	VrId	AddrType	IP	RowStat
I1	01	1	A	active
I1	01	1	C	active
I1	01	2	Y	active
I1	01	2	Z	active
I1	02	1	B	active
I1	02	2	X	active

----- MIB Tables For VRRP Router "VR2": -----

vrrpv3OperationsTable

if	VrId	AddrType	State	Prior	IpAddr	
I2	01	1	B	1-254	A	--(..)--
I2	01	2	M	255	Y	--(..)--
I2	02	1	M	255	B	--(..)--
I2	02	2	B	1-254	X	--(..)--

vrrpv3AssociatedIpAddrTable

if	VrId	AddrType	IP	RowStat
I2	01	1	A	active
I2	01	1	C	active
I2	01	2	Y	active
I2	01	2	Z	active
I2	02	1	B	active
I2	02	2	X	active

NOTES:

1) For "State": M = Master; B = Backup.
In the vrrpv3OperationsTable, a "priority" of 255 indicates that the respective router owns the IP address, e.g., this IP address is native to the router (i.e., "the IP Address Owner").

10. Definitions

This MIB module makes reference to the following documents [RFC2578], [RFC2579], [RFC2580], [RFC2863], and [RFC4001].

```
VRRPV3-MIB DEFINITIONS ::= BEGIN

    IMPORTS
        MODULE-IDENTITY, OBJECT-TYPE,
        NOTIFICATION-TYPE, Counter32,
        Integer32, mib-2, Unsigned32,
        Counter64, TimeTicks
            FROM SNMPv2-SMI                 -- RFC2578

        TEXTUAL-CONVENTION, RowStatus,
        MacAddress, TruthValue, TimeStamp,
        TimeInterval
            FROM SNMPv2-TC                  -- RFC2579

        MODULE-COMPLIANCE, OBJECT-GROUP,
        NOTIFICATION-GROUP
            FROM SNMPv2-CONF                -- RFC2580
```

```
        ifIndex
            FROM IF-MIB                       -- RFC2863
        InetAddressType, InetAddress

            FROM INET-ADDRESS-MIB;            -- RFC4001

    vrrpv3MIB  MODULE-IDENTITY
        LAST-UPDATED "201202130000Z"          -- Feb 13, 2012
        ORGANIZATION "IETF VRRP Working Group"
        CONTACT-INFO
               "WG E-Mail: vrrp@ietf.org

                Editor:    Kalyan Tata
                           Nokia
                           313 Fairchild Dr,
                           Mountain View, CA 94043
                           Tata_kalyan@yahoo.com"

        DESCRIPTION
            "This MIB describes objects used for managing Virtual
             Router Redundancy Protocol version 3 (VRRPv3).

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             identified as authors of the code.  All rights
             reserved.

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

             This version of the MIB module is part of RFC 6527.
             Please see the RFC for full legal notices."

        REVISION "201202120000Z"    -- Feb 13, 2012
        DESCRIPTION "Initial version as published in RFC 6527."

        ::= { mib-2 207 }

   -- Textual Conventions

      Vrrpv3VrIdTC ::= TEXTUAL-CONVENTION
        DISPLAY-HINT "d"
        STATUS       current
        DESCRIPTION
```

```
            "The value of the Virtual Router Identifier noted as
            (VRID) in RFC 5798.  This, along with interface index
            (ifIndex) and IP version, serves to uniquely identify
            a virtual router on a given VRRP router."
        REFERENCE "RFC 5798 (Sections 3 and 5.2.3)"
        SYNTAX      Integer32 (1..255)

--  VRRPv3 MIB Groups

   vrrpv3Notifications   OBJECT IDENTIFIER ::= { vrrpv3MIB 0 }
   vrrpv3Objects         OBJECT IDENTIFIER ::= { vrrpv3MIB 1 }
   vrrpv3Conformance     OBJECT IDENTIFIER ::= { vrrpv3MIB 2 }

-- VRRPv3 MIB Objects

   vrrpv3Operations      OBJECT IDENTIFIER ::= { vrrpv3Objects 1 }
   vrrpv3Statistics      OBJECT IDENTIFIER ::= { vrrpv3Objects 2 }

--  VRRPv3 Operations Table

    vrrpv3OperationsTable OBJECT-TYPE
        SYNTAX       SEQUENCE OF Vrrpv3OperationsEntry
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION
            "Unified Operations table for a VRRP router that
             consists of a sequence (i.e., one or more conceptual
             rows) of 'vrrpv3OperationsEntry' items each of which
             describe the operational characteristics of a virtual
             router."

        ::= { vrrpv3Operations 1 }

    vrrpv3OperationsEntry OBJECT-TYPE
        SYNTAX       Vrrpv3OperationsEntry
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION
            "An entry in the vrrpv3OperationsTable containing the
             operational characteristics of a virtual router.
             On a VRRP router, a given virtual router is
             identified by a combination of ifIndex, VRID, and
             the IP version.  ifIndex represents an interface of
             the router.

             A row must be created with vrrpv3OperationsStatus
             set to initialize(1) and cannot transition to
             backup(2) or master(3) until
```

```
                vrrpv3OperationsRowStatus is transitioned to
                active(1).

                The information in this table is persistent and when
                written the entity SHOULD save the change to non-
                volatile storage."

