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IP Forwarding Table MIB
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Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes managed objects used for implementations of the Internet Protocol (IP) in an IP version independent manner.

Table of Contents

1. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

o An overall architecture, described in RFC 2571 [2].

o Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIv1 and described in STD 16, RFC 1155 [3], STD 16, RFC 1212 [4] and RFC 1215 [5]. The second version, called SMIv2, is described in STD 58, RFC 2578 [6], STD 58, RFC 2579 [7] and STD 58, RFC 2580 [8].

o Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [9]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [10] and RFC 1906 [11]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [11], RFC 2572 [12] and RFC 2574 [13].

o Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [9]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [14].

o A set of fundamental applications described in RFC 2573 [15] and the view-based access control mechanism described in RFC 2575 [16].

A more detailed introduction to the current SNMP Management Framework can be found in RFC 2570 [17].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This memo specifies a MIB module that is compliant to the SMIv2. A MIB conforming to the SMIv1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIv2 will be converted into textual descriptions in SMIv1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

2. Revision History

Changes from draft-ops-rfc2096-update-00.txt:

12 Jul 2001

Renamed to IPNG working group draft

Added scopes to the uses of instance

Added inetCidrRouteDiscards to replace ipRoutingDiscards

Fixed some remaining ipCidr*/inetCidr* confusion in DESCRIPTIONs

Changes from first draft posted to v6mib mailing list:

23 Feb 2001

Update MODULE-IDENTITY

Delete inetCidrRouteTos, add inetCidrRouteInstance in INDEX of inetCidrRouteTable.

Use InterfaceIndex, InetAddressPrefixLength and InetAutonomousSystemNumber TC's, and limit the SIZE of inetCidrRouteDest and inetCidrRouteNextHop

Update conformance info.

Added copyright and table of contents.

3. Overview

The MIB consists of one current table and two current global objects.

(1) The object inetCidrForwardNumber indicates the number of current routes. This is primarily to avoid having to read the table in order to determine this number.

(2) The object inetCidrForwardDiscards counts the number of routes that were discarded even though they were invalid.

(3) The inetCidrRouteTable provides the ability to display IP version independent multipath CIDR routes.

In addition, there is one deprecated table and object, and one obsolete table and object, representing previous revisions of this MIB.

(1) The obsolete object ipForwardNumber represents the number of entries in the obsolete ipForwardTable.

(2) The obsolete ipForwardTable updates the RFC 1213 ipRouteTable to display multipath IP Routes. This is in turn obsoleted by the ipCidrRouteTable.

(3) The deprecated object ipCidrRouteNumber represents the number of entries in the deprecated ipCidrRouteTable.

(4) The deprecated ipCidrRouteTable updates the RFC 1213 ipRouteTable to display multipath IP Routes having the same network number but differing network masks.

