Network Working Group
Request for Comments: 1213
Obsoletes: RFC 1158

K. McCloghrie
Hughes LAN Systems, Inc.
M. Rose
Performance Systems International
Editors

March 1991

Management Information Base for Network Management of TCP/IP-based internets: MIB-II

Status of this Memo

This memo defines the second version of the Management Information Base (MIB-II) for use with network management protocols in TCP/IP-based internets. 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.

Table of Contents

1. Abstract

This memo defines the second version of the Management Information Base (MIB-II) for use with network management protocols in TCP/IP-based internets. In particular, together with its companion memos which describe the structure of management information (RFC 1155) along with the network management protocol (RFC 1157) for TCP/IP-based internets, these documents provide a simple, workable architecture and system for managing TCP/IP-based internets and in particular the Internet community.

2. Introduction

As reported in RFC 1052, IAB Recommendations for the Development of Internet Network Management Standards [1], a two-prong strategy for network management of TCP/IP-based internets was undertaken. In the short-term, the Simple Network Management Protocol (SNMP) was to be used to manage nodes in the Internet community. In the long-term, the use of the OSI network management framework was to be examined. Two documents were produced to define the management information: RFC 1065, which defined the Structure of Management Information (SMI) [2], and RFC 1066, which defined the Management Information Base (MIB) [3]. Both of these documents were designed so as to be compatible with both the SNMP and the OSI network management framework.

This strategy was quite successful in the short-term: Internet-based network management technology was fielded, by both the research and commercial communities, within a few months. As a result of this, portions of the Internet community became network manageable in a timely fashion.

As reported in RFC 1109, Report of the Second Ad Hoc Network Management Review Group [4], the requirements of the SNMP and the OSI

network management frameworks were more different than anticipated. As such, the requirement for compatibility between the SMI/MIB and both frameworks was suspended. This action permitted the operational network management framework, the SNMP, to respond to new operational needs in the Internet community by producing this document.

As such, the current network management framework for TCP/IP- based internets consists of: Structure and Identification of Management Information for TCP/IP-based internets, RFC 1155 [12], which describes how managed objects contained in the MIB are defined; Management Information Base for Network Management of TCP/IP-based internets: MIB-II, this memo, which describes the managed objects contained in the MIB (and supercedes RFC 1156 [13]); and, the Simple Network Management Protocol, RFC 1098 [5], which defines the protocol used to manage these objects.

3. Changes from RFC 1156

Features of this MIB include:

(1) incremental additions to reflect new operational requirements;

(2) upwards compatibility with the SMI/MIB and the SNMP;

(3) improved support for multi-protocol entities; and,

(4) textual clean-up of the MIB to improve clarity and readability.

The objects defined in MIB-II have the OBJECT IDENTIFIER prefix:

```
mib-2      OBJECT IDENTIFIER ::= { mgmt 1 }
```

which is identical to the prefix used in MIB-I.

3.1. Deprecated Objects

In order to better prepare implementors for future changes in the MIB, a new term "deprecated" may be used when describing an object. A deprecated object in the MIB is one which must be supported, but one which will most likely be removed from the next version of the MIB (e.g., MIB-III).

MIB-II marks one object as being deprecated:

```
atTable
```

As a result of deprecating the atTable object, the entire Address Translation group is deprecated.

Note that no functionality is lost with the deprecation of these objects: new objects providing equivalent or superior functionality are defined in MIB-II.

3.2. Display Strings

In the past, there have been misinterpretations of the MIB as to when a string of octets should contain printable characters, meant to be displayed to a human. As a textual convention in the MIB, the datatype

```
DisplayString ::=
    OCTET STRING
```

is introduced. A DisplayString is restricted to the NVT ASCII character set, as defined in pages 10-11 of [6].

The following objects are now defined in terms of DisplayString:

```
sysDescr
ifDescr
```

It should be noted that this change has no effect on either the syntax nor semantics of these objects. The use of the DisplayString notation is merely an artifact of the explanatory method used in MIB-II and future MIBs.

Further it should be noted that any object defined in terms of OCTET STRING may contain arbitrary binary data, in which each octet may take any value from 0 to 255 (decimal).

3.3. Physical Addresses

As a further, textual convention in the MIB, the datatype

```
PhysAddress ::=
    OCTET STRING
```

is introduced to represent media- or physical-level addresses.

The following objects are now defined in terms of PhysAddress:

```
ifPhysAddress
atPhysAddress
ipNetToMediaPhysAddress
```

It should be noted that this change has no effect on either the syntax nor semantics of these objects. The use of the PhysAddress notation is merely an artifact of the explanatory method used in MIB-II and future MIBs.

3.4. The System Group

Four new objects are added to this group:

- sysContact
- sysName
- sysLocation
- sysServices

These provide contact, administrative, location, and service information regarding the managed node.

3.5. The Interfaces Group

The definition of the ifNumber object was incorrect, as it required all interfaces to support IP. (For example, devices without IP, such as MAC-layer bridges, could not be managed if this definition was strictly followed.) The description of the ifNumber object is changed accordingly.

The ifTable object was mistaken marked as read-write, it has been (correctly) re-designated as not-accessible. In addition, several new values have been added to the ifType column in the ifTable object:

- ppp(23)
- softwareLoopback(24)
- eon(25)
- ethernet-3Mbit(26)
- nsip(27)
- slip(28)
- ultra(29)
- ds3(30)
- sip(31)
- frame-relay(32)

Finally, a new column has been added to the ifTable object:

- ifSpecific

which provides information about information specific to the media being used to realize the interface.

3.6. The Address Translation Group

In MIB-I this group contained a table which permitted mappings from network addresses (e.g., IP addresses) to physical addresses (e.g., MAC addresses). Experience has shown that efficient implementations of this table make two assumptions: a single network protocol environment, and mappings occur only from network address to physical address.

The need to support multi-protocol nodes (e.g., those with both the IP and CLNP active), and the need to support the inverse mapping (e.g., for ES-IS), have invalidated both of these assumptions. As such, the atTable object is declared deprecated.

In order to meet both the multi-protocol and inverse mapping requirements, MIB-II and its successors will allocate up to two address translation tables inside each network protocol group. That is, the IP group will contain one address translation table, for going from IP addresses to physical addresses. Similarly, when a document defining MIB objects for the CLNP is produced (e.g., [7]), it will contain two tables, for mappings in both directions, as this is required for full functionality.

It should be noted that the choice of two tables (one for each direction of mapping) provides for ease of implementation in many cases, and does not introduce undue burden on implementations which realize the address translation abstraction through a single internal table.

3.7. The IP Group

The access attribute of the variable ipForwarding has been changed from read-only to read-write.

In addition, there is a new column to the ipAddrTable object,

```
ipAdEntReasmMaxSize
```

which keeps track of the largest IP datagram that can be re-assembled on a particular interface.

The descriptor of the ipRoutingTable object has been changed to ipRouteTable for consistency with the other IP routing objects. There are also three new columns in the ipRouteTable object,

```
ipRouteMask
ipRouteMetric5
ipRouteInfo
```

the first is used for IP routing subsystems that support arbitrary subnet masks, and the latter two are IP routing protocol-specific.

Two new objects are added to the IP group:

ipNetToMediaTable
ipRoutingDiscards

the first is the address translation table for the IP group (providing identical functionality to the now deprecated atTable in the address translation group), and the latter provides information when routes are lost due to a lack of buffer space.

3.8. The ICMP Group

There are no changes to this group.

3.9. The TCP Group

Two new variables are added:

tcpInErrs
tcpOutRsts

which keep track of the number of incoming TCP segments in error and the number of resets generated by a TCP.

3.10. The UDP Group

A new table:

udpTable

is added.

3.11. The EGP Group

Experience has indicated a need for additional objects that are useful in EGP monitoring. In addition to making several additions to the egpNeighborTable object, i.e.,

egpNeighAs
egpNeighInMsgs
egpNeighInErrs
egpNeighOutMsgs
egpNeighOutErrs
egpNeighInErrMsgs
egpNeighOutErrMsgs

```
egpNeighStateUps
egpNeighStateDowns
egpNeighIntervalHello
egpNeighIntervalPoll
egpNeighMode
egpNeighEventTrigger
```

a new variable is added:

```
egpAs
```

which gives the autonomous system associated with this EGP entity.

3.12. The Transmission Group

MIB-I was lacking in that it did not distinguish between different types of transmission media. A new group, the Transmission group, is allocated for this purpose:

```
transmission OBJECT IDENTIFIER ::= { mib-2 10 }
```

When Internet-standard definitions for managing transmission media are defined, the transmission group is used to provide a prefix for the names of those objects.

Typically, such definitions reside in the experimental portion of the MIB until they are "proven", then as a part of the Internet standardization process, the definitions are accordingly elevated and a new object identifier, under the transmission group is defined. By convention, the name assigned is:

```
type OBJECT IDENTIFIER ::= { transmission number }
```

where "type" is the symbolic value used for the media in the ifType column of the ifTable object, and "number" is the actual integer value corresponding to the symbol.

3.13. The SNMP Group

The application-oriented working groups of the IETF have been tasked to be receptive towards defining MIB variables specific to their respective applications.

For the SNMP, it is useful to have statistical information. A new group, the SNMP group, is allocated for this purpose:

```
snmp   OBJECT IDENTIFIER ::= { mib-2 11 }
```

3.14. Changes from RFC 1158

Features of this MIB include:

(1) The managed objects in this document have been defined using the conventions defined in the Internet-standard SMI, as amended by the extensions specified in [14]. It must be emphasized that definitions made using these extensions are semantically identically to those in RFC 1158.