            INDEX    { ifIndex, vrrpv3OperationsVrId,
                       vrrpv3OperationsInetAddrType
                     }
            ::= { vrrpv3OperationsTable 1 }

        Vrrpv3OperationsEntry ::=

            SEQUENCE {
                vrrpv3OperationsVrId
                    Vrrpv3VrIdTC,
                vrrpv3OperationsInetAddrType
                    InetAddressType,
                vrrpv3OperationsMasterIpAddr
                    InetAddress,
                vrrpv3OperationsPrimaryIpAddr
                    InetAddress,
                vrrpv3OperationsVirtualMacAddr
                    MacAddress,
                vrrpv3OperationsStatus
                    INTEGER,
                vrrpv3OperationsPriority
                    Unsigned32,
                vrrpv3OperationsAddrCount
                    Integer32,
                vrrpv3OperationsAdvInterval
                    TimeInterval,
                vrrpv3OperationsPreemptMode
                    TruthValue,
                vrrpv3OperationsAcceptMode
                    TruthValue,
                vrrpv3OperationsUpTime
                    TimeTicks,
                vrrpv3OperationsRowStatus
                    RowStatus
        }
        vrrpv3OperationsVrId OBJECT-TYPE
            SYNTAX       Vrrpv3VrIdTC
            MAX-ACCESS   not-accessible
            STATUS       current
            DESCRIPTION
```

```
            "This object contains the Virtual Router Identifier
             (VRID)."
        REFERENCE "RFC 4001"
        ::= { vrrpv3OperationsEntry 1 }

    vrrpv3OperationsInetAddrType OBJECT-TYPE
        SYNTAX       InetAddressType
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION
           "The IP address type of Vrrpv3OperationsEntry and
            Vrrpv3AssociatedIpAddrEntry.  This value determines
            the type for vrrpv3OperationsMasterIpAddr,
            vrrpv3OperationsPrimaryIpAddr, and
            vrrpv3AssociatedIpAddrAddress.

             ipv4(1) and ipv6(2) are the only two values supported
             in this MIB module."
        REFERENCE "RFC 4001"
        ::= { vrrpv3OperationsEntry 2 }

    vrrpv3OperationsMasterIpAddr OBJECT-TYPE
        SYNTAX       InetAddress
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
          "The master router's real IP address.  The master router
          would set this address to vrrpv3OperationsPrimaryIpAddr
          while transitioning to master state.  For backup
          routers, this is the IP address listed as the source in
          the VRRP advertisement last received by this virtual
          router."
        REFERENCE "RFC 5798"
        ::= { vrrpv3OperationsEntry 3 }

    vrrpv3OperationsPrimaryIpAddr OBJECT-TYPE
        SYNTAX       InetAddress
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
            "In the case where there is more than one IP
            Address (associated IP addresses) for a given
            'ifIndex', this object is used to specify the IP
            address that will become the
            vrrpv3OperationsMasterIpAddr', should the virtual
            router transition from backup state to master."
        ::= { vrrpv3OperationsEntry 4 }
```

```
    vrrpv3OperationsVirtualMacAddr OBJECT-TYPE
        SYNTAX       MacAddress
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
           "The virtual MAC address of the virtual router.
           Although this object can be derived from the
           'vrrpv3OperationsVrId' object, it is defined so that it
           is easily obtainable by a management application and
           can be included in VRRP-related SNMP notifications."
        ::= { vrrpv3OperationsEntry 5 }

    vrrpv3OperationsStatus OBJECT-TYPE
        SYNTAX       INTEGER {
            initialize(1),
            backup(2),
            master(3)
        }
        MAX-ACCESS   read-only
        STATUS       current

        DESCRIPTION
            "The current state of the virtual router.  This object
            has three defined values:

            - 'initialize', which indicates that the
               virtual router is waiting for a startup event.

            - 'backup', which indicates that the virtual router is
               monitoring the availability of the master router.

            - 'master', which indicates that the virtual router
               is forwarding packets for IP addresses that are
               associated with this router."
        REFERENCE "RFC 5798"
        ::= { vrrpv3OperationsEntry 6 }

    vrrpv3OperationsPriority OBJECT-TYPE
        SYNTAX       Unsigned32 (0..255)
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
          "This object specifies the priority to be used for the
          virtual router master election process; higher values
          imply higher priority.

          A priority of '0', although not settable, is sent by