4. Definitions

```
IP-FORWARD-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE,
    IpAddress, Integer32, Gauge32,
    Unsigned32, Counter32              FROM SNMPv2-SMI
    RowStatus                          FROM SNMPv2-TC
    MODULE-COMPLIANCE, OBJECT-GROUP    FROM SNMPv2-CONF
    InterfaceIndex                     FROM IF-MIB
    ip                                 FROM IP-MIB
    IANAipRouteProtocol                FROM IANA-RTPROTO-MIB
    InetAddress, InetAddressType,
    InetAddressPrefixLength,
    InetAutonomousSystemNumber         FROM INET-ADDRESS-MIB;
```

```
ipForward MODULE-IDENTITY
    LAST-UPDATED "200107130000Z"
    ORGANIZATION "IETF IPv6 MIB Revision Team"
    CONTACT-INFO
           "Editor:
            Bill Fenner
            AT&T Labs - Research
            75 Willow Rd
            Menlo Park, CA

            Phone: +1 650 330-7893
            Email: <fenner@research.att.com>"
    DESCRIPTION
           "The MIB module for the management of CIDR multipath IP
            Routes."
    REVISION      "200107130000Z"
    DESCRIPTION
           "IP version neutral revision, published as RFC XXXX."
    REVISION      "9609190000Z"
    DESCRIPTION
           "Revised to support CIDR routes."
    ::= { ip 24 }

inetCidrRouteNumber OBJECT-TYPE
    SYNTAX     Gauge32
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
           "The number of current inetCidrRouteTable entries that are
            not invalid."
    ::= { ipForward 6 }

inetCidrRouteDiscards OBJECT-TYPE
    SYNTAX     Counter32
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
           "The number of routing entries which were chosen to be
            discarded even though they are valid.  One possible reason
            for discarding such an entry could be to free-up buffer
            space for other routing entries."
    ::= { ipForward 8 }

--  Inet CIDR Route Table

--  The Inet CIDR Route Table deprecates and replaces the ipCidrRoute
--  Table currently in the IP Forwarding Table MIB.
--  It adds IP protocol independence.
```

```
inetCidrRouteTable OBJECT-TYPE
    SYNTAX     SEQUENCE OF InetCidrRouteEntry
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "This entity's IP Routing table."
    REFERENCE
       "RFC 1213 Section 6.6, The IP Group"
    ::= { ipForward 7 }

inetCidrRouteEntry OBJECT-TYPE
    SYNTAX     InetCidrRouteEntry
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "A particular route to a particular destination, under a
            particular policy."
    INDEX {
        inetCidrRouteInstance,
        inetCidrRouteDestType,
        inetCidrRouteDest,
        inetCidrRoutePfxLen,
        inetCidrRouteNextHopType,
        inetCidrRouteNextHop
        }
    ::= { inetCidrRouteTable 1 }

InetCidrRouteEntry ::= SEQUENCE {
        inetCidrRouteInstance     Unsigned32,
        inetCidrRouteDestType     InetAddressType,
        inetCidrRouteDest         InetAddress,
        inetCidrRoutePfxLen       InetAddressPrefixLength,
        inetCidrRouteNextHopType  InetAddressType,
        inetCidrRouteNextHop      InetAddress,
        inetCidrRouteIfIndex      InterfaceIndex,
        inetCidrRouteType         INTEGER,
        inetCidrRouteProto        IANAipRouteProtocol,
        inetCidrRouteAge          Integer32,
        inetCidrRouteNextHopAS    InetAutonomousSystemNumber,
        inetCidrRouteMetric1      Integer32,
        inetCidrRouteMetric2      Integer32,
        inetCidrRouteMetric3      Integer32,
        inetCidrRouteMetric4      Integer32,
        inetCidrRouteMetric5      Integer32,
        inetCidrRouteStatus       RowStatus
    }

inetCidrRouteInstance OBJECT-TYPE
```

```
    SYNTAX     Unsigned32
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "The instance identifier of the (conceptual) routing table
            containing this route.  This identifier may be used to
            represent multiple routing tables, type-of-service routing,
            scopes, or any other use of multiple tables.

            XXX This needs more discussion."
    ::= { inetCidrRouteEntry 1 }

inetCidrRouteDestType OBJECT-TYPE
    SYNTAX     InetAddressType
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "The type of inetCidrRouteDest.  Only IPv4 and IPv6 addresses
            are expected."
    ::= { inetCidrRouteEntry 2 }

inetCidrRouteDest OBJECT-TYPE
    SYNTAX     InetAddress (SIZE(0..36))
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "The destination IP address of this route.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of x with the value of the mask formed from the
            corresponding instance of the inetCidrRoutePfxLen object is
            not equal to x."
    ::= { inetCidrRouteEntry 3 }

inetCidrRoutePfxLen OBJECT-TYPE
    SYNTAX     InetAddressPrefixLength
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "Indicate the number of leading one bits which form the mask
            to be logical-ANDed with the destination address before
            being compared to the value in the inetCidrRouteDest field.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of the mask formed from x with the value of the
            corresponding instance of the inetCidrRouteDest object is
```

```
            not equal to inetCidrRouteDest."
    ::= { inetCidrRouteEntry 4 }

inetCidrRouteNextHopType OBJECT-TYPE
