Status of this Memo

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

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.

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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 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
-- 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 destination, 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
    \[Page 4\]
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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 ipForwardDest."

\[
\text{DEFVAL} \{ '00000000'h \} \quad \text{-- 0.0.0.0}
\]

::= { 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 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.

<table>
<thead>
<tr>
<th>PRECEDENCE</th>
<th>TYPE OF SERVICE</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>IP TOS Field</th>
<th>Policy Code</th>
<th>IP TOS Field</th>
<th>Policy Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 0 0 0 ==&gt; 0</td>
<td>0</td>
<td>0 0 0 1 ==&gt; 2</td>
<td></td>
</tr>
<tr>
<td>0 0 1 0 ==&gt; 4</td>
<td></td>
<td>0 0 1 1 ==&gt; 6</td>
<td></td>
</tr>
<tr>
<td>0 1 0 0 ==&gt; 8</td>
<td></td>
<td>0 1 0 1 ==&gt; 10</td>
<td></td>
</tr>
</tbody>
</table>
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
ACCESS   read-only
STATUS   mandatory
DESCRIPTION
"On remote routes, the address of the next system 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 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
}

ACCESS read-only
STATUS mandatory
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   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. 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 )
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

This document was produced by the Router Requirements Working Group, of which Phil Almquist is the chair.

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

6. References


Security Considerations

Security issues are not discussed in this memo.

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