          the master router to indicate that this router has
```

```
            ceased to participate in VRRP, and a backup virtual
            router should transition to become a new master.

            A priority of 255 is used for the router that owns the
            associated IP address(es) for VRRP over IPv4 and hence
            is not settable.

            Setting the values of this object to 0 or 255 should be
            rejected by the agents implementing this MIB module.
            For example, an SNMP agent would return 'badValue(3)'
            when a user tries to set the values 0 or 255 for this
            object."

        REFERENCE "RFC 5798, Section 6.1"
        DEFVAL       { 100 }
        ::= { vrrpv3OperationsEntry 7 }

    vrrpv3OperationsAddrCount OBJECT-TYPE
        SYNTAX       Integer32 (0..255)
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The number of IP addresses that are associated with
            this virtual router.  This number is equal to the
            number of rows in the vrrpv3AssociatedAddrTable that
            correspond to a given ifIndex/VRID/IP version."
        REFERENCE "RFC 5798, Section 6.1"
        ::= { vrrpv3OperationsEntry 8 }

    vrrpv3OperationsAdvInterval OBJECT-TYPE
        SYNTAX       TimeInterval (1..4095)
        UNITS        "centiseconds"
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
            "The time interval, in centiseconds, between sending
            advertisement messages.  Only the master router sends
            VRRP advertisements."
        REFERENCE "RFC 5798, Section 6.1"
        DEFVAL       { 100}
        ::= { vrrpv3OperationsEntry 9 }

    vrrpv3OperationsPreemptMode OBJECT-TYPE
        SYNTAX       TruthValue
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
```

```
            "Controls whether a higher priority virtual router will
            preempt a lower priority master."
        REFERENCE "RFC 5798, Section 6.1"
        DEFVAL       { true }
        ::= { vrrpv3OperationsEntry 10 }

    vrrpv3OperationsAcceptMode OBJECT-TYPE
        SYNTAX       TruthValue
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
           "Controls whether a virtual router in master state
           will accept packets addressed to the address owner's
           IPv6 address as its own if it is not the IPv6 address
           owner.  Default is false(2).
           This object is not relevant for rows representing VRRP
           over IPv4 and should be set to false(2)."
        DEFVAL       { false }
        ::= { vrrpv3OperationsEntry 11 }

    vrrpv3OperationsUpTime OBJECT-TYPE
        SYNTAX       TimeTicks
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "This value represents the amount of time, in
            TimeTicks (hundredth of a second), since this virtual
            router (i.e., the 'vrrpv3OperationsStatus')
            transitioned out of 'initialize'."
        REFERENCE "RFC 5798, Section 6.1"
        ::= { vrrpv3OperationsEntry 12 }

    vrrpv3OperationsRowStatus OBJECT-TYPE
        SYNTAX       RowStatus
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
          "The RowStatus variable should be used in accordance to
           installation and removal conventions for conceptual
           rows.

           To create a row in this table, a manager sets this
           object to either createAndGo(4) or createAndWait(5).
           Until instances of all corresponding columns are
           appropriately configured, the value of the
           corresponding instance of the
           'vrrpv3OperationsRowStatus' column will be read as
           notReady(3).
```

```
            In particular, a newly created row cannot be made
            active(1) until (minimally) the corresponding instance
            of vrrpv3OperationsInetAddrType, vrrpv3OperationsVrId,
            and vrrpv3OperationsPrimaryIpAddr has been set, and
            there is at least one active row in the
            'vrrpv3AssociatedIpAddrTable' defining an associated
            IP address.

            notInService(2) should be used to administratively
            bring the row down.

            A typical order of operation to add a row is:
            1. Create a row in vrrpv3OperationsTable with
            createAndWait(5).
            2. Create one or more corresponding rows in
            vrrpv3AssociatedIpAddrTable.
            3. Populate the vrrpv3OperationsEntry.
            4. Set vrrpv3OperationsRowStatus to active(1).

            A typical order of operation to delete an entry is:
            1. Set vrrpv3OperationsRowStatus to notInService(2).
            2. Set the corresponding rows in
            vrrpv3AssociatedIpAddrTable to destroy(6) to delete
            the entry.
            3. Set vrrpv3OperationsRowStatus to destroy(6) to
            delete the entry."