    SYNTAX     InetAddressType
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "The address type of inetCidrRouteNextHop.  Must be the same
            as that of inetCidrRouteDestType, or unknown if there is no
            next hop."
    ::= { inetCidrRouteEntry 5 }

inetCidrRouteNextHop OBJECT-TYPE
    SYNTAX     InetAddress (SIZE(0..36))
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "On remote routes, the address of the next system en route;
            Otherwise, a zero-length string."
    ::= { inetCidrRouteEntry 6 }

inetCidrRouteIfIndex OBJECT-TYPE
    SYNTAX     InterfaceIndex
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "The ifIndex value which identifies the local interface
            through which the next hop of this route should be reached."
    ::= { inetCidrRouteEntry 7 }

inetCidrRouteType OBJECT-TYPE
    SYNTAX     INTEGER {
                other    (1), -- not specified by this MIB
                reject   (2), -- route which discards traffic and
                              --  returns notification
                local    (3), -- local interface
                remote   (4), -- remote destination
                blackhole(5)  -- route which discards traffic silently
              }
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "The type of route.  Note that local(3) refers to a route for
            which the next hop is the final destination; remote(4)
            refers to a route for which the next hop is not the final
            destination.
```

```
            Routes which do not result in traffic forwarding or
            rejection should not be displayed even if the implementation
            keeps them stored internally.

            reject(2) refers to a route which, if matched, discards the
            message as unreachable and returns a notification (e.g. ICMP
            error) to the message sender.  This is used in some
            protocols as a means of correctly aggregating routes.
            blackhole(5) refers to a route which, if matched, discards
            the message silently."
    ::= { inetCidrRouteEntry 8 }

inetCidrRouteProto OBJECT-TYPE
    SYNTAX     IANAipRouteProtocol
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
           "The routing mechanism via which this route was learned.
            Inclusion of values for gateway routing protocols is not
            intended to imply that hosts should support those
            protocols."
    ::= { inetCidrRouteEntry 9 }

-- XXX new type?  TimeTicks?
inetCidrRouteAge OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
           "The number of seconds since this route was last updated or
            otherwise determined to be correct.  Note that no semantics
            of `too old' can be implied except through knowledge of the
            routing protocol by which the route was learned."
    ::= { inetCidrRouteEntry 10 }

inetCidrRouteNextHopAS OBJECT-TYPE
    SYNTAX     InetAutonomousSystemNumber
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "The Autonomous System Number of the Next Hop.  The semantics
            of this object are determined by the routing-protocol
            specified in the route's inetCidrRouteProto value. When this
            object is unknown or not relevant its value should be set to
            zero."
    DEFVAL { 0 }
    ::= { inetCidrRouteEntry 11 }
```

```
inetCidrRouteMetric1 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "The primary routing metric for this route.  The semantics of
            this metric are determined by the routing-protocol specified
            in the route's inetCidrRouteProto value.  If this metric is
            not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { inetCidrRouteEntry 12 }

inetCidrRouteMetric2 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's inetCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { inetCidrRouteEntry 13 }

inetCidrRouteMetric3 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's inetCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { inetCidrRouteEntry 14 }

inetCidrRouteMetric4 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's inetCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { inetCidrRouteEntry 15 }
```

```
inetCidrRouteMetric5 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's inetCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { inetCidrRouteEntry 16 }

inetCidrRouteStatus OBJECT-TYPE
    SYNTAX     RowStatus
    MAX-ACCESS read-create
    STATUS     current
    DESCRIPTION
           "The row status variable, used according to row installation
            and removal conventions."
    ::= { inetCidrRouteEntry 17 }



--  Conformance information

ipForwardConformance OBJECT IDENTIFIER ::= { ipForward 5 }

ipForwardGroups      OBJECT IDENTIFIER ::= { ipForwardConformance 1 }
ipForwardCompliances OBJECT IDENTIFIER ::= { ipForwardConformance 2 }

--  Compliance statements

ipForwardCompliance2 MODULE-COMPLIANCE
    STATUS     current
    DESCRIPTION
           "The compliance statement for systems which have routing
            tables.  XXX is this right?"
   MODULE  -- this module
   MANDATORY-GROUPS { inetForwardCidrRouteGroup }
   ::= { ipForwardCompliances 3 }

-- units of conformance

inetForwardCidrRouteGroup OBJECT-GROUP
    OBJECTS { inetCidrRouteNumber, inetCidrRouteDiscards,