(2) The PhysAddress textual convention has been introduced to represent media addresses.

(3) The ACCESS clause of sysLocation is now read-write.

(4) The definition of sysServices has been clarified.

(5) New ifType values (29-32) have been defined. In addition, the textual-descriptor for the DS1 and E1 interface types has been corrected.

(6) The definition of ipForwarding has been clarified.

(7) The definition of ipRouteType has been clarified.

(8) The ipRouteMetric5 and ipRouteInfo objects have been defined.

(9) The ACCESS clause of tcpConnState is now read-write, to support deletion of the TCB associated with a TCP connection. The definition of this object has been clarified to explain this usage.

(10) The definition of egpNeighEventTrigger has been clarified.

(11) The definition of several of the variables in the new snmp group have been clarified. In addition, the snmpInBadTypes and snmpOutReadOnlys objects are no longer present. (However, the object identifiers associated with those objects are reserved to prevent future use.)

(12) The definition of snmpInReadOnlys has been clarified.

(13) The textual descriptor of the snmpEnableAuthTraps has been changed to snmpEnableAuthenTraps, and the definition has been clarified.

(14) The ipRoutingDiscards object was added.

(15) The optional use of an implementation-dependent, small positive integer was disallowed when identifying instances of the IP address and routing tables.

4. 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) [8] 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 [12] 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 [9], subject to the additional requirements imposed by the SNMP.

4.1. Format of Definitions

Section 6 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 [14].

5. Overview

Consistent with the IAB directive to produce simple, workable systems in the short-term, the list of managed objects defined here, has been derived by taking only those elements which are considered essential.

This approach of taking only the essential objects is NOT restrictive, since the SMI defined in the companion memo provides

three extensibility mechanisms: one, the addition of new standard objects through the definitions of new versions of the MIB; two, the addition of widely-available but non-standard objects through the experimental subtree; and three, the addition of private objects through the enterprises subtree. Such additional objects can not only be used for vendor-specific elements, but also for experimentation as required to further the knowledge of which other objects are essential.

The design of MIB-II is heavily influenced by the first extensibility mechanism. Several new variables have been added based on operational experience and need. Based on this, the criteria for including an object in MIB-II are remarkably similar to the MIB-I criteria:

(1) An object needed to be essential for either fault or configuration management.

(2) Only weak control objects were permitted (by weak, it is meant that tampering with them can do only limited damage). This criterion reflects the fact that the current management protocols are not sufficiently secure to do more powerful control operations.

(3) Evidence of current use and utility was required.

(4) In MIB-I, an attempt was made to limit the number of objects to about 100 to make it easier for vendors to fully instrument their software. In MIB-II, this limit was raised given the wide technological base now implementing MIB-I.

(5) To avoid redundant variables, it was required that no object be included that can be derived from others in the MIB.

(6) Implementation specific objects (e.g., for BSD UNIX) were excluded.

(7) It was agreed to avoid heavily instrumenting critical sections of code. The general guideline was one counter per critical section per layer.

MIB-II, like its predecessor, the Internet-standard MIB, contains only essential elements. There is no need to allow individual objects to be optional. Rather, the objects are arranged into the following groups:

- System
- Interfaces
- Address Translation (deprecated)
- IP
- ICMP
- TCP
- UDP
- EGP
- Transmission
- SNMP

These groups are the basic unit of conformance: This method is as follows: if the semantics of a group is applicable to an implementation, then it must implement all objects in that group. For example, an implementation must implement the EGP group if and only if it implements the EGP.

There are two reasons for defining these groups: to provide a means of assigning object identifiers; and, to provide a method for implementations of managed agents to know which objects they must implement.