        ::= { vrrpv3OperationsEntry 13 }

    --  VRRP Associated Address Table

        vrrpv3AssociatedIpAddrTable OBJECT-TYPE
            SYNTAX       SEQUENCE OF Vrrpv3AssociatedIpAddrEntry
            MAX-ACCESS   not-accessible
            STATUS       current
            DESCRIPTION
                "The table of addresses associated with each virtual
                 router."
            ::= { vrrpv3Operations 2 }

        vrrpv3AssociatedIpAddrEntry OBJECT-TYPE
            SYNTAX       Vrrpv3AssociatedIpAddrEntry
            MAX-ACCESS   not-accessible
            STATUS       current
            DESCRIPTION
               "An entry in the table contains an IP address that is
               associated with a virtual router.  The number of rows
               for a given IP version, VrID, and ifIndex will equal
               the number of IP addresses associated (e.g., backed up)
```

```
            by the virtual router (equivalent to
            'vrrpv3OperationsIpAddrCount').

            Rows in the table cannot be modified unless the value
            of 'vrrpv3OperationsStatus' for the corresponding entry
            in the vrrpv3OperationsTable has transitioned to
            initialize(1).

            The information in this table is persistent and when
            written the entity SHOULD save the change to non-
            volatile storage."

        INDEX    { ifIndex, vrrpv3OperationsVrId,
                   vrrpv3OperationsInetAddrType,
                   vrrpv3AssociatedIpAddrAddress }

        ::= { vrrpv3AssociatedIpAddrTable 1 }

    Vrrpv3AssociatedIpAddrEntry ::=
        SEQUENCE {
            vrrpv3AssociatedIpAddrAddress

                InetAddress,
            vrrpv3AssociatedIpAddrRowStatus
                RowStatus
    }

    vrrpv3AssociatedIpAddrAddress OBJECT-TYPE
        SYNTAX       InetAddress (SIZE (0|4|16))
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION
            "The assigned IP addresses that a virtual router is
            responsible for backing up.

            The IP address type is determined by the value of
            vrrpv3OperationsInetAddrType in the index of this
            row."
        REFERENCE "RFC 5798"
        ::= { vrrpv3AssociatedIpAddrEntry 1 }

    vrrpv3AssociatedIpAddrRowStatus OBJECT-TYPE
        SYNTAX       RowStatus
        MAX-ACCESS   read-create
        STATUS       current
        DESCRIPTION
          "The row status variable, used according to
          installation and removal conventions for conceptual
```

```
            rows.  To create a row in this table, a manager sets
            this object to either createAndGo(4) or
            createAndWait(5).  Setting this object to active(1)
            results in the addition of an associated address for a
            virtual router.  Setting this object to notInService(2)
            results in administratively bringing down the row.

            Destroying the entry or setting it to destroy(6)
            removes the associated address from the virtual router.
            The use of other values is implementation-dependent.

            Implementations should not allow deletion of the last
            row corresponding to an active row in
            vrrpv3OperationsTable.

            Refer to the description of vrrpv3OperationsRowStatus
            for typical row creation and deletion scenarios."
          ::= { vrrpv3AssociatedIpAddrEntry 2 }

   --  VRRP Router Statistics

       vrrpv3RouterChecksumErrors OBJECT-TYPE
           SYNTAX       Counter64
           MAX-ACCESS   read-only
           STATUS       current
           DESCRIPTION
               "The total number of VRRP packets received with an
               invalid VRRP checksum value.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system, and at
               other times as indicated by the value of
               vrrpv3GlobalStatisticsDiscontinuityTime."

           REFERENCE "RFC 5798, Section 5.2.8"
           ::= { vrrpv3Statistics 1 }

       vrrpv3RouterVersionErrors OBJECT-TYPE
           SYNTAX       Counter64
           MAX-ACCESS   read-only
           STATUS       current
           DESCRIPTION
               "The total number of VRRP packets received with an
               unknown or unsupported version number.

               Discontinuities in the value of this counter can occur
               at re-initialization of the management system, and at
```

```
                other times as indicated by the value of
                vrrpv3GlobalStatisticsDiscontinuityTime."

            REFERENCE "RFC 5798, Section 5.2.1"
            ::= { vrrpv3Statistics 2 }

        vrrpv3RouterVrIdErrors OBJECT-TYPE
            SYNTAX       Counter64
            MAX-ACCESS   read-only
           STATUS       current
            DESCRIPTION