              inetCidrRouteIfIndex, inetCidrRouteType,
              inetCidrRouteProto, inetCidrRouteAge,
              inetCidrRouteNextHopAS, inetCidrRouteMetric1,
```

```
              inetCidrRouteMetric2, inetCidrRouteMetric3,
              inetCidrRouteMetric4, inetCidrRouteMetric5, inetCidrRouteStatus
          }
    STATUS     current
    DESCRIPTION
           "The IP version independent CIDR Route Table."
    ::= { ipForwardGroups 4 }

--  Deprecated Objects

ipCidrRouteNumber OBJECT-TYPE
    SYNTAX     Gauge32
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "The number of current ipCidrRouteTable entries that are not
            invalid.  This object is deprecated in favor of
            inetCidrRouteNumber and the inetCidrRouteTable."
    ::= { ipForward 3 }

--  IP CIDR Route Table

--  The IP CIDR Route Table obsoletes and replaces the ipRoute
--  Table current in MIB-I and MIB-II and the IP Forwarding Table.
--  It adds knowledge of the autonomous system of the next hop,
--  multiple next hops, and policy routing, and Classless
--  Inter-Domain Routing.

ipCidrRouteTable OBJECT-TYPE
    SYNTAX     SEQUENCE OF IpCidrRouteEntry
    MAX-ACCESS not-accessible
    STATUS     deprecated
    DESCRIPTION
           "This entity's IP Routing table.  This table has been
            deprecated in favor of the IP version neutral
            inetCidrRouteTable."
    REFERENCE
       "RFC 1213 Section 6.6, The IP Group"
    ::= { ipForward 4 }

ipCidrRouteEntry OBJECT-TYPE
    SYNTAX     IpCidrRouteEntry
    MAX-ACCESS not-accessible
    STATUS     deprecated
    DESCRIPTION
           "A particular route to a particular destination, under a
            particular policy."
    INDEX {
```

```
        ipCidrRouteDest,
        ipCidrRouteMask,
        ipCidrRouteTos,
        ipCidrRouteNextHop
        }
    ::= { ipCidrRouteTable 1 }

IpCidrRouteEntry ::= SEQUENCE {
        ipCidrRouteDest       IpAddress,
        ipCidrRouteMask       IpAddress,
        ipCidrRouteTos        Integer32,
        ipCidrRouteNextHop    IpAddress,
        ipCidrRouteIfIndex    Integer32,
        ipCidrRouteType       INTEGER,
        ipCidrRouteProto      INTEGER,
        ipCidrRouteAge        Integer32,
        ipCidrRouteInfo       OBJECT IDENTIFIER,
        ipCidrRouteNextHopAS  Integer32,
        ipCidrRouteMetric1    Integer32,
        ipCidrRouteMetric2    Integer32,
        ipCidrRouteMetric3    Integer32,
        ipCidrRouteMetric4    Integer32,
        ipCidrRouteMetric5    Integer32,
        ipCidrRouteStatus     RowStatus
    }

ipCidrRouteDest OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "The destination IP address of this route.

            This object may not take a Multicast (Class D) address
            value.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of x with the value of the corresponding
            instance of the ipCidrRouteMask object is not equal to x."
    ::= { ipCidrRouteEntry 1 }

ipCidrRouteMask OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "Indicate the mask to be logical-ANDed with the destination
```

```
            address before being compared to the value in the
            ipCidrRouteDest field.  For those systems that do not
            support arbitrary subnet masks, an agent constructs the
            value of the ipCidrRouteMask by reference to the IP Address
            Class.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of x with the value of the corresponding
            instance of the ipCidrRouteDest object is not equal to
            ipCidrRouteDest."
    ::= { ipCidrRouteEntry 2 }

-- The following convention is included for specification
-- of TOS Field contents.  At this time, the Host Requirements
-- and the Router Requirements documents disagree on the width
-- of the TOS field.  This mapping describes the Router
-- Requirements mapping, and leaves room to widen the TOS field
-- without impact to fielded systems.

ipCidrRouteTos OBJECT-TYPE
    SYNTAX     Integer32 (0..2147483647)
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "The policy specifier is the IP TOS Field.  The encoding
            of IP TOS is as specified by the following convention.
            Zero indicates the default path if no more specific
            policy applies.

            +-----+-----+-----+-----+-----+-----+-----+-----+
            |                 |                       |     |
            |   PRECEDENCE    |    TYPE OF SERVICE    |  0  |
            |                 |                       |     |
            +-----+-----+-----+-----+-----+-----+-----+-----+

                                              IP TOS                IP TOS
               Field     Policy      Field     Policy
               Contents    Code      Contents    Code
               0 0 0 0  ==>   0      0 0 0 1  ==>   2
               0 0 1 0  ==>   4      0 0 1 1  ==>   6
               0 1 0 0  ==>   8      0 1 0 1  ==>  10
               0 1 1 0  ==>  12      0 1 1 1  ==>  14
               1 0 0 0  ==>  16      1 0 0 1  ==>  18
               1 0 1 0  ==>  20      1 0 1 1  ==>  22
               1 1 0 0  ==>  24      1 1 0 1  ==>  26
               1 1 1 0  ==>  28      1 1 1 1  ==>  30"
    ::= { ipCidrRouteEntry 3 }
```

```
ipCidrRouteNextHop OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "On remote routes, the address of the next system en route;