6. Definitions

```
        RFC1213-MIB DEFINITIONS ::= BEGIN

        IMPORTS
                mgmt, NetworkAddress, IpAddress, Counter, Gauge,
                        TimeTicks
                    FROM RFC1155-SMI
                OBJECT-TYPE
                        FROM RFC-1212;

        --  This MIB module uses the extended OBJECT-TYPE macro as
        --  defined in [14];


        --  MIB-II (same prefix as MIB-I)

        mib-2      OBJECT IDENTIFIER ::= { mgmt 1 }

        -- textual conventions

        DisplayString ::=
            OCTET STRING
        -- This data type is used to model textual information taken
        -- from the NVT ASCII character set.  By convention, objects
        -- with this syntax are declared as having
```

```
--
--      SIZE (0..255)

PhysAddress ::=
    OCTET STRING
-- This data type is used to model media addresses.  For many
-- types of media, this will be in a binary representation.
-- For example, an ethernet address would be represented as
-- a string of 6 octets.


-- groups in MIB-II

system       OBJECT IDENTIFIER ::= { mib-2 1 }

interfaces   OBJECT IDENTIFIER ::= { mib-2 2 }

at           OBJECT IDENTIFIER ::= { mib-2 3 }

ip           OBJECT IDENTIFIER ::= { mib-2 4 }

icmp         OBJECT IDENTIFIER ::= { mib-2 5 }

tcp          OBJECT IDENTIFIER ::= { mib-2 6 }

udp          OBJECT IDENTIFIER ::= { mib-2 7 }

egp          OBJECT IDENTIFIER ::= { mib-2 8 }

-- historical (some say hysterical)
-- cmot      OBJECT IDENTIFIER ::= { mib-2 9 }

transmission OBJECT IDENTIFIER ::= { mib-2 10 }

snmp         OBJECT IDENTIFIER ::= { mib-2 11 }


-- the System group

-- Implementation of the System group is mandatory for all
-- systems.  If an agent is not configured to have a value
-- for any of these variables, a string of length 0 is
-- returned.

sysDescr OBJECT-TYPE
    SYNTAX  DisplayString (SIZE (0..255))
    ACCESS  read-only
    STATUS  mandatory
```

```
            DESCRIPTION
                    "A textual description of the entity.  This value
                    should include the full name and version
                    identification of the system's hardware type,
                    software operating-system, and networking
                    software.  It is mandatory that this only contain
                    printable ASCII characters."
            ::= { system 1 }

        sysObjectID OBJECT-TYPE
            SYNTAX  OBJECT IDENTIFIER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The vendor's authoritative identification of the
                    network management subsystem contained in the
                    entity.  This value is allocated within the SMI
                    enterprises subtree (1.3.6.1.4.1) and provides an
                    easy and unambiguous means for determining 'what
                    kind of box' is being managed.  For example, if
                    vendor 'Flintstones, Inc.' was assigned the
                    subtree 1.3.6.1.4.1.4242, it could assign the
                    identifier 1.3.6.1.4.1.4242.1.1 to its 'Fred
                    Router'."
            ::= { system 2 }

        sysUpTime OBJECT-TYPE
            SYNTAX  TimeTicks
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The time (in hundredths of a second) since the
                    network management portion of the system was last
                    re-initialized."
            ::= { system 3 }

        sysContact OBJECT-TYPE
            SYNTAX  DisplayString (SIZE (0..255))
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The textual identification of the contact person
                    for this managed node, together with information
                    on how to contact this person."
            ::= { system 4 }

        sysName OBJECT-TYPE
            SYNTAX  DisplayString (SIZE (0..255))
```

```
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "An administratively-assigned name for this
                    managed node.  By convention, this is the node's
                    fully-qualified domain name."
            ::= { system 5 }

        sysLocation OBJECT-TYPE
            SYNTAX  DisplayString (SIZE (0..255))
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The physical location of this node (e.g.,
                    'telephone closet, 3rd floor')."
            ::= { system 6 }

        sysServices OBJECT-TYPE
            SYNTAX  INTEGER (0..127)
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "A value which indicates the set of services that
                    this entity primarily offers.

                    The value is a sum.  This sum initially takes the
                    value zero, Then, for each layer, L, in the range
                    1 through 7, that this node performs transactions
                    for, 2 raised to (L - 1) is added to the sum.  For
                    example, a node which performs primarily routing
                    functions would have a value of 4 (2^(3-1)).  In
                    contrast, a node which is a host offering
                    application services would have a value of 72
                    (2^(4-1) + 2^(7-1)).  Note that in the context of
                    the Internet suite of protocols, values should be
                    calculated accordingly:

                         layer  functionality
                             1  physical (e.g., repeaters)
                             2  datalink/subnetwork (e.g., bridges)
                             3  internet (e.g., IP gateways)
                             4  end-to-end  (e.g., IP hosts)
                             7  applications (e.g., mail relays)

                    For systems including OSI protocols, layers 5 and
                    6 may also be counted."
            ::= { system 7 }
```

```
        -- the Interfaces group

        -- Implementation of the Interfaces group is mandatory for
        -- all systems.

        ifNumber OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of network interfaces (regardless of
                    their current state) present on this system."
            ::= { interfaces 1 }


        -- the Interfaces table

        -- The Interfaces table contains information on the entity's
        -- interfaces.  Each interface is thought of as being
        -- attached to a 'subnetwork'.  Note that this term should
        -- not be confused with 'subnet' which refers to an
        -- addressing partitioning scheme used in the Internet suite
        -- of protocols.

        ifTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF IfEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "A list of interface entries.  The number of
                    entries is given by the value of ifNumber."
            ::= { interfaces 2 }

        ifEntry OBJECT-TYPE
            SYNTAX  IfEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "An interface entry containing objects at the
                    subnetwork layer and below for a particular
                    interface."
            INDEX   { ifIndex }
            ::= { ifTable 1 }

        IfEntry ::=
            SEQUENCE {
                ifIndex
                    INTEGER,
```

```
                ifDescr
                    DisplayString,
                ifType
                    INTEGER,
                ifMtu
                    INTEGER,
                ifSpeed
                    Gauge,
                ifPhysAddress
                    PhysAddress,
                ifAdminStatus
                    INTEGER,
                ifOperStatus
                    INTEGER,
                ifLastChange
                    TimeTicks,
                ifInOctets
                    Counter,
                ifInUcastPkts
                    Counter,
                ifInNUcastPkts
                    Counter,
                ifInDiscards
                    Counter,
                ifInErrors
                    Counter,
                ifInUnknownProtos
                    Counter,
                ifOutOctets
                    Counter,
                ifOutUcastPkts
                    Counter,
                ifOutNUcastPkts
                    Counter,
                ifOutDiscards
                    Counter,
                ifOutErrors
                    Counter,
                ifOutQLen
                    Gauge,
                ifSpecific
                    OBJECT IDENTIFIER
            }

        ifIndex OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
```

```
            DESCRIPTION
                    "A unique value for each interface.  Its value
                    ranges between 1 and the value of ifNumber.  The
                    value for each interface must remain constant at
                    least from one re-initialization of the entity's
                    network management system to the next re-
                    initialization."
            ::= { ifEntry 1 }

        ifDescr OBJECT-TYPE
            SYNTAX  DisplayString (SIZE (0..255))
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "A textual string containing information about the
                    interface.  This string should include the name of
                    the manufacturer, the product name and the version
                    of the hardware interface."
            ::= { ifEntry 2 }

        ifType OBJECT-TYPE
            SYNTAX  INTEGER {
                        other(1),           -- none of the following
                        regular1822(2),
                        hdh1822(3),
                        ddn-x25(4),
                        rfc877-x25(5),
                        ethernet-csmacd(6),
                        iso88023-csmacd(7),
                        iso88024-tokenBus(8),
                        iso88025-tokenRing(9),
                        iso88026-man(10),
                        starLan(11),
                        proteon-10Mbit(12),
                        proteon-80Mbit(13),
                        hyperchannel(14),
                        fddi(15),
                        lapb(16),
                        sdlc(17),
                        ds1(18),            -- T-1
                        e1(19),             -- european equiv. of T-1
                        basicISDN(20),
                        primaryISDN(21),    -- proprietary serial
                        propPointToPointSerial(22),
                        ppp(23),
                        softwareLoopback(24),
                        eon(25),             -- CLNP over IP [11]
                        ethernet-3Mbit(26),
```

```
                    nsip(27),           -- XNS over IP
                    slip(28),           -- generic SLIP
                    ultra(29),          -- ULTRA technologies
                    ds3(30),            -- T-3
                    sip(31),            -- SMDS
                    frame-relay(32)
                }
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The type of interface, distinguished according to
                    the physical/link protocol(s) immediately 'below'
                    the network layer in the protocol stack."
            ::= { ifEntry 3 }

        ifMtu OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The size of the largest datagram which can be
                    sent/received on the interface, specified in
                    octets.  For interfaces that are used for
                    transmitting network datagrams, this is the size
                    of the largest network datagram that can be sent
                    on the interface."
            ::= { ifEntry 4 }

        ifSpeed OBJECT-TYPE
            SYNTAX  Gauge
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "An estimate of the interface's current bandwidth
                    in bits per second.  For interfaces which do not
                    vary in bandwidth or for those where no accurate
                    estimation can be made, this object should contain
                    the nominal bandwidth."
            ::= { ifEntry 5 }

        ifPhysAddress OBJECT-TYPE
            SYNTAX  PhysAddress
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The interface's address at the protocol layer
                    immediately 'below' the network layer in the
                    protocol stack.  For interfaces which do not have
```

```
                such an address (e.g., a serial line), this object
                should contain an octet string of zero length."
        ::= { ifEntry 6 }

    ifAdminStatus OBJECT-TYPE
        SYNTAX  INTEGER {
                    up(1),       -- ready to pass packets
                    down(2),
                    testing(3)   -- in some test mode
                }
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The desired state of the interface.  The
                testing(3) state indicates that no operational
                packets can be passed."
        ::= { ifEntry 7 }

    ifOperStatus OBJECT-TYPE
        SYNTAX  INTEGER {
                    up(1),       -- ready to pass packets
                    down(2),
                    testing(3)   -- in some test mode
                }
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The current operational state of the interface.
                The testing(3) state indicates that no operational
                packets can be passed."
        ::= { ifEntry 8 }

    ifLastChange OBJECT-TYPE
        SYNTAX  TimeTicks
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The value of sysUpTime at the time the interface
                entered its current operational state.  If the
                current state was entered prior to the last re-
                initialization of the local network management
                subsystem, then this object contains a zero
                value."
        ::= { ifEntry 9 }

    ifInOctets OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
```

```
            STATUS  mandatory
            DESCRIPTION
                    "The total number of octets received on the
                    interface, including framing characters."
            ::= { ifEntry 10 }

        ifInUcastPkts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of subnetwork-unicast packets
                    delivered to a higher-layer protocol."
            ::= { ifEntry 11 }

        ifInNUcastPkts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of non-unicast (i.e., subnetwork-
                    broadcast or subnetwork-multicast) packets
                    delivered to a higher-layer protocol."
            ::= { ifEntry 12 }

        ifInDiscards OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of inbound packets which were chosen
                    to be discarded even though no errors had been
                    detected to prevent their being deliverable to a
                    higher-layer protocol.  One possible reason for
                    discarding such a packet could be to free up
                    buffer space."
            ::= { ifEntry 13 }

        ifInErrors OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of inbound packets that contained
                    errors preventing them from being deliverable to a
                    higher-layer protocol."
            ::= { ifEntry 14 }
```

```
        ifInUnknownProtos OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of packets received via the interface
                    which were discarded because of an unknown or
