Network Working Group
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IP Forwarding Table MIB

Status of this Memo

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in TCP/IP-based internets. In particular, it defines objects for managing routes in the IP Internet.

It is proposed that the ipRouteTable defined by MIB-II (RFC 1213) be deprecated and replaced with this table. This adds the ability to set or display multi-path routes, and varying routes by network management policy.

Table of Contents

1. The Network Management Framework

The Internet-standard Network Management Framework consists of three components. They are:

RFC 1155 which defines the SMI, the mechanisms used for describing and naming objects for the purpose of management. RFC 1212 defines a

more concise description mechanism, which is wholly consistent with the SMI.

RFC 1156 which defines MIB-I, the core set of managed objects for the Internet suite of protocols. RFC 1213 defines MIB-II, an evolution of MIB-I based on implementation experience and new operational requirements.

RFC 1157 which defines the SNMP, the protocol used for network access to managed objects.

The Framework permits new objects to be defined for the purpose of experimentation and evaluation.

2. Objects

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the subset of Abstract Syntax Notation One (ASN.1) [7] defined in the SMI. In particular, each object has a name, a syntax, and an encoding. The name is an object identifier, an administratively assigned name, which specifies an object type. The object type together with an object instance serves to uniquely identify a specific instantiation of the object. For human convenience, we often use a textual string, termed the OBJECT DESCRIPTOR, to also refer to the object type.

The syntax of an object type defines the abstract data structure corresponding to that object type. The ASN.1 language is used for this purpose. However, the SMI [3] purposely restricts the ASN.1 constructs which may be used. These restrictions are explicitly made for simplicity.

The encoding of an object type is simply how that object type is represented using the object type's syntax. Implicitly tied to the notion of an object type's syntax and encoding is how the object type is represented when being transmitted on the network.

The SMI specifies the use of the basic encoding rules of ASN.1 [8], subject to the additional requirements imposed by the SNMP.

2.1. Format of Definitions

Section 4 contains contains the specification of all object types contained in this MIB module. The object types are defined using the conventions defined in the SMI, as amended by the extensions specified in [9].

3. Overview

3.1. Structure of MIB

The IP Forwarding Table is quite analogous to the older ipRoute Table. The principal differences are:

(1) It is somewhat re-organized, for aesthetic reasons,

(2) It has the Next Hop Autonomous System Number, useful primarily to the administrators of regional networks,

(3) It is instanced by Policy and Next Hop as well as by ultimate destination. Thus, multiple multipath routes can be managed, not just a single route, along with the circumstances under which the any given route might be chosen.

4. Definitions

```
RFC1354-MIB DEFINITIONS ::= BEGIN

IMPORTS
        Gauge, IpAddress
                FROM RFC1155-SMI
        mib-2, ip
                FROM RFC1213-MIB
        OBJECT-TYPE
                FROM RFC-1212;

--  This MIB module uses the extended OBJECT-TYPE macro as
--  defined in [9].
ipForward  OBJECT IDENTIFIER ::= { ip 24 }

    ipForwardNumber OBJECT-TYPE
        SYNTAX   Gauge
        ACCESS   read-only
        STATUS   mandatory
        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
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     --  the autonomous system of the next hop, multiple next hop
     --  support, and policy routing support.


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


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


         IpForwardEntry ::=
             SEQUENCE {
                 ipForwardDest
                     IpAddress,
                 ipForwardMask
                     IpAddress,
                 ipForwardPolicy
                     INTEGER,
                 ipForwardNextHop
                     IpAddress,
                 ipForwardIfIndex
                     INTEGER,
                 ipForwardType
                     INTEGER,
                 ipForwardProto
                     INTEGER,
                 ipForwardAge
```

```
                INTEGER,
            ipForwardInfo
                OBJECT IDENTIFIER,
            ipForwardNextHopAS
                INTEGER,
            ipForwardMetric1
                INTEGER,
            ipForwardMetric2
                INTEGER,
            ipForwardMetric3
                INTEGER,
            ipForwardMetric4
                INTEGER,
            ipForwardMetric5
                INTEGER
        }

    ipForwardDest OBJECT-TYPE
        SYNTAX   IpAddress
        ACCESS   read-only
        STATUS   mandatory
        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
        ACCESS   read-write
        STATUS   mandatory
        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 Ad-
```

```
            dress 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 ipForward-
            Dest."
        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   INTEGER
        ACCESS   read-only
        STATUS   mandatory
        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 ipForwardPro-
            to 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  ei-
            ther 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
        ACCESS   read-only
        STATUS   mandatory
        DESCRIPTION
            "On remote routes, the address of the next sys-
            tem en route; Otherwise, 0.0.0.0."
        ::= { ipForwardEntry 4 }


    ipForwardIfIndex OBJECT-TYPE
        SYNTAX   INTEGER
        ACCESS   read-write
        STATUS   mandatory
        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
                 }
        ACCESS   read-write
        STATUS   mandatory
        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 destina-
            tion.

            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 iden-
            tified    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 current-
            ly  in  use.  Proper interpretation of such en-
            tries requires examination of the relevant  ip-
            ForwardType 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
                 }
        ACCESS   read-only
        STATUS   mandatory
        DESCRIPTION
            "The routing mechanism via which this route was
            learned.  Inclusion of values for gateway rout-
            ing protocols is not  intended  to  imply  that
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```
            hosts should support those protocols."
        ::= { ipForwardEntry 7 }


    ipForwardAge OBJECT-TYPE
        SYNTAX   INTEGER
        ACCESS   read-only
        STATUS   mandatory
        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
        ACCESS   read-write
        STATUS   mandatory
        DESCRIPTION
            "A reference to MIB definitions specific to the
            particular  routing protocol which is responsi-
            ble 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  identif-
            ier, and any implementation conforming to ASN.1
            and the Basic Encoding Rules must  be  able  to
            generate and recognize this value."
        DEFVAL  { { 0 0 } } -- 0.0
        ::= { ipForwardEntry 9 }


    ipForwardNextHopAS OBJECT-TYPE
        SYNTAX   INTEGER
        ACCESS   read-write
        STATUS   mandatory
        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   INTEGER
            ACCESS   read-write
            STATUS   mandatory
            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   INTEGER
            ACCESS   read-write
            STATUS   mandatory
            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   INTEGER
            ACCESS   read-write
            STATUS   mandatory
            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   INTEGER
            ACCESS   read-write
            STATUS   mandatory
            DESCRIPTION
               "An alternate routing metric  for  this  route.
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            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   INTEGER
        ACCESS   read-write
        STATUS   mandatory
        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 }

END
```

5. Acknowledgements

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Chris Gunner (DEC) and Keith McCloghrie (Hughes LAN Systems) made significant comments on it, and it is better for their input.

6. References

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7. Security Considerations

Security issues are not discussed in this memo.

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