            Otherwise, 0.0.0.0."
    ::= { ipCidrRouteEntry 4 }

ipCidrRouteIfIndex OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "The ifIndex value which identifies  the local interface
            through which the next hop of this route should be reached."
    DEFVAL { 0 }
    ::= { ipCidrRouteEntry 5 }

ipCidrRouteType OBJECT-TYPE
    SYNTAX     INTEGER {
                other    (1), -- not specified by this MIB
                reject   (2), -- route which discards traffic
                local    (3), -- local interface
                remote   (4)  -- remote destination
              }
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "The type of route.  Note that local(3) refers to a route for
            which the next hop is the final destination; remote(4)
            refers to a route for which the next hop is not the final
            destination.

            Routes which do not result in traffic forwarding or
            rejection should not be displayed even if the implementation
            keeps them stored internally.

            reject (2) refers to a route which, if matched, discards the
            message as unreachable. This is used in some protocols as a
            means of correctly aggregating routes."
    ::= { ipCidrRouteEntry 6 }

ipCidrRouteProto OBJECT-TYPE
    SYNTAX     INTEGER {
                other     (1),  -- not specified
                local     (2),  -- local interface
                netmgmt   (3),  -- static route
```

```
                icmp      (4),  -- result of ICMP Redirect

                        -- the following are all dynamic
                        -- routing protocols
                egp        (5),  -- Exterior Gateway Protocol
                ggp        (6),  -- Gateway-Gateway Protocol
                hello      (7),  -- FuzzBall HelloSpeak
                rip        (8),  -- Berkeley RIP or RIP-II
                isIs       (9),  -- Dual IS-IS
                esIs       (10), -- ISO 9542
                ciscoIgrp  (11), -- Cisco IGRP
                bbnSpfIgp  (12), -- BBN SPF IGP
                ospf       (13), -- Open Shortest Path First
                bgp        (14), -- Border Gateway Protocol
                idpr       (15), -- InterDomain Policy Routing
                ciscoEigrp (16)  -- Cisco EIGRP
              }
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "The routing mechanism via which this route was learned.
            Inclusion of values for gateway routing protocols is not
            intended to imply that hosts should support those
            protocols."
    ::= { ipCidrRouteEntry 7 }

ipCidrRouteAge OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "The number of seconds since this route was last updated or
            otherwise determined to be correct.  Note that no semantics
            of `too old' can be implied except through knowledge of the
            routing protocol by which the route was learned."
    DEFVAL  { 0 }
    ::= { ipCidrRouteEntry 8 }

ipCidrRouteInfo OBJECT-TYPE
    SYNTAX     OBJECT IDENTIFIER
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "A reference to MIB definitions specific to the particular
            routing protocol which is responsible for this route, as
            determined by the value specified in the route's
            ipCidrRouteProto value.  If this information is not present,
            its value should be set to the OBJECT IDENTIFIER { 0 0 },
```

```
            which is a syntactically valid object identifier, and any
            implementation conforming to ASN.1 and the Basic Encoding
            Rules must be able to generate and recognize this value."
    ::= { ipCidrRouteEntry 9 }

ipCidrRouteNextHopAS OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "The Autonomous System Number of the Next Hop.  The semantics
            of this object are determined by the routing-protocol
            specified in the route's ipCidrRouteProto value. When this
            object is unknown or not relevant its value should be set to
            zero."
    DEFVAL { 0 }
    ::= { ipCidrRouteEntry 10 }

ipCidrRouteMetric1 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "The primary routing metric for this route.  The semantics of
            this metric are determined by the routing-protocol specified
            in the route's ipCidrRouteProto value.  If this metric is
            not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipCidrRouteEntry 11 }

ipCidrRouteMetric2 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipCidrRouteEntry 12 }

ipCidrRouteMetric3 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
```

```
            of this metric are determined by the routing-protocol
            specified in the route's ipCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipCidrRouteEntry 13 }

ipCidrRouteMetric4 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipCidrRouteEntry 14 }

ipCidrRouteMetric5 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipCidrRouteProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipCidrRouteEntry 15 }

ipCidrRouteStatus OBJECT-TYPE
    SYNTAX     RowStatus
    MAX-ACCESS read-create
    STATUS     deprecated
    DESCRIPTION
           "The row status variable, used according to row installation