                "The total number of VRRP packets received with a
                 VRID that is not valid for any virtual router on this
                 router.

                Discontinuities in the value of this counter can occur
                at re-initialization of the management system, and at
                other times as indicated by the value of
                vrrpv3GlobalStatisticsDiscontinuityTime."

            REFERENCE "RFC 5798, Section 5.2.3"
            ::= { vrrpv3Statistics 3 }

       vrrpv3GlobalStatisticsDiscontinuityTime OBJECT-TYPE
           SYNTAX     TimeStamp
           MAX-ACCESS read-only
           STATUS     current
           DESCRIPTION
             "The value of sysUpTime on the most recent occasion at
              which one of vrrpv3RouterChecksumErrors,
              vrrpv3RouterVersionErrors, and vrrpv3RouterVrIdErrors
              suffered a discontinuity.

              If no such discontinuities have occurred since the last
              re-initialization of the local management subsystem,
              then this object contains a zero value."

           ::= { vrrpv3Statistics 4 }

      --  VRRP Router Statistics Table

        vrrpv3StatisticsTable OBJECT-TYPE
            SYNTAX       SEQUENCE OF Vrrpv3StatisticsEntry
            MAX-ACCESS   not-accessible
            STATUS       current
            DESCRIPTION
                "Table of virtual router statistics."
            ::= { vrrpv3Statistics 5 }
```

```
    vrrpv3StatisticsEntry OBJECT-TYPE
        SYNTAX       Vrrpv3StatisticsEntry
        MAX-ACCESS   not-accessible
        STATUS       current
        DESCRIPTION
            "An entry in the table containing statistics
            information about a given virtual router."
        AUGMENTS    { vrrpv3OperationsEntry }
        ::= { vrrpv3StatisticsTable 1 }

    Vrrpv3StatisticsEntry ::=
        SEQUENCE {
            vrrpv3StatisticsMasterTransitions
                Counter32,
            vrrpv3StatisticsNewMasterReason
                INTEGER,
            vrrpv3StatisticsRcvdAdvertisements
                Counter64,
            vrrpv3StatisticsAdvIntervalErrors
                Counter64,
            vrrpv3StatisticsIpTtlErrors
                Counter64,
            vrrpv3StatisticsProtoErrReason
                INTEGER,
            vrrpv3StatisticsRcvdPriZeroPackets
                Counter64,
            vrrpv3StatisticsSentPriZeroPackets
                Counter64,
            vrrpv3StatisticsRcvdInvalidTypePackets
                Counter64,
            vrrpv3StatisticsAddressListErrors
                Counter64,
            vrrpv3StatisticsPacketLengthErrors
                Counter64,
            vrrpv3StatisticsRowDiscontinuityTime
                 TimeStamp,
            vrrpv3StatisticsRefreshRate
                 Unsigned32
        }

    vrrpv3StatisticsMasterTransitions OBJECT-TYPE
        SYNTAX       Counter32
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of times that this virtual router's
            state has transitioned to master state.
```

```
            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."
        ::= { vrrpv3StatisticsEntry 1 }

    vrrpv3StatisticsNewMasterReason OBJECT-TYPE
        SYNTAX        INTEGER {
            notMaster (0),
            priority  (1),
            preempted (2),
            masterNoResponse (3)
        }
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
           "This indicates the reason for the virtual router to
           transition to master state.  If the virtual router
           never transitioned to master state, the value of this
           object is notMaster(0).  Otherwise, this indicates the
           reason this virtual router transitioned to master
           state the last time.  Used by vrrpv3NewMaster
           notification."
        ::= { vrrpv3StatisticsEntry 2 }

     vrrpv3StatisticsRcvdAdvertisements OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of VRRP advertisements received by
            this virtual router.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."

        ::= { vrrpv3StatisticsEntry 3 }

     vrrpv3StatisticsAdvIntervalErrors OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of VRRP advertisement packets
            received for which the advertisement interval is
```

```
            different from the vrrpv3OperationsAdvInterval
            configured on this virtual router.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."

        ::= { vrrpv3StatisticsEntry 4 }

    vrrpv3StatisticsIpTtlErrors OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of VRRP packets received by the
            virtual router with IPv4 TTL (for VRRP over IPv4) or
            IPv6 Hop Limit (for VRRP over IPv6) not equal to 255.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."
        REFERENCE "RFC 5798, Section 5.1.1.3"