                    unsupported protocol."
            ::= { ifEntry 15 }

        ifOutOctets OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of octets transmitted out of the
                    interface, including framing characters."
            ::= { ifEntry 16 }

        ifOutUcastPkts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of packets that higher-level
                    protocols requested be transmitted to a
                    subnetwork-unicast address, including those that
                    were discarded or not sent."
            ::= { ifEntry 17 }

        ifOutNUcastPkts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of packets that higher-level
                    protocols requested be transmitted to a non-
                    unicast (i.e., a subnetwork-broadcast or
                    subnetwork-multicast) address, including those
                    that were discarded or not sent."
            ::= { ifEntry 18 }

        ifOutDiscards OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of outbound packets which were chosen
```

```
                to be discarded even though no errors had been
                detected to prevent their being transmitted.  One
                possible reason for discarding such a packet could
                be to free up buffer space."
        ::= { ifEntry 19 }

    ifOutErrors OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of outbound packets that could not be
                transmitted because of errors."
        ::= { ifEntry 20 }

    ifOutQLen OBJECT-TYPE
        SYNTAX  Gauge
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The length of the output packet queue (in
                packets)."
        ::= { ifEntry 21 }

    ifSpecific OBJECT-TYPE
        SYNTAX  OBJECT IDENTIFIER
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "A reference to MIB definitions specific to the
                particular media being used to realize the
                interface.  For example, if the interface is
                realized by an ethernet, then the value of this
                object refers to a document defining objects
                specific to ethernet.  If this information is not
                present, its value should be set to the OBJECT
                IDENTIFIER { 0 0 }, which is a syntatically valid
                object identifier, and any conformant
                implementation of ASN.1 and BER must be able to
                generate and recognize this value."
        ::= { ifEntry 22 }


    -- the Address Translation group

    -- Implementation of the Address Translation group is
    -- mandatory for all systems.  Note however that this group
    -- is deprecated by MIB-II. That is, it is being included
```

```
        -- solely for compatibility with MIB-I nodes, and will most
        -- likely be excluded from MIB-III nodes.  From MIB-II and
        -- onwards, each network protocol group contains its own
        -- address translation tables.

        -- The Address Translation group contains one table which is
        -- the union across all interfaces of the translation tables
        -- for converting a NetworkAddress (e.g., an IP address) into
        -- a subnetwork-specific address.  For lack of a better term,
        -- this document refers to such a subnetwork-specific address
        -- as a 'physical' address.

        -- Examples of such translation tables are: for broadcast
        -- media where ARP is in use, the translation table is
        -- equivalent to the ARP cache; or, on an X.25 network where
        -- non-algorithmic translation to X.121 addresses is
        -- required, the translation table contains the
        -- NetworkAddress to X.121 address equivalences.

        atTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF AtEntry
            ACCESS  not-accessible
            STATUS  deprecated
            DESCRIPTION
                    "The Address Translation tables contain the
                    NetworkAddress to 'physical' address equivalences.
                    Some interfaces do not use translation tables for
                    determining address equivalences (e.g., DDN-X.25
                    has an algorithmic method); if all interfaces are
                    of this type, then the Address Translation table
                    is empty, i.e., has zero entries."
            ::= { at 1 }

        atEntry OBJECT-TYPE
            SYNTAX  AtEntry
            ACCESS  not-accessible
            STATUS  deprecated
            DESCRIPTION
                    "Each entry contains one NetworkAddress to
                    'physical' address equivalence."
            INDEX   { atIfIndex,
                      atNetAddress }
            ::= { atTable 1 }

        AtEntry ::=
            SEQUENCE {
                atIfIndex
                    INTEGER,
```

```
                atPhysAddress
                    PhysAddress,
                atNetAddress
                    NetworkAddress
            }

        atIfIndex OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-write
            STATUS  deprecated
            DESCRIPTION
                    "The interface on which this entry's equivalence
                    is effective.  The interface identified by a
                    particular value of this index is the same
                    interface as identified by the same value of
                    ifIndex."
            ::= { atEntry 1 }

        atPhysAddress OBJECT-TYPE
            SYNTAX  PhysAddress
            ACCESS  read-write
            STATUS  deprecated
            DESCRIPTION
                    "The media-dependent 'physical' address.

                    Setting this object to a null string (one of zero
                    length) has the effect of invaliding the
                    corresponding entry in the atTable object.  That
                    is, it effectively dissasociates the interface
                    identified with said entry from the mapping
                    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 atPhysAddress object."
            ::= { atEntry 2 }

        atNetAddress OBJECT-TYPE
            SYNTAX  NetworkAddress
            ACCESS  read-write
            STATUS  deprecated
            DESCRIPTION
                    "The NetworkAddress (e.g., the IP address)
                    corresponding to the media-dependent 'physical'
                    address."
```

```
        ::= { atEntry 3 }


    -- the IP group

    -- Implementation of the IP group is mandatory for all
    -- systems.

    ipForwarding OBJECT-TYPE
        SYNTAX  INTEGER {
                    forwarding(1),    -- acting as a gateway
                    not-forwarding(2) -- NOT acting as a gateway
                }
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The indication of whether this entity is acting
                as an IP gateway in respect to the forwarding of
                datagrams received by, but not addressed to, this
                entity.  IP gateways forward datagrams.  IP hosts
                do not (except those source-routed via the host).

                Note that for some managed nodes, this object may
                take on only a subset of the values possible.
                Accordingly, it is appropriate for an agent to
                return a 'badValue' response if a management
                station attempts to change this object to an
                inappropriate value."
        ::= { ip 1 }

    ipDefaultTTL OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The default value inserted into the Time-To-Live
                field of the IP header of datagrams originated at
                this entity, whenever a TTL value is not supplied
                by the transport layer protocol."
        ::= { ip 2 }

    ipInReceives OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of input datagrams received from
                interfaces, including those received in error."
```

```
            ::= { ip 3 }

        ipInHdrErrors OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of input datagrams discarded due to
                    errors in their IP headers, including bad
                    checksums, version number mismatch, other format
                    errors, time-to-live exceeded, errors discovered
                    in processing their IP options, etc."
            ::= { ip 4 }

        ipInAddrErrors OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of input datagrams discarded because
                    the IP address in their IP header's destination
                    field was not a valid address to be received at
                    this entity.  This count includes invalid
                    addresses (e.g., 0.0.0.0) and addresses of
                    unsupported Classes (e.g., Class E).  For entities
                    which are not IP Gateways and therefore do not
                    forward datagrams, this counter includes datagrams
                    discarded because the destination address was not
                    a local address."
            ::= { ip 5 }

        ipForwDatagrams OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of input datagrams for which this
                    entity was not their final IP destination, as a
                    result of which an attempt was made to find a
                    route to forward them to that final destination.
                    In entities which do not act as IP Gateways, this
                    counter will include only those packets which were
                    Source-Routed via this entity, and the Source-
                    Route option processing was successful."
            ::= { ip 6 }

        ipInUnknownProtos OBJECT-TYPE
            SYNTAX  Counter
```

```
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of locally-addressed datagrams
                    received successfully but discarded because of an
                    unknown or unsupported protocol."
            ::= { ip 7 }

        ipInDiscards OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of input IP datagrams for which no
                    problems were encountered to prevent their
                    continued processing, but which were discarded
                    (e.g., for lack of buffer space).  Note that this
                    counter does not include any datagrams discarded
                    while awaiting re-assembly."
            ::= { ip 8 }

        ipInDelivers OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of input datagrams successfully
                    delivered to IP user-protocols (including ICMP)."
            ::= { ip 9 }

        ipOutRequests OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of IP datagrams which local IP
                    user-protocols (including ICMP) supplied to IP in
                    requests for transmission.  Note that this counter
                    does not include any datagrams counted in
                    ipForwDatagrams."
            ::= { ip 10 }

        ipOutDiscards OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of output IP datagrams for which no
```

```
                problem was encountered to prevent their
                transmission to their destination, but which were
                discarded (e.g., for lack of buffer space).  Note
                that this counter would include datagrams counted
                in ipForwDatagrams if any such packets met this
                (discretionary) discard criterion."
        ::= { ip 11 }

    ipOutNoRoutes OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP datagrams discarded because no
                route could be found to transmit them to their
                destination.  Note that this counter includes any
                packets counted in ipForwDatagrams which meet this
                'no-route' criterion.  Note that this includes any
                datagarms which a host cannot route because all of
                its default gateways are down."
        ::= { ip 12 }

    ipReasmTimeout OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The maximum number of seconds which received
                fragments are held while they are awaiting
                reassembly at this entity."
        ::= { ip 13 }

    ipReasmReqds OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP fragments received which needed
                to be reassembled at this entity."
        ::= { ip 14 }

    ipReasmOKs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP datagrams successfully re-
                assembled."
```

```
        ::= { ip 15 }

    ipReasmFails OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of failures detected by the IP re-
                assembly algorithm (for whatever reason: timed
                out, errors, etc).  Note that this is not
                necessarily a count of discarded IP fragments
                since some algorithms (notably the algorithm in
                RFC 815) can lose track of the number of fragments
                by combining them as they are received."
        ::= { ip 16 }

    ipFragOKs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP datagrams that have been
                successfully fragmented at this entity."
        ::= { ip 17 }

    ipFragFails OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP datagrams that have been
                discarded because they needed to be fragmented at
                this entity but could not be, e.g., because their
                Don't Fragment flag was set."
        ::= { ip 18 }

    ipFragCreates OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of IP datagram fragments that have
                been generated as a result of fragmentation at
                this entity."
        ::= { ip 19 }
```

```
        -- the IP address table

        -- The IP address table contains this entity's IP addressing
        -- information.

        ipAddrTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF IpAddrEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "The table of addressing information relevant to
                    this entity's IP addresses."
            ::= { ip 20 }

        ipAddrEntry OBJECT-TYPE
            SYNTAX  IpAddrEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "The addressing information for one of this
                    entity's IP addresses."
            INDEX   { ipAdEntAddr }
            ::= { ipAddrTable 1 }

        IpAddrEntry ::=
            SEQUENCE {
                ipAdEntAddr
                    IpAddress,
                ipAdEntIfIndex
                    INTEGER,
                ipAdEntNetMask
                    IpAddress,
                ipAdEntBcastAddr
                    INTEGER,
                ipAdEntReasmMaxSize
                    INTEGER (0..65535)
            }

        ipAdEntAddr OBJECT-TYPE
            SYNTAX  IpAddress
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The IP address to which this entry's addressing
                    information pertains."
            ::= { ipAddrEntry 1 }
```

```
        ipAdEntIfIndex OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The index value which uniquely identifies the
                    interface to which this entry is applicable.  The
                    interface identified by a particular value of this
                    index is the same interface as identified by the
