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IP Forwarding Table MIB

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

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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. This document obsoletes RFC 2096.

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1. Introduction

This document defines a portion of the Management Information Base (MIB) for use in managing objects related to the forwarding of Internet Protocol (IP) packets in an IP version-independent manner.

It should be noted that the MIB definition described herein does not support multiple instances based on the same address family type. However, it does support an instance of the MIB per address family.

2. 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].

3. The Internet-Standard Management Framework

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

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIV2, which is described in STD 58, RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].

4. Overview

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

1. The object `inetCidrRouteNumber` 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 `inetCidrRouteDiscards` counts the number of valid routes that were discarded from `inetCidrRouteTable` for any reason. This object replaces the `ipRoutingDiscards` and `ipv6DiscardedRoutes` objects.
3. The `inetCidrRouteTable` provides the ability to display IP version-independent multipath CIDR routes.

4.1. Relationship to Other MIBs

This MIB definition contains several deprecated and obsolete tables and objects. The following subsections describe the relationship between these objects and other MIB modules.

4.1.1. RFC 1213

The `ipRouteTable` object was originally defined in RFC 1213 [RFC1213]. It was updated by `ipForwardTable` in RFC 1354 [RFC1354].

4.1.2. RFC 1354

The `ipForwardTable` object replaced the `ipRouteTable` object from RFC 1213. It was in turn obsoleted by the `ipCidrRouteTable` defined in RFC 2096 [RFC2096].

In addition, RFC 1354 introduced `ipForwardNumber`. This object reflects the number of entries found in `ipForwardTable`. It was obsoleted by `ipCidrRouteNumber`, defined in RFC 2096.

4.1.3. RFC 2096

In RFC 2096, the `ipCidrRouteTable` and `ipCidrRouteNumber` were introduced. The `ipCidrRouteTable` object supports multipath IP routes having the same network number but differing network masks. The number of entries in that table is reflected in `ipCidrRouteNumber`. These objects are deprecated by the definitions contained in this MIB definition.

4.1.4. RFC 2011 and 2465

RFC 2011 [RFC2011] contains the `ipRoutingDiscards` object, which counts the number of valid routes that have been removed from the `ipCidrRouteTable` object. The corresponding `ipv6DiscardedRoutes` object is defined in RFC 2465 [RFC2465]. These objects are deprecated in favor of the version-independent object `inetCidrRouteDiscards` defined in this MIB.

5. Definitions

IP-FORWARD-MIB DEFINITIONS ::= BEGIN

IMPORTS

| | |
|--------------------------------|-----------------|
| MODULE-IDENTITY, OBJECT-TYPE, | |
| IpAddress, Integer32, Gauge32, | |
| Counter32 | FROM SNMPv2-SMI |
| RowStatus | FROM SNMPv2-TC |

| | |
|-----------------------------------|------------------------|
| MODULE-COMPLIANCE, OBJECT-GROUP | FROM SNMPv2-CONF |
| InterfaceIndexOrZero | FROM IF-MIB |
| ip | FROM IP-MIB |
| IANAipRouteProtocol | FROM IANA-RTPROTO-MIB |
| InetAddress, InetAddressType, | |
| InetAddressPrefixLength, | |
| InetAddressAutonomousSystemNumber | FROM INET-ADDRESS-MIB; |

ipForward MODULE-IDENTITY

LAST-UPDATED "200602010000Z"

ORGANIZATION

"IETF IPv6 Working Group

<http://www.ietf.org/html.charters/ipv6-charter.html>"

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DESCRIPTION

"The MIB module for the management of CIDR multipath IP Routes.

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REVISION "200602010000Z"

DESCRIPTION

"IPv4/v6 version-independent revision. Minimal changes were made to the original RFC 2096 MIB to allow easy upgrade of existing IPv4 implementations to the version-independent MIB. These changes include:

Adding inetCidrRouteDiscards as a replacement for the deprecated ipRoutingDiscards and ipv6DiscardedRoutes objects.

Adding a new conformance statement to support the implementation of the IP Forwarding MIB in a read-only mode.

The inetCidrRouteTable replaces the IPv4-specific ipCidrRouteTable, its related objects, and related conformance statements.

Published as RFC 4292."

REVISION "199609190000Z"
DESCRIPTION
"Revised to support CIDR routes.
Published as RFC 2096."

REVISION "199207022156Z"
DESCRIPTION
"Initial version, published as RFC 1354."
::= { 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 valid route entries discarded from the
inetCidrRouteTable. Discarded route entries do not
appear in the inetCidrRouteTable. One possible reason
for discarding an entry would be to free-up buffer space
for other route table 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 (as reflected in the inetCidrRoutePolicy object).

Dynamically created rows will survive an agent reboot.

Implementers need to be aware that if the total number of elements (octets or sub-identifiers) in inetCidrRouteDest, inetCidrRoutePolicy, and inetCidrRouteNextHop exceeds 111, then OIDs of column instances in this table will have more than 128 sub-identifiers and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3."