        ::= { vrrpv3StatisticsEntry 5 }

    vrrpv3StatisticsProtoErrReason OBJECT-TYPE
        SYNTAX        INTEGER {
            noError (0),
            ipTtlError (1),
            versionError  (2),
            checksumError (3),
            vrIdError(4)
        }
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "This indicates the reason for the last protocol
            error.  This SHOULD be set to noError(0) when no
            protocol errors are encountered.  Used by
            vrrpv3ProtoError notification."
        ::= { vrrpv3StatisticsEntry 6 }

    vrrpv3StatisticsRcvdPriZeroPackets OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
```

```
            "The total number of VRRP packets received by the
            virtual router with a priority of '0'.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."
        REFERENCE "RFC 5798, Section 5.2.4"
        ::= { vrrpv3StatisticsEntry 7 }

    vrrpv3StatisticsSentPriZeroPackets OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of VRRP packets sent by the virtual
            router with a priority of '0'.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."
        REFERENCE "RFC 5798, Section 5.2.4"
        ::= { vrrpv3StatisticsEntry 8 }

    vrrpv3StatisticsRcvdInvalidTypePackets OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The number of VRRP packets received by the virtual
            router with an invalid value in the 'type' field.

            Discontinuities in the value of this counter can occur
            at re-initialization of the management system, and at
            other times as indicated by the value of
            vrrpv3StatisticsRowDiscontinuityTime."
        ::= { vrrpv3StatisticsEntry 9 }

    vrrpv3StatisticsAddressListErrors OBJECT-TYPE
        SYNTAX       Counter64
        MAX-ACCESS   read-only
        STATUS       current
        DESCRIPTION
            "The total number of packets received for which the
            address list does not match the locally configured
            list for the virtual router.
```

```
                Discontinuities in the value of this counter can occur
                at re-initialization of the management system, and at
                other times as indicated by the value of
                vrrpv3StatisticsRowDiscontinuityTime."
            ::= { vrrpv3StatisticsEntry 10 }

        vrrpv3StatisticsPacketLengthErrors OBJECT-TYPE
            SYNTAX       Counter64
            MAX-ACCESS   read-only
            STATUS       current
            DESCRIPTION
                "The total number of packets received with a packet
                length less than the length of the VRRP header.

                Discontinuities in the value of this counter can occur
                at re-initialization of the management system, and at
                other times as indicated by the value of
                vrrpv3StatisticsRowDiscontinuityTime."
            ::= { vrrpv3StatisticsEntry 11 }

        vrrpv3StatisticsRowDiscontinuityTime OBJECT-TYPE
            SYNTAX     TimeStamp
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
               "The value of sysUpTime on the most recent occasion at
               which any one or more of this entry's counters
               suffered a discontinuity.

               If no such discontinuities have occurred since the last
               re-initialization of the local management subsystem,
               then this object contains a zero value."
            ::= { vrrpv3StatisticsEntry 12 }

        vrrpv3StatisticsRefreshRate OBJECT-TYPE
            SYNTAX     Unsigned32
            UNITS "milliseconds"
            MAX-ACCESS read-only
            STATUS     current
            DESCRIPTION
              "The minimum reasonable polling interval for this entry.
               This object provides an indication of the minimum
               amount of time required to update the counters in this
               entry."
            ::= { vrrpv3StatisticsEntry 13 }

    --   Notification Definitions
    --   Notifications may be controlled using SNMP-NOTIFICATION-MIB
```

```
       vrrpv3NewMaster NOTIFICATION-TYPE
           OBJECTS      {
                          vrrpv3OperationsMasterIpAddr,
                          vrrpv3StatisticsNewMasterReason
                        }
           STATUS       current
           DESCRIPTION
               "The newMaster notification indicates that the sending
               agent has transitioned to master state."
           ::= { vrrpv3Notifications 1 }

       vrrpv3ProtoError NOTIFICATION-TYPE
           OBJECTS      {
                          vrrpv3StatisticsProtoErrReason
                        }
           STATUS       current
           DESCRIPTION
               "The notification indicates that the sending agent has
               encountered the protocol error indicated by