            and removal conventions."
    ::= { ipCidrRouteEntry 16 }



-- compliance statements

ipForwardCompliance MODULE-COMPLIANCE
    STATUS     deprecated
    DESCRIPTION
           "The compliance statement for SNMPv2 entities which implement
            the ipForward MIB."
```

```
   MODULE  -- this module
   MANDATORY-GROUPS { ipForwardCidrRouteGroup }

   ::= { ipForwardCompliances 1 }

-- units of conformance

ipForwardCidrRouteGroup OBJECT-GROUP
    OBJECTS { ipCidrRouteNumber,
              ipCidrRouteDest, ipCidrRouteMask, ipCidrRouteTos,
              ipCidrRouteNextHop, ipCidrRouteIfIndex, ipCidrRouteType,
              ipCidrRouteProto, ipCidrRouteAge, ipCidrRouteInfo,
              ipCidrRouteNextHopAS, ipCidrRouteMetric1,
              ipCidrRouteMetric2, ipCidrRouteMetric3,
              ipCidrRouteMetric4, ipCidrRouteMetric5, ipCidrRouteStatus
        }
    STATUS     deprecated
    DESCRIPTION
           "The CIDR Route Table."
    ::= { ipForwardGroups 3 }

-- Obsoleted Definitions - Objects

ipForwardNumber OBJECT-TYPE
    SYNTAX     Gauge32
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "The number of current ipForwardTable entries that are not
            invalid."
    ::= { ipForward 1 }

--  IP Forwarding Table

--  The IP Forwarding Table obsoletes and replaces the ipRoute
--  Table current in MIB-I and MIB-II.  It adds knowledge of
--  the autonomous system of the next hop, multiple next hop
--  support, and policy routing support.

ipForwardTable OBJECT-TYPE
    SYNTAX     SEQUENCE OF IpForwardEntry
    MAX-ACCESS not-accessible
    STATUS     obsolete
    DESCRIPTION
           "This entity's IP Routing table."
    REFERENCE
       "RFC 1213 Section 6.6, The IP Group"
    ::= { ipForward 2 }
```

```
ipForwardEntry OBJECT-TYPE
    SYNTAX     IpForwardEntry
    MAX-ACCESS not-accessible
    STATUS     obsolete
    DESCRIPTION
           "A particular route to a particular destination, under a
            particular policy."
    INDEX {
        ipForwardDest,
        ipForwardProto,
        ipForwardPolicy,
        ipForwardNextHop
        }
    ::= { ipForwardTable 1 }

IpForwardEntry ::= SEQUENCE {
        ipForwardDest       IpAddress,
        ipForwardMask       IpAddress,
        ipForwardPolicy     Integer32,
        ipForwardNextHop    IpAddress,
        ipForwardIfIndex    Integer32,
        ipForwardType       INTEGER,
        ipForwardProto      INTEGER,
        ipForwardAge        Integer32,
        ipForwardInfo       OBJECT IDENTIFIER,
        ipForwardNextHopAS  Integer32,
        ipForwardMetric1    Integer32,
        ipForwardMetric2    Integer32,
        ipForwardMetric3    Integer32,
        ipForwardMetric4    Integer32,
        ipForwardMetric5    Integer32
    }

ipForwardDest OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "The destination IP address of this route.  An entry with a
            value of 0.0.0.0 is considered a default route.

            This object may not take a Multicast (Class D) address
            value.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of x with the value of the corresponding
            instance of the ipForwardMask object is not equal to x."
```

```
    ::= { ipForwardEntry 1 }

ipForwardMask OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "Indicate the mask to be logical-ANDed with the destination
            address before being compared to the value in the
            ipForwardDest field.  For those systems that do not support
            arbitrary subnet masks, an agent constructs the value of the
            ipForwardMask by reference to the IP Address Class.

            Any assignment (implicit or otherwise) of an instance of
            this object to a value x must be rejected if the bitwise
            logical-AND of x with the value of the corresponding
            instance of the ipForwardDest object is not equal to
            ipForwardDest."
    DEFVAL { '00000000'h }      -- 0.0.0.0
    ::= { ipForwardEntry 2 }

-- The following convention is included for specification
-- of TOS Field contents.  At this time, the Host Requirements
-- and the Router Requirements documents disagree on the width
-- of the TOS field.  This mapping describes the Router
-- Requirements mapping, and leaves room to widen the TOS field
-- without impact to fielded systems.

ipForwardPolicy OBJECT-TYPE
    SYNTAX     Integer32 (0..2147483647)
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "The general set of conditions that would cause
            the selection of one multipath route (set of
            next hops for a given destination) is referred
            to as 'policy'.

            Unless the mechanism indicated by ipForwardProto
            specifies otherwise, the policy specifier is
            the IP TOS Field.  The encoding of IP TOS is as
            specified by the following convention.  Zero
            indicates the default path if no more specific
            policy applies.

            +-----+-----+-----+-----+-----+-----+-----+-----+
            |                 |                       |     |
            |   PRECEDENCE    |    TYPE OF SERVICE    |  0  |
```

```
            |                |                      |     |
            +-----+-----+-----+-----+-----+-----+-----+-----+
```