                    same value of ifIndex."
            ::= { ipAddrEntry 2 }

        ipAdEntNetMask OBJECT-TYPE
            SYNTAX  IpAddress
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The subnet mask associated with the IP address of
                    this entry.  The value of the mask is an IP
                    address with all the network bits set to 1 and all
                    the hosts bits set to 0."
            ::= { ipAddrEntry 3 }

        ipAdEntBcastAddr OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The value of the least-significant bit in the IP
                    broadcast address used for sending datagrams on
                    the (logical) interface associated with the IP
                    address of this entry.  For example, when the
                    Internet standard all-ones broadcast address is
                    used, the value will be 1.  This value applies to
                    both the subnet and network broadcasts addresses
                    used by the entity on this (logical) interface."
            ::= { ipAddrEntry 4 }

        ipAdEntReasmMaxSize OBJECT-TYPE
            SYNTAX  INTEGER (0..65535)
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The size of the largest IP datagram which this
                    entity can re-assemble from incoming IP fragmented
                    datagrams received on this interface."
            ::= { ipAddrEntry 5 }
```

```
        -- the IP routing table

        -- The IP routing table contains an entry for each route
        -- presently known to this entity.

        ipRouteTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF IpRouteEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "This entity's IP Routing table."
            ::= { ip 21 }

        ipRouteEntry OBJECT-TYPE
            SYNTAX  IpRouteEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "A route to a particular destination."
            INDEX   { ipRouteDest }
            ::= { ipRouteTable 1 }

        IpRouteEntry ::=
            SEQUENCE {
                ipRouteDest
                    IpAddress,
                ipRouteIfIndex
                    INTEGER,
                ipRouteMetric1
                    INTEGER,
                ipRouteMetric2
                    INTEGER,
                ipRouteMetric3
                    INTEGER,
                ipRouteMetric4
                    INTEGER,
                ipRouteNextHop
                    IpAddress,
                ipRouteType
                    INTEGER,
                ipRouteProto
                    INTEGER,
                ipRouteAge
                    INTEGER,
                ipRouteMask
                    IpAddress,
                ipRouteMetric5
                    INTEGER,
```

```
            ipRouteInfo
                OBJECT IDENTIFIER
        }

    ipRouteDest OBJECT-TYPE
        SYNTAX  IpAddress
        ACCESS  read-write
        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.  Multiple routes to a single
                destination can appear in the table, but access to
                such multiple entries is dependent on the table-
                access mechanisms defined by the network
                management protocol in use."
        ::= { ipRouteEntry 1 }

    ipRouteIfIndex OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The index value which uniquely identifies the
                local interface through which the next hop of this
                route should be reached.  The interface identified
                by a particular value of this index is the same
                interface as identified by the same value of
                ifIndex."
        ::= { ipRouteEntry 2 }

    ipRouteMetric1 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
                ipRouteProto value.  If this metric is not used,
                its value should be set to -1."
        ::= { ipRouteEntry 3 }

    ipRouteMetric2 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
                ipRouteProto value.  If this metric is not used,
                its value should be set to -1."
        ::= { ipRouteEntry 4 }

    ipRouteMetric3 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
                ipRouteProto value.  If this metric is not used,
                its value should be set to -1."
        ::= { ipRouteEntry 5 }

    ipRouteMetric4 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
                ipRouteProto value.  If this metric is not used,
                its value should be set to -1."
        ::= { ipRouteEntry 6 }

    ipRouteNextHop OBJECT-TYPE
        SYNTAX  IpAddress
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The IP address of the next hop of this route.
                (In the case of a route bound to an interface
                which is realized via a broadcast media, the value
                of this field is the agent's IP address on that
                interface.)"
        ::= { ipRouteEntry 7 }

    ipRouteType OBJECT-TYPE
        SYNTAX  INTEGER {
                    other(1),        -- none of the following

                    invalid(2),      -- an invalidated route
```

```
                                    -- route to directly
                    direct(3),      -- connected (sub-)network

                                    -- route to a non-local
                    indirect(4)     -- host/network/sub-network
                }
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "The type of route.  Note that the values
                direct(3) and indirect(4) refer to the notion of
                direct and indirect routing in the IP
                architecture.

                Setting this object to the value invalid(2) has
                the effect of invalidating the corresponding entry
                in the ipRouteTable object.  That is, it
                effectively dissasociates 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 ipRouteType object."
        ::= { ipRouteEntry 8 }

    ipRouteProto OBJECT-TYPE
        SYNTAX  INTEGER {
                    other(1),       -- none of the following

                                    -- non-protocol information,
                                    -- e.g., manually configured
                    local(2),       -- entries

                                    -- set via a network
                    netmgmt(3),     -- management protocol

                                    -- obtained via ICMP,
                    icmp(4),        -- e.g., Redirect

                                    -- the remaining values are
                                    -- all gateway routing
                                    -- protocols
                    egp(5),
                    ggp(6),
```

```
                        hello(7),
                        rip(8),
                        is-is(9),
                        es-is(10),
                        ciscoIgrp(11),
                        bbnSpfIgp(12),
                        ospf(13),
                        bgp(14)
                    }
            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."
            ::= { ipRouteEntry 9 }

        ipRouteAge OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-write
            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."
            ::= { ipRouteEntry 10 }

        ipRouteMask 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 ipRouteDest field.  For those systems
                    that do not support arbitrary subnet masks, an
                    agent constructs the value of the ipRouteMask by
                    determining whether the value of the correspondent
                    ipRouteDest field belong to a class-A, B, or C
                    network, and then using one of:

                         mask           network
                         255.0.0.0      class-A
                         255.255.0.0    class-B
                         255.255.255.0  class-C
```

```
                If the value of the ipRouteDest is 0.0.0.0 (a
                default route), then the mask value is also
                0.0.0.0.  It should be noted that all IP routing
                subsystems implicitly use this mechanism."
        ::= { ipRouteEntry 11 }

    ipRouteMetric5 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
                ipRouteProto value.  If this metric is not used,
                its value should be set to -1."
        ::= { ipRouteEntry 12 }

    ipRouteInfo OBJECT-TYPE
        SYNTAX  OBJECT IDENTIFIER
        ACCESS  read-only
        STATUS  mandatory
        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 ipRouteProto value.  If
                this information is not present, its value should
                be set to the OBJECT IDENTIFIER { 0 0 }, which is
                a syntatically valid object identifier, and any
                conformant implementation of ASN.1 and BER must be
                able to generate and recognize this value."
        ::= { ipRouteEntry 13 }


    -- the IP Address Translation table

    -- The IP address translation table contain the IpAddress to
    -- 'physical' address equivalences.  Some interfaces do not
    -- use translation tables for determining address
    -- equivalences (e.g., DDN-X.25 has an algorithmic method);
    -- if all interfaces are of this type, then the Address
    -- Translation table is empty, i.e., has zero entries.

    ipNetToMediaTable OBJECT-TYPE
        SYNTAX  SEQUENCE OF IpNetToMediaEntry
        ACCESS  not-accessible
        STATUS  mandatory
```

```
            DESCRIPTION
                    "The IP Address Translation table used for mapping
                    from IP addresses to physical addresses."
            ::= { ip 22 }

        ipNetToMediaEntry OBJECT-TYPE
            SYNTAX  IpNetToMediaEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "Each entry contains one IpAddress to ‘physical’
                    address equivalence."
            INDEX   { ipNetToMediaIfIndex,
                      ipNetToMediaNetAddress }
            ::= { ipNetToMediaTable 1 }

        IpNetToMediaEntry ::=
            SEQUENCE {
                ipNetToMediaIfIndex
                    INTEGER,
                ipNetToMediaPhysAddress
                    PhysAddress,
                ipNetToMediaNetAddress
                    IpAddress,
                ipNetToMediaType
                    INTEGER
            }

        ipNetToMediaIfIndex OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The interface on which this entry’s equivalence
                    is effective.  The interface identified by a
                    particular value of this index is the same
                    interface as identified by the same value of
                    ifIndex."
            ::= { ipNetToMediaEntry 1 }

        ipNetToMediaPhysAddress OBJECT-TYPE
            SYNTAX  PhysAddress
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The media-dependent ‘physical’ address."
            ::= { ipNetToMediaEntry 2 }
```

```
        ipNetToMediaNetAddress OBJECT-TYPE
            SYNTAX  IpAddress
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The IpAddress corresponding to the media-
                    dependent 'physical' address."
            ::= { ipNetToMediaEntry 3 }

        ipNetToMediaType OBJECT-TYPE
            SYNTAX  INTEGER {
                        other(1),        -- none of the following
                        invalid(2),      -- an invalidated mapping
                        dynamic(3),
                        static(4)
                    }
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The type of mapping.

                    Setting this object to the value invalid(2) has
                    the effect of invalidating the corresponding entry
                    in the ipNetToMediaTable.  That is, it effectively
                    dissasociates the interface identified with said
                    entry from the mapping 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
                    ipNetToMediaType object."
            ::= { ipNetToMediaEntry 4 }


        -- additional IP objects

        ipRoutingDiscards OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            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."
        ::= { ip 23 }


    -- the ICMP group

    -- Implementation of the ICMP group is mandatory for all
    -- systems.

    icmpInMsgs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of ICMP messages which the
                entity received.  Note that this counter includes
                all those counted by icmpInErrors."
        ::= { icmp 1 }

    icmpInErrors OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP messages which the entity
                received but determined as having ICMP-specific
                errors (bad ICMP checksums, bad length, etc.)."
        ::= { icmp 2 }

    icmpInDestUnreachs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Destination Unreachable
                messages received."
        ::= { icmp 3 }

    icmpInTimeExcds OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Time Exceeded messages
                received."
        ::= { icmp 4 }
```

```
        icmpInParmProbs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Parameter Problem messages
                    received."
            ::= { icmp 5 }

        icmpInSrcQuenchs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Source Quench messages
                    received."
            ::= { icmp 6 }

        icmpInRedirects OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Redirect messages received."
            ::= { icmp 7 }

        icmpInEchos OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Echo (request) messages
                    received."
            ::= { icmp 8 }

        icmpInEchoReps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Echo Reply messages received."
            ::= { icmp 9 }

        icmpInTimestamps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
```

```
                "The number of ICMP Timestamp (request) messages
                received."
        ::= { icmp 10 }

    icmpInTimestampReps OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Timestamp Reply messages
                received."
        ::= { icmp 11 }

    icmpInAddrMasks OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Address Mask Request messages
                received."
        ::= { icmp 12 }

    icmpInAddrMaskReps OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Address Mask Reply messages
                received."
        ::= { icmp 13 }

    icmpOutMsgs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of ICMP messages which this
                entity attempted to send.  Note that this counter
                includes all those counted by icmpOutErrors."
        ::= { icmp 14 }

    icmpOutErrors OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP messages which this entity did
                not send due to problems discovered within ICMP
```

```
                such as a lack of buffers.  This value should not
                include errors discovered outside the ICMP layer
                such as the inability of IP to route the resultant
                datagram.  In some implementations there may be no
                types of error which contribute to this counter's
                value."