               vrrpv3StatisticsProtoErrReason."
           ::= { vrrpv3Notifications 2 }

   --  Conformance Information

    vrrpv3Compliances  OBJECT IDENTIFIER ::= { vrrpv3Conformance 1 }
    vrrpv3Groups       OBJECT IDENTIFIER ::= { vrrpv3Conformance 2 }

   -- Compliance Statements

       vrrpv3FullCompliance MODULE-COMPLIANCE
           STATUS current
           DESCRIPTION
              "The compliance statement"
           MODULE -- this module
           MANDATORY-GROUPS  {
               vrrpv3OperationsGroup,
               vrrpv3StatisticsGroup,
               vrrpv3InfoGroup,
               vrrpv3NotificationsGroup
           }
           OBJECT        vrrpv3OperationsPriority
           WRITE-SYNTAX  Unsigned32 (1..254)
           DESCRIPTION  "Setable values are from 1 to 254."
           ::= { vrrpv3Compliances 1 }

       vrrpv3ReadOnlyCompliance MODULE-COMPLIANCE
           STATUS current
           DESCRIPTION
```

```
            "When this MIB module is implemented without support
            for read-create (i.e., in read-only mode), then such
            an implementation can claim read-only compliance.
            Such a device can then be monitored, but cannot be
            configured with this MIB."

        MODULE -- this module
        MANDATORY-GROUPS  {
            vrrpv3OperationsGroup,
            vrrpv3StatisticsGroup,
            vrrpv3StatisticsDiscontinuityGroup,
            vrrpv3InfoGroup,
            vrrpv3NotificationsGroup
        }

        OBJECT        vrrpv3OperationsPriority
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        OBJECT        vrrpv3OperationsPrimaryIpAddr
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."
        OBJECT        vrrpv3OperationsAdvInterval
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        OBJECT        vrrpv3OperationsPreemptMode
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        OBJECT        vrrpv3OperationsAcceptMode
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        OBJECT        vrrpv3OperationsRowStatus
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        OBJECT        vrrpv3AssociatedIpAddrRowStatus
        MIN-ACCESS    read-only
        DESCRIPTION  "Write access is not required."

        ::= { vrrpv3Compliances 2 }

   -- Conformance Groups

       vrrpv3OperationsGroup   OBJECT-GROUP
           OBJECTS  {
```

```
            vrrpv3OperationsVirtualMacAddr,
            vrrpv3OperationsStatus,
            vrrpv3OperationsPriority,
            vrrpv3OperationsMasterIpAddr,
            vrrpv3OperationsAdvInterval,
            vrrpv3OperationsPreemptMode,
            vrrpv3OperationsAcceptMode,
            vrrpv3OperationsUpTime,
            vrrpv3OperationsRowStatus,
            vrrpv3OperationsAddrCount,
            vrrpv3OperationsPrimaryIpAddr,
            vrrpv3AssociatedIpAddrRowStatus
            }
        STATUS current
        DESCRIPTION
           "Conformance group for VRRPv3 operations."
        ::= { vrrpv3Groups 1 }

    vrrpv3StatisticsGroup  OBJECT-GROUP
        OBJECTS  {
            vrrpv3RouterChecksumErrors,
            vrrpv3RouterVersionErrors,
            vrrpv3RouterVrIdErrors,
            vrrpv3StatisticsMasterTransitions,
            vrrpv3StatisticsNewMasterReason,
            vrrpv3StatisticsRcvdAdvertisements,
            vrrpv3StatisticsAdvIntervalErrors,
            vrrpv3StatisticsRcvdPriZeroPackets,
            vrrpv3StatisticsSentPriZeroPackets,
            vrrpv3StatisticsRcvdInvalidTypePackets,
            vrrpv3StatisticsIpTtlErrors,
            vrrpv3StatisticsProtoErrReason,
            vrrpv3StatisticsAddressListErrors,
            vrrpv3StatisticsPacketLengthErrors,
            vrrpv3StatisticsRowDiscontinuityTime,
            vrrpv3StatisticsRefreshRate
            }
        STATUS current
        DESCRIPTION
           "Conformance group for VRRPv3 statistics."
        ::= { vrrpv3Groups 2 }

    vrrpv3StatisticsDiscontinuityGroup  OBJECT-GROUP
        OBJECTS  {
            vrrpv3GlobalStatisticsDiscontinuityTime
            }
        STATUS current
        DESCRIPTION
```

```
            "Objects providing information about counter
             discontinuities."
        ::= { vrrpv3Groups 3 }

    vrrpv3InfoGroup  OBJECT-GROUP
        OBJECTS  {
            vrrpv3StatisticsProtoErrReason,
            vrrpv3StatisticsNewMasterReason
            }
        STATUS current
        DESCRIPTION
           "Conformance group for objects contained in VRRPv3
            notifications."
        ::= { vrrpv3Groups 4 }

    vrrpv3NotificationsGroup NOTIFICATION-GROUP
        NOTIFICATIONS {
            vrrpv3NewMaster,
            vrrpv3ProtoError
            }
        STATUS current
        DESCRIPTION
           "The VRRP MIB Notification Group."
        ::= { vrrpv3Groups 5 }

END
```