IP TOS Field Contents	Policy Code	IP TOS Field Contents	Policy Code
0 0 0 0	0	0 0 0 1	2
0 0 1 0	4	0 0 1 1	6
0 1 0 0	8	0 1 0 1	10
0 1 1 0	12	0 1 1 1	14
1 0 0 0	16	1 0 0 1	18
1 0 1 0	20	1 0 1 1	22
1 1 0 0	24	1 1 0 1	26
1 1 1 0	28	1 1 1 1	30

```
            Protocols defining 'policy' otherwise must either
            define a set of values which are valid for
            this object or must implement an integer-instanced
            policy table for which this object's
            value acts as an index."
    ::= { ipForwardEntry 3 }

ipForwardNextHop OBJECT-TYPE
    SYNTAX     IpAddress
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "On remote routes, the address of the next system en route;
            Otherwise, 0.0.0.0."
    ::= { ipForwardEntry 4 }

ipForwardIfIndex OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "The ifIndex value which identifies the local interface
            through which the next hop of this route should be reached."
    DEFVAL { 0 }
    ::= { ipForwardEntry 5 }

ipForwardType OBJECT-TYPE
    SYNTAX     INTEGER {
                other    (1), -- not specified by this MIB
                invalid  (2), -- logically deleted
                local    (3), -- local interface
                remote   (4)  -- remote destination
             }
```

```
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "The type of route.  Note that local(3) refers to a route for
            which the next hop is the final destination; remote(4)
            refers to a route for which the next hop is not the final
            destination.

            Setting this object to the value invalid(2) has the effect
            of invalidating the corresponding entry in the
            ipForwardTable object.  That is, it effectively
            disassociates the destination identified with said entry
            from the route identified with said entry.  It is an
            implementation-specific matter as to whether the agent
            removes an invalidated entry from the table.  Accordingly,
            management stations must be prepared to receive tabular
            information from agents that corresponds to entries not
            currently in use.  Proper interpretation of such entries
            requires examination of the relevant ipForwardType object."
    DEFVAL { invalid }
    ::= { ipForwardEntry 6 }

ipForwardProto OBJECT-TYPE
    SYNTAX     INTEGER {
                other     (1),  -- not specified
                local     (2),  -- local interface
                netmgmt   (3),  -- static route
                icmp      (4),  -- result of ICMP Redirect

                        -- the following are all dynamic
                        -- routing protocols
                egp       (5),  -- Exterior Gateway Protocol
                ggp       (6),  -- Gateway-Gateway Protocol
                hello     (7),  -- FuzzBall HelloSpeak
                rip       (8),  -- Berkeley RIP or RIP-II
                is-is     (9),  -- Dual IS-IS
                es-is     (10), -- ISO 9542
                ciscoIgrp (11), -- Cisco IGRP
                bbnSpfIgp (12), -- BBN SPF IGP
                ospf      (13), -- Open Shortest Path First
                bgp       (14), -- Border Gateway Protocol
                idpr      (15)  -- InterDomain Policy Routing
             }
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "The routing mechanism via which this route was learned.
            Inclusion of values for gateway routing protocols is not
```

```
            intended to imply that hosts should support those
            protocols."
    ::= { ipForwardEntry 7 }

ipForwardAge OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-only
    STATUS     obsolete
    DESCRIPTION
           "The number of seconds since this route was last updated or
            otherwise determined to be correct.  Note that no semantics
            of `too old' can be implied except through knowledge of the
            routing protocol by which the route was learned."
    DEFVAL  { 0 }
    ::= { ipForwardEntry 8 }

ipForwardInfo OBJECT-TYPE
    SYNTAX     OBJECT IDENTIFIER
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "A reference to MIB definitions specific to the particular
            routing protocol which is responsible for this route, as
            determined by the value specified in the route's
            ipForwardProto value.  If this information is not present,
            its value should be set to the OBJECT IDENTIFIER { 0 0 },
            which is a syntactically valid object identifier, and any
            implementation conforming to ASN.1 and the Basic Encoding
            Rules must be able to generate and recognize this value."
    ::= { ipForwardEntry 9 }

ipForwardNextHopAS OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "The Autonomous System Number of the Next Hop.  When this is
            unknown or not relevant to the protocol indicated by
            ipForwardProto, zero."
    DEFVAL { 0 }
    ::= { ipForwardEntry 10 }

ipForwardMetric1 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "The primary routing metric for this route.  The semantics of
```

```
            this metric are determined by the routing-protocol specified
            in the route's ipForwardProto value.  If this metric is not
            used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipForwardEntry 11 }

ipForwardMetric2 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipForwardProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipForwardEntry 12 }

ipForwardMetric3 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipForwardProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipForwardEntry 13 }

ipForwardMetric4 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
            of this metric are determined by the routing-protocol
            specified in the route's ipForwardProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipForwardEntry 14 }

ipForwardMetric5 OBJECT-TYPE
    SYNTAX     Integer32
    MAX-ACCESS read-create
    STATUS     obsolete
    DESCRIPTION
           "An alternate routing metric for this route.  The semantics
```

```
            of this metric are determined by the routing-protocol
            specified in the route's ipForwardProto value.  If this
            metric is not used, its value should be set to -1."
    DEFVAL { -1 }
    ::= { ipForwardEntry 15 }



-- Obsoleted Definitions - Groups
-- compliance statements

ipForwardOldCompliance MODULE-COMPLIANCE
    STATUS     obsolete
    DESCRIPTION
           "The compliance statement for SNMP entities which implement
            the ipForward MIB."

   MODULE  -- this module
   MANDATORY-GROUPS { ipForwardMultiPathGroup }

   ::= { ipForwardCompliances 2 }

ipForwardMultiPathGroup OBJECT-GROUP
    OBJECTS { ipForwardNumber,
              ipForwardDest, ipForwardMask, ipForwardPolicy,
              ipForwardNextHop, ipForwardIfIndex, ipForwardType,
              ipForwardProto, ipForwardAge, ipForwardInfo,
              ipForwardNextHopAS,
              ipForwardMetric1, ipForwardMetric2, ipForwardMetric3,
              ipForwardMetric4, ipForwardMetric5
        }
    STATUS     obsolete
    DESCRIPTION
           "IP Multipath Route Table."
    ::= { ipForwardGroups 2 }

END
```