INDEX {

inetCidrRouteDestType,
inetCidrRouteDest,
inetCidrRoutePfxLen,
inetCidrRoutePolicy,
inetCidrRouteNextHopType,
inetCidrRouteNextHop
}

::= { inetCidrRouteTable 1 }

InetCidrRouteEntry ::= SEQUENCE {

| | |
|--------------------------|-----------------------------|
| inetCidrRouteDestType | InetAddressType, |
| inetCidrRouteDest | InetAddress, |
| inetCidrRoutePfxLen | InetAddressPrefixLength, |
| inetCidrRoutePolicy | OBJECT IDENTIFIER, |
| inetCidrRouteNextHopType | InetAddressType, |
| inetCidrRouteNextHop | InetAddress, |
| inetCidrRouteIfIndex | InterfaceIndexOrZero, |
| inetCidrRouteType | INTEGER, |
| inetCidrRouteProto | IANAipRouteProtocol, |
| inetCidrRouteAge | Gauge32, |
| 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.

Only those address types that may appear in an actual routing table are allowed as values of this object."

```
REFERENCE "RFC 4001"
```

```
::= { inetCidrRouteEntry 1 }
```

inetCidrRouteDest OBJECT-TYPE

```

SYNTAX      InetAddress
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION

```

"The destination IP address of this route.

The type of this address is determined by the value of the inetCidrRouteDestType object.

The values for the index objects inetCidrRouteDest and inetCidrRoutePfxLen must be consistent. When the value of inetCidrRouteDest (excluding the zone index, if one is present) is x, then the bitwise logical-AND of x with the value of the mask formed from the corresponding index object inetCidrRoutePfxLen MUST be equal to x. If not, then the index pair is not consistent and an inconsistentName error must be returned on SET or CREATE requests."

```
::= { inetCidrRouteEntry 2 }
```

inetCidrRoutePfxLen OBJECT-TYPE

```

SYNTAX      InetAddressPrefixLength
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION

```

"Indicates the number of leading one bits that form the mask to be logical-ANDed with the destination address before being compared to the value in the

inetCidrRouteDest field.

The values for the index objects inetCidrRouteDest and inetCidrRoutePfxLen must be consistent. When the value of inetCidrRouteDest (excluding the zone index, if one is present) is x, then the bitwise logical-AND of x with the value of the mask formed from the corresponding index object inetCidrRoutePfxLen MUST be equal to x. If not, then the index pair is not consistent and an inconsistentName error must be returned on SET or CREATE requests."

```
::= { inetCidrRouteEntry 3 }
```

inetCidrRoutePolicy OBJECT-TYPE

SYNTAX OBJECT IDENTIFIER

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This object is an opaque object without any defined semantics. Its purpose is to serve as an additional index that may delineate between multiple entries to the same destination. The value { 0 0 } shall be used as the default value for this object."

```
::= { inetCidrRouteEntry 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.

Value should be set to unknown(0) for non-remote routes.

Only those address types that may appear in an actual routing table are allowed as values of this object."

REFERENCE "RFC 4001"

```
::= { inetCidrRouteEntry 5 }
```

inetCidrRouteNextHop OBJECT-TYPE

SYNTAX InetAddress

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.

The type of this address is determined by the value of the inetCidrRouteNextHopType object."

```
::= { inetCidrRouteEntry 6 }
```

inetCidrRouteIfIndex OBJECT-TYPE

SYNTAX InterfaceIndexOrZero

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The ifIndex value that identifies the local interface through which the next hop of this route should be reached. A value of 0 is valid and represents the scenario where no interface is specified."

```
::= { inetCidrRouteEntry 7 }
```

inetCidrRouteType OBJECT-TYPE

```
SYNTAX INTEGER {
    other      (1), -- not specified by this MIB
    reject    (2), -- route that discards traffic and
                  -- returns ICMP notification
    local     (3), -- local interface
    remote    (4), -- remote destination
    blackhole (5) -- route that 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 that 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 that, 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 that, 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      Gauge32
    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.

        A row entry cannot be modified when the status is
        marked as active(1)."
```

```

    ::= { inetCidrRouteEntry 17 }

-- Conformance information

ipForwardConformance
    OBJECT IDENTIFIER ::= { ipForward 5 }

ipForwardGroups
    OBJECT IDENTIFIER ::= { ipForwardConformance 1 }

ipForwardCompliances
    OBJECT IDENTIFIER ::= { ipForwardConformance 2 }

-- Compliance statements

ipForwardFullCompliance MODULE-COMPLIANCE
    STATUS      current
    DESCRIPTION
        "When this MIB is implemented for read-create, the
        implementation can claim full compliance.