11. Security Considerations

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are the tables and objects and their sensitivity/vulnerability:

The objects vrrpv3OperationsPriority, vrrpv3OperationsPrimaryIpAddr, vrrpv3OperationsAdvInterval, vrrpv3OperationsPreemptMode, vrrpv3OperationsAcceptMode, vrrpv3OperationsRowStatus, and vrrpv3AssociatedIpAddrRowStatus possess the read-create attribute. Manipulation of these objects is capable of affecting the operation of a virtual router.

Examples of how these objects could adversely affect the operation of a virtual router include:

- An unauthorized change to vrrpv3OperationsPriority can affect the priority used in master election, resulting in this router either becoming master when it should not, or in some other router being elected by preference. While this will disrupt the operator's plans, it will only replicate the unfortunate failure of multiple routers, and any router that does become master will be capable of filling that role.

- Modification of vrrpv3OperationsPrimaryIpAddr would cause the configured router to take on an incorrect IP address if it becomes master, which would be potentially very disruptive to the network operation.

- A malicious change to vrrpv3OperationsAdvInterval could either result in the configured router flooding the network with advertisements when it becomes master, or the new master not advertising frequently enough such that some routers do not learn about the new master.

- vrrpv3OperationsPreemptMode controls whether this router will preempt another master router. Setting it inappropriately will at worse cause one router to be master against the operator's plans, but that router will still be qualified to operate as a master.

- Setting the vrrpv3OperationsAcceptMode could prevent an IPv6-capable VRRP router from accepting packets addressed to the address owner's IPv6 address as its own even if it is not the IPv6 address owner. Although the default for this object is false(2), unauthorized setting of this object to false might restrict the function of some parts of the network.

- The vrrpv3OperationsRowStatus object that could be used to disable a virtual router. While there are other columns that, if changed, could disrupt operations, they cannot be changed without first changing the RowStatus object.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPsec), there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementations MUST provide the security features described by the SNMPv3 framework (see [RFC3410]), including full support for authentication and privacy via the User-based Security Model (USM) [RFC3414] with the AES cipher algorithm [RFC3826]. Implementations MAY also provide support for the Transport Security Model (TSM)

[RFC5591] in combination with a secure transport such as SSH [RFC5592] or TLS/DTLS [RFC6353].

Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

12. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER value
vrrpv3MIB	{ mib-2 207 vrrpv3MIB VRRPV3-MIB }

This document obsoletes RFC 2787. Therefore, IANA has deprecated value 68 under 'mib-2', which is assigned to VRRP-MIB.

13. Normative References

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