5. Open Issues / To Do

Trash this completely and start from scratch with a new MIB?

The Instance Identifier can be used for IPv6 scopes, for Diffserv Code Points, or any other multi-instance purpose. How to tell what a given instance means?

Any other objects from RFC 2465's ipv6RouteTable?

Better wording for ipForwardCompliance2?

Note: more open issues / to do items scattered in comments in MIB.

6. Acknoledgments

This document contains objects modified from RFC 2096 [1].

7. References

[1] F. Baker, "IP Forwarding Table MIB", RFC 2096, January 1997.

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[11] Case, J., McCloghrie, K., Rose, M., and S. Waldbusser, "Transport Mappings for Version 2 of the Simple Network Management Protocol

(SNMPv2)", RFC 1906, January 1996.

[12] Case, J., Harrington D., Presuhn R., and B. Wijnen, "Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)", RFC 2572, April 1999.

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[15] Levi, D., Meyer, P., and B. Stewart, "SNMPv3 Applications", RFC 2573, April 1999.

[16] Wijnen, B., Presuhn, R., and K. McCloghrie, "View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)", RFC 2575, April 1999.

[17] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction to Version 3 of the Internet-standard Network Management Framework", RFC 2570, April 1999.

8. Security Considerations

There are a number of management objects defined in this MIB that have 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.

There are a number of managed objects in this MIB that may contain sensitive information. These are:

The routing table can be used to discover information about the network topology within a domain.

It is thus important to control even GET access to these objects and possibly to even encrypt the values of these object when sending them over the network via SNMP. Not all versions of SNMP provide features for such a secure environment.

SNMPv1 by itself is not a secure environment. Even if the network itself is secure (for example by using IPSec), even then, 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.

It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model RFC 2574 [13] and the View-based Access Control Model RFC 2575 [16] is recommended.

It is then a customer/user responsibility to ensure that the SNMP entity giving access to an instance of this MIB, 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.

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