        ::= { icmp 15 }

    icmpOutDestUnreachs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Destination Unreachable
                messages sent."
        ::= { icmp 16 }

    icmpOutTimeExcds OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Time Exceeded messages sent."
        ::= { icmp 17 }

    icmpOutParmProbs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Parameter Problem messages
                sent."
        ::= { icmp 18 }

    icmpOutSrcQuenchs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Source Quench messages sent."
        ::= { icmp 19 }

    icmpOutRedirects OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Redirect messages sent.  For a
```

```
                host, this object will always be zero, since hosts
                do not send redirects."
        ::= { icmp 20 }

    icmpOutEchos OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Echo (request) messages sent."
        ::= { icmp 21 }

    icmpOutEchoReps OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Echo Reply messages sent."
        ::= { icmp 22 }

    icmpOutTimestamps OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Timestamp (request) messages
                sent."
        ::= { icmp 23 }

    icmpOutTimestampReps OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Timestamp Reply messages
                sent."
        ::= { icmp 24 }

    icmpOutAddrMasks OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of ICMP Address Mask Request messages
                sent."
        ::= { icmp 25 }
```

```
        icmpOutAddrMaskReps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of ICMP Address Mask Reply messages
                    sent."
            ::= { icmp 26 }


        -- the TCP group

        -- Implementation of the TCP group is mandatory for all
        -- systems that implement the TCP.

        -- Note that instances of object types that represent
        -- information about a particular TCP connection are
        -- transient; they persist only as long as the connection
        -- in question.

        tcpRtoAlgorithm OBJECT-TYPE
            SYNTAX  INTEGER {
                        other(1),    -- none of the following

                        constant(2), -- a constant rto
                        rsre(3),     -- MIL-STD-1778, Appendix B
                        vanj(4)      -- Van Jacobson's algorithm [10]
                    }
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The algorithm used to determine the timeout value
                    used for retransmitting unacknowledged octets."
            ::= { tcp 1 }

        tcpRtoMin OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The minimum value permitted by a TCP
                    implementation for the retransmission timeout,
                    measured in milliseconds.  More refined semantics
                    for objects of this type depend upon the algorithm
                    used to determine the retransmission timeout.  In
                    particular, when the timeout algorithm is rsre(3),
                    an object of this type has the semantics of the
                    LBOUND quantity described in RFC 793."
```

```
        ::= { tcp 2 }


    tcpRtoMax OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The maximum value permitted by a TCP
                implementation for the retransmission timeout,
                measured in milliseconds.  More refined semantics
                for objects of this type depend upon the algorithm
                used to determine the retransmission timeout.  In
                particular, when the timeout algorithm is rsre(3),
                an object of this type has the semantics of the
                UBOUND quantity described in RFC 793."
        ::= { tcp 3 }

    tcpMaxConn OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The limit on the total number of TCP connections
                the entity can support.  In entities where the
                maximum number of connections is dynamic, this
                object should contain the value -1."
        ::= { tcp 4 }

    tcpActiveOpens OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of times TCP connections have made a
                direct transition to the SYN-SENT state from the
                CLOSED state."
        ::= { tcp 5 }

    tcpPassiveOpens OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of times TCP connections have made a
                direct transition to the SYN-RCVD state from the
                LISTEN state."
        ::= { tcp 6 }
```

```
        tcpAttemptFails OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of times TCP connections have made a
                    direct transition to the CLOSED state from either
                    the SYN-SENT state or the SYN-RCVD state, plus the
                    number of times TCP connections have made a direct
                    transition to the LISTEN state from the SYN-RCVD
                    state."
            ::= { tcp 7 }

        tcpEstabResets OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of times TCP connections have made a
                    direct transition to the CLOSED state from either
                    the ESTABLISHED state or the CLOSE-WAIT state."
            ::= { tcp 8 }

        tcpCurrEstab OBJECT-TYPE
            SYNTAX  Gauge
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of TCP connections for which the
                    current state is either ESTABLISHED or CLOSE-
                    WAIT."
            ::= { tcp 9 }

        tcpInSegs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of segments received, including
                    those received in error.  This count includes
                    segments received on currently established
                    connections."
            ::= { tcp 10 }

        tcpOutSegs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
```

```
            DESCRIPTION
                    "The total number of segments sent, including
                    those on current connections but excluding those
                    containing only retransmitted octets."
            ::= { tcp 11 }

        tcpRetransSegs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of segments retransmitted - that
                    is, the number of TCP segments transmitted
                    containing one or more previously transmitted
                    octets."
            ::= { tcp 12 }


        -- the TCP Connection table

        -- The TCP connection table contains information about this
        -- entity's existing TCP connections.

        tcpConnTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF TcpConnEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "A table containing TCP connection-specific
                    information."
            ::= { tcp 13 }

        tcpConnEntry OBJECT-TYPE
            SYNTAX  TcpConnEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "Information about a particular current TCP
                    connection.  An object of this type is transient,
                    in that it ceases to exist when (or soon after)
                    the connection makes the transition to the CLOSED
                    state."
            INDEX   { tcpConnLocalAddress,
                      tcpConnLocalPort,
                      tcpConnRemAddress,
                      tcpConnRemPort }
            ::= { tcpConnTable 1 }
```

```
        TcpConnEntry ::=
            SEQUENCE {
                tcpConnState
                    INTEGER,
                tcpConnLocalAddress
                    IpAddress,
                tcpConnLocalPort
                    INTEGER (0..65535),
                tcpConnRemAddress
                    IpAddress,
                tcpConnRemPort
                    INTEGER (0..65535)
            }

        tcpConnState OBJECT-TYPE
            SYNTAX  INTEGER {
                        closed(1),
                        listen(2),
                        synSent(3),
                        synReceived(4),
                        established(5),
                        finWait1(6),
                        finWait2(7),
                        closeWait(8),
                        lastAck(9),
                        closing(10),
                        timeWait(11),
                        deleteTCB(12)
                    }
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "The state of this TCP connection.

                    The only value which may be set by a management
                    station is deleteTCB(12).  Accordingly, it is
                    appropriate for an agent to return a 'badValue'
                    response if a management station attempts to set
                    this object to any other value.

                    If a management station sets this object to the
                    value deleteTCB(12), then this has the effect of
                    deleting the TCB (as defined in RFC 793) of the
                    corresponding connection on the managed node,
                    resulting in immediate termination of the
                    connection.

                    As an implementation-specific option, a RST
```

```
                segment may be sent from the managed node to the
                other TCP endpoint (note however that RST segments
                are not sent reliably)."
        ::= { tcpConnEntry 1 }

    tcpConnLocalAddress OBJECT-TYPE
        SYNTAX  IpAddress
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The local IP address for this TCP connection.  In
                the case of a connection in the listen state which
                is willing to accept connections for any IP
                interface associated with the node, the value
                0.0.0.0 is used."
        ::= { tcpConnEntry 2 }

    tcpConnLocalPort OBJECT-TYPE
        SYNTAX  INTEGER (0..65535)
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The local port number for this TCP connection."
        ::= { tcpConnEntry 3 }

    tcpConnRemAddress OBJECT-TYPE
        SYNTAX  IpAddress
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The remote IP address for this TCP connection."
        ::= { tcpConnEntry 4 }

    tcpConnRemPort OBJECT-TYPE
        SYNTAX  INTEGER (0..65535)
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The remote port number for this TCP connection."
        ::= { tcpConnEntry 5 }


    -- additional TCP objects

    tcpInErrs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
```

```
            DESCRIPTION
                    "The total number of segments received in error
                    (e.g., bad TCP checksums)."
            ::= { tcp 14 }

        tcpOutRsts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of TCP segments sent containing the
                    RST flag."
            ::= { tcp 15 }


        -- the UDP group

        -- Implementation of the UDP group is mandatory for all
        -- systems which implement the UDP.

        udpInDatagrams OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of UDP datagrams delivered to
                    UDP users."
            ::= { udp 1 }

        udpNoPorts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of received UDP datagrams for
                    which there was no application at the destination
                    port."
            ::= { udp 2 }

        udpInErrors OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of received UDP datagrams that could
                    not be delivered for reasons other than the lack
                    of an application at the destination port."
            ::= { udp 3 }
```

```
        udpOutDatagrams OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of UDP datagrams sent from this
                    entity."
            ::= { udp 4 }


        -- the UDP Listener table

        -- The UDP listener table contains information about this
        -- entity's UDP end-points on which a local application is
        -- currently accepting datagrams.

        udpTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF UdpEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "A table containing UDP listener information."
            ::= { udp 5 }

        udpEntry OBJECT-TYPE
            SYNTAX  UdpEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "Information about a particular current UDP
                    listener."
            INDEX   { udpLocalAddress, udpLocalPort }
            ::= { udpTable 1 }

        UdpEntry ::=
            SEQUENCE {
                udpLocalAddress
                    IpAddress,
                udpLocalPort
                    INTEGER (0..65535)
            }

        udpLocalAddress OBJECT-TYPE
            SYNTAX  IpAddress
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The local IP address for this UDP listener.  In
```

```
                the case of a UDP listener which is willing to
                accept datagrams for any IP interface associated
                with the node, the value 0.0.0.0 is used."
        ::= { udpEntry 1 }

    udpLocalPort OBJECT-TYPE
        SYNTAX  INTEGER (0..65535)
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The local port number for this UDP listener."
        ::= { udpEntry 2 }


    -- the EGP group

    -- Implementation of the EGP group is mandatory for all
    -- systems which implement the EGP.

    egpInMsgs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of EGP messages received without
                error."
        ::= { egp 1 }

    egpInErrors OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The number of EGP messages received that proved
                to be in error."
        ::= { egp 2 }

    egpOutMsgs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of locally generated EGP
                messages."
        ::= { egp 3 }

    egpOutErrors OBJECT-TYPE
        SYNTAX  Counter
```

```
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of locally generated EGP messages not
                    sent due to resource limitations within an EGP
                    entity."
            ::= { egp 4 }


        -- the EGP Neighbor table

        -- The EGP neighbor table contains information about this
        -- entity's EGP neighbors.

        egpNeighTable OBJECT-TYPE
            SYNTAX  SEQUENCE OF EgpNeighEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "The EGP neighbor table."
            ::= { egp 5 }

        egpNeighEntry OBJECT-TYPE
            SYNTAX  EgpNeighEntry
            ACCESS  not-accessible
            STATUS  mandatory
            DESCRIPTION
                    "Information about this entity's relationship with
                    a particular EGP neighbor."
            INDEX   { egpNeighAddr }
            ::= { egpNeighTable 1 }

        EgpNeighEntry ::=
            SEQUENCE {
                egpNeighState
                    INTEGER,
                egpNeighAddr
                    IpAddress,
                egpNeighAs
                    INTEGER,
                egpNeighInMsgs
                    Counter,
                egpNeighInErrs
                    Counter,
                egpNeighOutMsgs
                    Counter,
                egpNeighOutErrs
                    Counter,
```

```
                egpNeighInErrMsgs
                    Counter,
                egpNeighOutErrMsgs
                    Counter,
                egpNeighStateUps
