Internet-Draft M. Wasserman, Editor
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# IP Forwarding Table MIB

## 1 Status of this Memo

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This document is a product of the IPv6 MIB Revision Design Team and it is a working item of the IPv6 Working Group. Comments should be addressed to the editor, or to the IPv6 Working Group mailing list at ipng@sunroof.eng.sun.com.

## 2 Abstract

This document 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 related to the forwarding of Internet Protocol (IP) packets, in an IP version independent manner.

## 3 Copyright Notice



## 4 Conventions Used In This Document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

## 5 Table of Contents



## 6 Revision History

Changes from draft-ietf-ipngwg-rfc-2096-update-00.txt:

27 Jun 2001 Added inetCidrRouteDscp index and inetCidrRouteWeight object to the inetCidrRouteTable.

Restored inetCidrRouteNextHopType variable (may be different from inetCidrRouteDestType, due to global vs. non-global distinction in new InetAddress TCs).

Removed inetCidrRouteInstance object. Use to identify a conceptual routing table is obviated by new InetAddress types and inclusion of DSCP index.

Changed editor, moved author information to end, several editorial changes.

13 Jul 2001 Removed inetCidrRouteNextHopType.

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 Updated MODULE-IDENTITY

Deleted inetCidrRouteTos, add inetCidrRouteInstance in INDEX of inetCidrRouteTable.



Used InterfaceIndex, InetAddressPrefixLength and InetAutonomousSystemNumber TC's, and limited the SIZE of inetCidrRouteDest and inetCidrRouteNextHop

Updated conformance info. Added copyright and table of contents.

## 7 The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

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

- 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].

- 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].

- 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].

- 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.



## 8 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 valid routes that were discarded for any reason.

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.



## 9 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:
            Margaret Wasserman
            Wind River
```

```
            10 Tara Blvd, Suite 330
            Nashua, NH 03062

            Phone: +1 603 897-2067
            Email: <mrw@windriver.com>"
    DESCRIPTION
           "The MIB module for the management of CIDR multipath IP
            Routes."
    REVISION      "200206270000Z"
    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 {
            inetCidrRouteDestType,
            inetCidrRouteDest,
            inetCidrRoutePfxLen,
            inetCidrRouteDscp,
            inetCidrRouteNextHopType,
            inetCidrRouteNextHop
            }
        ::= { inetCidrRouteTable 1 }

    InetCidrRouteEntry ::= SEQUENCE {
            inetCidrRouteDestType     InetAddressType,
            inetCidrRouteDest         InetAddress,
            inetCidrRoutePfxLen       InetAddressPrefixLength,
            inetCidrRouteDscp,        Octet,
            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
        }

    inetCidrRouteDestType OBJECT-TYPE
        SYNTAX     InetAddressType
        MAX-ACCESS not-accessible
        STATUS     current
        DESCRIPTION
```

```
            "The type of the inetCidrRouteDest address, as defined
             in the InetAddress MIB [19]"
    ::= { inetCidrRouteEntry 1 }

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 2 }

inetCidrRoutePfxLen OBJECT-TYPE
    SYNTAX     InetAddressPrefixLength
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "Indicates 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 3 }

inetCidrRouteDscp OBJECT-TYPE
    SYNTAX     Octet
    MAX-ACCESS read-only
    STATUS     deprecated
    DESCRIPTION
           "Indicates the Differentiated Services Code Point (DSCP)
            [18] to which the routing information in this entry
```



```
            applies.

            The field is formatted as follows:
```

```
                0   1   2   3   4   5   6   7
               +---+---+---+---+---+---+---+---+
               |         DSCP          |  CU   |
               +---+---+---+---+---+---+---+---+

               DSCP: differentiated services codepoint
               CU: currently unused

            The first three bits (0-2) of the DSCP are compatible
            with the defined per-hop-behaviours for the IP
            preference field. The remaining three bits can be used
            to further discriminate the level and type of service
            indicated. "
    ::= { ipCidrRouteEntry 4 }

inetCidrRouteNextHopType OBJECT-TYPE
    SYNTAX     InetAddressType
    MAX-ACCESS not-accessible
    STATUS     current
    DESCRIPTION
           "The type of the inetCidrRouteNextHop address, as
            defined in the InetAddress MIB [19].

            Value should be set to unknown(0) for non-remote
            routes."
    ::= { 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.  For non-remote routes, 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 ICMP 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 }

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 }

    inetCidrRouteWeight OBJECT-TYPE
        SYNTAX     Unsigned32
        MAX-ACCESS read-only
        STATUS     current
        DESCRIPTION
               "The system internal weight value for this route.
                The semantics of this value are determined by
                the implementation. Generally, when multiple paths
                are available, the route with the lowest weight
                value will be preferred.  Implementations that do
                not include a weighting concept should return 0
                for all entries."
        ::= { inetCidrRouteEntry 17 }
```

```
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 18 }

--  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

Wasserman, Editor       Expires May 2002                      15
IP Forwarding Table MIB                                 June 2002

               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."
```



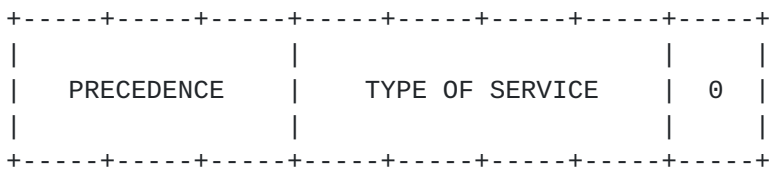
```
    DEFVAL { '00000000'h }      -- 0.0.0.0
    ::= { ipForwardEntry 2 }

-- 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.




| IP TOS Field Contents | IP TOS Policy Code | IP TOS Field Contents | IP TOS 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
```



## 10 Open Issues / To Do

Instance values for this MIB can be as long as 44 bytes. Can/should we do anything about this? May be alleviated by EOS plans?

Why include the scalar inetCidrRouteNumber? Is this used for something, or does it just require unnecessary MIB housekeeping?

Better wording for ipForwardCompliance2?

## 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 whom 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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