        There are a number of INDEX objects that cannot be
        represented in the form of OBJECT clauses in SMIV2,
        but for which there are compliance requirements,
        expressed in OBJECT clause form in this description:

        -- OBJECT      inetCidrRouteDestType
        -- SYNTAX      InetAddressType (ipv4(1), ipv6(2),
        --              ipv4z(3), ipv6z(4))
        -- DESCRIPTION
        --      This MIB requires support for global and
        --      non-global ipv4 and ipv6 addresses.
```

```

--
-- OBJECT      inetCidrRouteDest
-- SYNTAX      InetAddress (SIZE (4 | 8 | 16 | 20))
-- DESCRIPTION
--      This MIB requires support for global and
--      non-global IPv4 and IPv6 addresses.
--
-- OBJECT      inetCidrRouteNextHopType
-- SYNTAX      InetAddressType (unknown(0), ipv4(1),
--                               ipv6(2), ipv4z(3),
--                               ipv6z(4))
-- DESCRIPTION
--      This MIB requires support for global and
--      non-global ipv4 and ipv6 addresses.
--
-- OBJECT      inetCidrRouteNextHop
-- SYNTAX      InetAddress (SIZE (0 | 4 | 8 | 16 | 20))
-- DESCRIPTION
--      This MIB requires support for global and
--      non-global IPv4 and IPv6 addresses.
"

MODULE -- this module
MANDATORY-GROUPS { inetForwardCidrRouteGroup }

OBJECT      inetCidrRouteStatus
SYNTAX      RowStatus { active(1), notInService (2) }
WRITE-SYNTAX RowStatus { active(1), notInService (2),
                        createAndGo(4), destroy(6) }
DESCRIPTION "Support for createAndWait is not required."

 ::= { ipForwardCompliances 3 }

ipForwardReadOnlyCompliance MODULE-COMPLIANCE
STATUS      current
DESCRIPTION
    "When this MIB is implemented without support for read-
    create (i.e., in read-only mode), the implementation can
    claim read-only compliance."
MODULE -- this module
MANDATORY-GROUPS { inetForwardCidrRouteGroup }

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

OBJECT      inetCidrRouteType

```

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

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

OBJECT        inetCidrRouteMetric1
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

OBJECT        inetCidrRouteMetric2
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

OBJECT        inetCidrRouteMetric3
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

OBJECT        inetCidrRouteMetric4
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

OBJECT        inetCidrRouteMetric5
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

OBJECT        inetCidrRouteStatus
SYNTAX        RowStatus { active(1) }
MIN-ACCESS    read-only
DESCRIPTION
    "Write access is not required."

 ::= { ipForwardCompliances 4 }

-- units of conformance

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

```

        inetCidrRouteNextHopAS, inetCidrRouteMetric1,
        inetCidrRouteMetric2, inetCidrRouteMetric3,
        inetCidrRouteMetric4, inetCidrRouteMetric5,
        inetCidrRouteStatus, inetCidrRouteNumber
    }
    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, 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 | Contents | Policy | Code | 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"
 ::= { 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 that 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 that 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 that 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 that, 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 that 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 that
        implement the ipForward MIB.

        This compliance statement has been deprecated and
        replaced with ipForwardFullCompliance and
        ipForwardReadOnlyCompliance."

    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.

        This group has been deprecated and replaced with
        inetForwardCidrRouteGroup."
    ::= { 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 | | 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 |

Protocols defining 'policy' otherwise must either define a set of values that 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 that 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 that 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 that 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

```

6. Security Considerations

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

1. The `inetCidrRouteTable` contains routing and forwarding information that is critical to the operation of the network node (especially routers). Allowing unauthenticated write access to this table can compromise the validity of the forwarding information.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

1. The `inetCidrRouteTable` contains routing and forwarding information that can be used to compromise a network.

Specifically, this table can be used to construct a map of the network in preparation for a denial-of-service attack on the network infrastructure.

2. The `inetCidrRouteProto` object identifies the routing protocols in use within a network. This information can be used to determine how a denial-of-service attack should be launched.

SNMP versions prior to SNMPv3 did not include adequate security. 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 module.

It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [RFC3410], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

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

7. Changes from RFC 2096

This document obsoletes RFC 2096 in the following ways:

1. Replaces `ipCidrRouteTable` with `inetCidrRouteTable`. This applies to corresponding objects and conformance statements.
2. Utilizes the `InetAddress` TC to support IP version-independent implementations of the forwarding MIB. This gives common forwarding MIB support for IPv4 and IPv6.
3. Creates a read-only conformance statement to support implementations that only wish to retrieve data.
4. Creates the `inetCidrRouteDiscards` object to replace the deprecated `ipRoutingDiscards` and `ipv6DiscardedRoutes` objects.

The `inetCidrRouteTable` retains the logical structure of the `ipCidrRouteTable` in order to allow the easy upgrade of existing IPv4 implementations to the version-independent MIB.

8. Normative References

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9. Informative References

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- [RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.

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10. Authors and Acknowledgements

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