                    Counter,
                egpNeighStateDowns
                    Counter,
                egpNeighIntervalHello
                    INTEGER,
                egpNeighIntervalPoll
                    INTEGER,
                egpNeighMode
                    INTEGER,
                egpNeighEventTrigger
                    INTEGER
            }

        egpNeighState OBJECT-TYPE
            SYNTAX  INTEGER {
                        idle(1),
                        acquisition(2),
                        down(3),
                        up(4),
                        cease(5)
                    }
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The EGP state of the local system with respect to
                    this entry's EGP neighbor.  Each EGP state is
                    represented by a value that is one greater than
                    the numerical value associated with said state in
                    RFC 904."
            ::= { egpNeighEntry 1 }

        egpNeighAddr OBJECT-TYPE
            SYNTAX  IpAddress
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The IP address of this entry's EGP neighbor."
            ::= { egpNeighEntry 2 }

        egpNeighAs OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
```

```
            DESCRIPTION
                    "The autonomous system of this EGP peer.  Zero
                    should be specified if the autonomous system
                    number of the neighbor is not yet known."
            ::= { egpNeighEntry 3 }

        egpNeighInMsgs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of EGP messages received without error
                    from this EGP peer."
            ::= { egpNeighEntry 4 }

        egpNeighInErrs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of EGP messages received from this EGP
                    peer that proved to be in error (e.g., bad EGP
                    checksum)."
            ::= { egpNeighEntry 5 }

        egpNeighOutMsgs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of locally generated EGP messages to
                    this EGP peer."
            ::= { egpNeighEntry 6 }

        egpNeighOutErrs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of locally generated EGP messages not
                    sent to this EGP peer due to resource limitations
                    within an EGP entity."
            ::= { egpNeighEntry 7 }

        egpNeighInErrMsgs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
```

```
            DESCRIPTION
                    "The number of EGP-defined error messages received
                    from this EGP peer."
            ::= { egpNeighEntry 8 }

        egpNeighOutErrMsgs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of EGP-defined error messages sent to
                    this EGP peer."
            ::= { egpNeighEntry 9 }

        egpNeighStateUps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of EGP state transitions to the UP
                    state with this EGP peer."
            ::= { egpNeighEntry 10 }

        egpNeighStateDowns OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The number of EGP state transitions from the UP
                    state to any other state with this EGP peer."
            ::= { egpNeighEntry 11 }

        egpNeighIntervalHello OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The interval between EGP Hello command
                    retransmissions (in hundredths of a second).  This
                    represents the t1 timer as defined in RFC 904."
            ::= { egpNeighEntry 12 }

        egpNeighIntervalPoll OBJECT-TYPE
            SYNTAX  INTEGER
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The interval between EGP poll command
```

```
                retransmissions (in hundredths of a second).  This
                represents the t3 timer as defined in RFC 904."
        ::= { egpNeighEntry 13 }

    egpNeighMode OBJECT-TYPE
        SYNTAX  INTEGER { active(1), passive(2) }
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The polling mode of this EGP entity, either
                passive or active."
        ::= { egpNeighEntry 14 }

    egpNeighEventTrigger OBJECT-TYPE
        SYNTAX  INTEGER { start(1), stop(2) }
        ACCESS  read-write
        STATUS  mandatory
        DESCRIPTION
                "A control variable used to trigger operator-
                initiated Start and Stop events.  When read, this
                variable always returns the most recent value that
                egpNeighEventTrigger was set to.  If it has not
                been set since the last initialization of the
                network management subsystem on the node, it
                returns a value of 'stop'.

                When set, this variable causes a Start or Stop
                event on the specified neighbor, as specified on
                pages 8-10 of RFC 904.  Briefly, a Start event
                causes an Idle peer to begin neighbor acquisition
                and a non-Idle peer to reinitiate neighbor
                acquisition.  A stop event causes a non-Idle peer
                to return to the Idle state until a Start event
                occurs, either via egpNeighEventTrigger or
                otherwise."
        ::= { egpNeighEntry 15 }


    -- additional EGP objects

    egpAs OBJECT-TYPE
        SYNTAX  INTEGER
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The autonomous system number of this EGP entity."
        ::= { egp 6 }
```

```
        -- the Transmission group

        -- Based on the transmission media underlying each interface
        -- on a system, the corresponding portion of the Transmission
        -- group is mandatory for that system.

        -- When Internet-standard definitions for managing
        -- transmission media are defined, the transmission group is
        -- used to provide a prefix for the names of those objects.

        -- Typically, such definitions reside in the experimental
        -- portion of the MIB until they are "proven", then as a
        -- part of the Internet standardization process, the
        -- definitions are accordingly elevated and a new object
        -- identifier, under the transmission group is defined. By
        -- convention, the name assigned is:
        --
        --     type OBJECT IDENTIFIER    ::= { transmission number }
        --
        -- where "type" is the symbolic value used for the media in
        -- the ifType column of the ifTable object, and "number" is
        -- the actual integer value corresponding to the symbol.


        -- the SNMP group

        -- Implementation of the SNMP group is mandatory for all
        -- systems which support an SNMP protocol entity.  Some of
        -- the objects defined below will be zero-valued in those
        -- SNMP implementations that are optimized to support only
        -- those functions specific to either a management agent or
        -- a management station.  In particular, it should be
        -- observed that the objects below refer to an SNMP entity,
        -- and there may be several SNMP entities residing on a
        -- managed node (e.g., if the node is hosting acting as
        -- a management station).

        snmpInPkts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of Messages delivered to the
                    SNMP entity from the transport service."
            ::= { snmp 1 }

        snmpOutPkts OBJECT-TYPE
            SYNTAX  Counter
```

```
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Messages which were
                    passed from the SNMP protocol entity to the
                    transport service."
            ::= { snmp 2 }

        snmpInBadVersions OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Messages which were
                    delivered to the SNMP protocol entity and were for
                    an unsupported SNMP version."
            ::= { snmp 3 }

        snmpInBadCommunityNames OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Messages delivered to
                    the SNMP protocol entity which used a SNMP
                    community name not known to said entity."
            ::= { snmp 4 }

        snmpInBadCommunityUses OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Messages delivered to
                    the SNMP protocol entity which represented an SNMP
                    operation which was not allowed by the SNMP
                    community named in the Message."
            ::= { snmp 5 }

        snmpInASNParseErrs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of ASN.1 or BER errors
                    encountered by the SNMP protocol entity when
                    decoding received SNMP Messages."
            ::= { snmp 6 }
```

```
        -- { snmp 7 } is not used

        snmpInTooBigs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    delivered to the SNMP protocol entity and for
                    which the value of the error-status field is
                    'tooBig'."
            ::= { snmp 8 }

        snmpInNoSuchNames OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    delivered to the SNMP protocol entity and for
                    which the value of the error-status field is
                    'noSuchName'."
            ::= { snmp 9 }

        snmpInBadValues OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    delivered to the SNMP protocol entity and for
                    which the value of the error-status field is
                    'badValue'."
            ::= { snmp 10 }

        snmpInReadOnlys OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number valid SNMP PDUs which were
                    delivered to the SNMP protocol entity and for
                    which the value of the error-status field is
                    'readOnly'.  It should be noted that it is a
                    protocol error to generate an SNMP PDU which
                    contains the value 'readOnly' in the error-status
                    field, as such this object is provided as a means
                    of detecting incorrect implementations of the
```

```
                SNMP."
        ::= { snmp 11 }

    snmpInGenErrs OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of SNMP PDUs which were
                delivered to the SNMP protocol entity and for
                which the value of the error-status field is
                'genErr'."
        ::= { snmp 12 }

    snmpInTotalReqVars OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of MIB objects which have been
                retrieved successfully by the SNMP protocol entity
                as the result of receiving valid SNMP Get-Request
                and Get-Next PDUs."
        ::= { snmp 13 }

    snmpInTotalSetVars OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of MIB objects which have been
                altered successfully by the SNMP protocol entity
                as the result of receiving valid SNMP Set-Request
                PDUs."
        ::= { snmp 14 }

    snmpInGetRequests OBJECT-TYPE
        SYNTAX  Counter
        ACCESS  read-only
        STATUS  mandatory
        DESCRIPTION
                "The total number of SNMP Get-Request PDUs which
                have been accepted and processed by the SNMP
                protocol entity."
        ::= { snmp 15 }

    snmpInGetNexts OBJECT-TYPE
        SYNTAX  Counter
```

```
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Get-Next PDUs which have
                    been accepted and processed by the SNMP protocol
                    entity."
            ::= { snmp 16 }

        snmpInSetRequests OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Set-Request PDUs which
                    have been accepted and processed by the SNMP
                    protocol entity."
            ::= { snmp 17 }

        snmpInGetResponses OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Get-Response PDUs which
                    have been accepted and processed by the SNMP
                    protocol entity."
            ::= { snmp 18 }

        snmpInTraps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Trap PDUs which have
                    been accepted and processed by the SNMP protocol
                    entity."
            ::= { snmp 19 }

        snmpOutTooBigs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    generated by the SNMP protocol entity and for
                    which the value of the error-status field is
                    'tooBig.'"
            ::= { snmp 20 }
```

```
        snmpOutNoSuchNames OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    generated by the SNMP protocol entity and for
                    which the value of the error-status is
                    'noSuchName'."
            ::= { snmp 21 }

        snmpOutBadValues OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    generated by the SNMP protocol entity and for
                    which the value of the error-status field is
                    'badValue'."
            ::= { snmp 22 }

        -- { snmp 23 } is not used

        snmpOutGenErrs OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP PDUs which were
                    generated by the SNMP protocol entity and for
                    which the value of the error-status field is
                    'genErr'."
            ::= { snmp 24 }

        snmpOutGetRequests OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Get-Request PDUs which
                    have been generated by the SNMP protocol entity."
            ::= { snmp 25 }

        snmpOutGetNexts OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
```

```
            DESCRIPTION
                    "The total number of SNMP Get-Next PDUs which have
                    been generated by the SNMP protocol entity."
            ::= { snmp 26 }

        snmpOutSetRequests OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Set-Request PDUs which
                    have been generated by the SNMP protocol entity."
            ::= { snmp 27 }

        snmpOutGetResponses OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Get-Response PDUs which
                    have been generated by the SNMP protocol entity."
            ::= { snmp 28 }

        snmpOutTraps OBJECT-TYPE
            SYNTAX  Counter
            ACCESS  read-only
            STATUS  mandatory
            DESCRIPTION
                    "The total number of SNMP Trap PDUs which have
                    been generated by the SNMP protocol entity."
            ::= { snmp 29 }

        snmpEnableAuthenTraps OBJECT-TYPE
            SYNTAX  INTEGER { enabled(1), disabled(2) }
            ACCESS  read-write
            STATUS  mandatory
            DESCRIPTION
                    "Indicates whether the SNMP agent process is
                    permitted to generate authentication-failure
                    traps.  The value of this object overrides any
                    configuration information; as such, it provides a
                    means whereby all authentication-failure traps may
                    be disabled.

                    Note that it is strongly recommended that this
                    object be stored in non-volatile memory so that it
                    remains constant between re-initializations of the
                    network management system."
```

```
            ::= { snmp 30 }

        END
```

7. Acknowledgements

This document was produced by the SNMP Working Group:

Anne Ambler, Spider
Karl Auerbach, Sun
Fred Baker, ACC
David Bridgham, Epilogue Technology
Ken Brinkerhoff
Ron Broersma, NOSC
Brian Brown, Synoptics
Jack Brown, US Army
Theodore Brunner, Bellcore
Jeff Buffum, HP
Jeffrey Buffum, HP
John Burress, Wellfleet
Jeffrey D. Case, University of Tennessee at Knoxville
Chris Chiptasso, Spartacus
Paul Ciarfella, DEC
Bob Collet
John Cook, Chipcom
Tracy Cox, Bellcore
James R. Davin, MIT-LCS
Eric Decker, cisco
Kurt Dobbins, Cabletron
Nadya El-Afandi, Network Systems
Gary Ellis, HP
Fred Engle
Mike Erlinger
Mark S. Fedor, PSI
Richard Fox, Synoptics
Karen Frisa, CMU
Stan Froyd, ACC
Chris Gunner, DEC
Fred Harris, University of Tennessee at Knoxville
Ken Hibbard, Xylogics
Ole Jacobsen, Interop
Ken Jones
Satish Joshi, Synoptics
Frank Kastenholz, Racal-Interlan
Shimshon Kaufman, Spartacus
Ken Key, University of Tennessee at Knoxville
Jim Kinder, Fibercom
Alex Koifman, BBN

Christopher Kolb, PSI
Cheryl Krupczak, NCR
Paul Langille, DEC
Martin Lee Schoffstall, PSI
Peter Lin, Vitalink
John Lunny, TWG
Carl Malamud
Gary Malkin, FTP Software, Inc.
Randy Mayhew, University of Tennessee at Knoxville
Keith McCloghrie, Hughes LAN Systems
Donna McMaster, David Systems
Lynn Monsanto, Sun
Dave Perkins, 3COM
Jim Reinstedler, Ungerman Bass
Anil Rijsinghani, DEC
Kathy Rinehart, Arnold AFB
Kary Robertson
Marshall T. Rose, PSI (chair)
L. Michael Sabo, NCSC
Jon Saperia, DEC
Greg Satz, cisco
Martin Schoffstall, PSI
John Seligson
Steve Sherry, Xyplex
Fei Shu, NEC
Sam Sjogren, TGV
Mark Sleeper, Sparta
Lance Sprung
Mike St.Johns
Bob Stewart, Xyplex
Emil Sturniold
Kaj Tesink, Bellcore
Geoff Thompson, Synoptics
Dean Throop, Data General
Bill Townsend, Xylogics
Maurice Turcotte, Racal-Milgo
Kannan Varadhou
Sudhanshu Verma, HP
Bill Versteeg, Network Research Corporation
Warren Vik, Interactive Systems
David Waitzman, BBN
Steve Waldbusser, CMU
Dan Wintringhan
David Wood
Wengyik Yeong, PSI
Jeff Young, Cray Research

In addition, the comments of the following individuals are also acknolwedged:

Craig A. Finseth, Minnesota Supercomputer Center, Inc.
Jeffrey C. Honig, Cornell University Theory Center
Philip R. Karn, Bellcore

8. References

[1] Cerf, V., "IAB Recommendations for the Development of Internet Network Management Standards", RFC 1052, NRI, April 1988.

[2] Rose M., and K. McCloghrie, "Structure and Identification of Management Information for TCP/IP-based internets," RFC 1065, TWG, August 1988.

[3] McCloghrie, K., and M. Rose, "Management Information Base for Network Management of TCP/IP-based internets, RFC 1066, TWG, August 1988.

[4] Cerf, V., "Report of the Second Ad Hoc Network Management Review Group", RFC 1109, NRI, August 1989.

[5] Case, J., Fedor, M., Schoffstall, M., and J. Davin, "Simple Network Management Protocol (SNMP)", RFC 1098, University of Tennessee at Knoxville, NYSERNet, Inc., Rensselaer Polytechnic Institute, MIT Laboratory for Computer Science, April 1989.

[6] Postel, J., and J. Reynolds, "TELNET Protocol Specification", RFC 854, USC/Information Sciences Institute, May 1983.

[7] Satz, G., "Connectionless Network Protocol (ISO 8473) and End System to Intermediate System (ISO 9542) Management Information Base", RFC 1162, cisco Systems, Inc., June 1990.

[8] Information processing systems - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1), International Organization for Standardization, International Standard 8824, December 1987.

[9] Information processing systems - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Notation One (ASN.1), International Organization for Standardization, International Standard 8825, December 1987.

[10] Jacobson, V., "Congestion Avoidance and Control", SIGCOMM 1988, Stanford, California.

[11] Hagens, R., Hall, N., and M. Rose, "Use of the Internet as a Subnetwork for Experimentation with the OSI Network Layer", RFC 1070, U of Wiscsonsin - Madison, U of Wiscsonsin - Madison, The Wollongong Group, February 1989.

[12] Rose M., and K. McCloghrie, "Structure and Identification of Management Information for TCP/IP-based internets", RFC 1155, Performance Systems International, Hughes LAN Systems, May 1990.

[13] Case, J., Fedor, M., Schoffstall, M., and J. Davin, "Simple Network Management Protocol", RFC 1157, SNMP Research, Performance Systems International, Performance Systems International, MIT Laboratory for Computer Science, May 1990.

[14] Rose, M., and K. McCloghrie, Editors, "Concise MIB Definitions", RFC 1212, Performance Systems International, Hughes LAN Systems, March 1991.

9. Security Considerations

Security issues are not discussed in this memo.

10. Authors' Addresses

Keith McCloghrie
Hughes LAN Systems
1225 Charleston Road
Mountain View, CA 94043
1225 Charleston Road
Mountain View, CA 94043

Phone: (415) 966-7934

EMail: kzm@hls.com

Marshall T. Rose
Performance Systems International
5201 Great America Parkway
Suite 3106
Santa Clara, CA 95054

Phone: +1 408 562 6222

EMail: mrose@psi.com
X.500: rose, psi, us