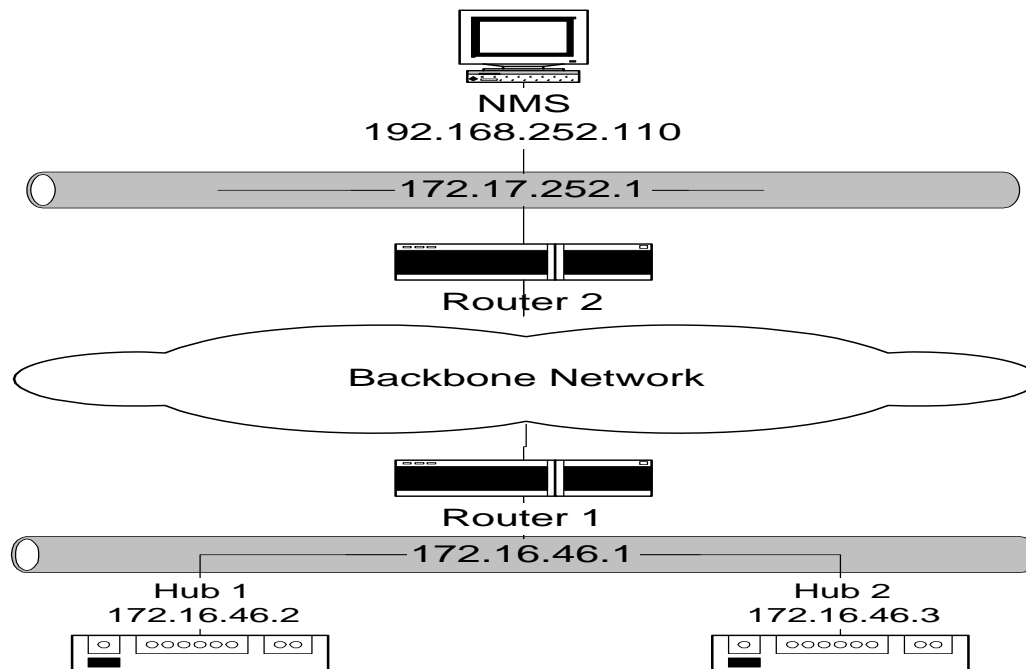


Chapter 4  
SNMPv1:  
Organization and Information Models

---

# Managed LAN



**Figure 4.1 A Managed LAN Network**

# Managed Hub: System Information

Title: System Information: 172.16.46.2

Name or IP Address: 172.16.46.2

System Name :

System Description : 3Com LinkBuilder FMS, SW  
version:3.02

System Contact :

System Location :

System Object ID :

.iso.org.dod.internet.private.enterprises.43.1.8.5

System Up Time : (2475380437) 286 days, 12:03:24.37

Figure 4.2(a) System Information on 172.16.46.2 Hub

---

# Managed Router: System Information

Title: System Information: router1.gatech.edu  
Name or IP Address: 172.16.252.1

System Name : router1.gatech.edu  
System Description : Cisco Internetwork Operating System Software  
: IOS (tm) 7000 Software (C7000-JS-M), Version  
: 11.2(6),RELEASE SOFTWARE (ge1)  
: Copyright (c) 1986-1997 by Cisco Systems, Inc.  
: Compiled Tue 06-May-97 19:11 by kuong  
System Contact :  
System Location :  
System Object ID : iso.org.dod.internet.private.enterprises.cisco.ciscoProducts.  
: cisco 7000  
System Up Time : (315131795) 36 days, 11:21:57.95

**Figure 4.2(c) System Information on Router**

---

# Managed Hub: Port Addresses

Index	Interface	IP address	Network Mask	Network Address	Link Address
1	3Com	172.16.46.2	255.255.255.0	172.16.46.0	0x08004E07C25C
2	3Com	192.168.101.1	255.255.255.0	192.168.101.0	<none>

---

# Managed Router: Port Addresses

Index	Interface	IP address	Network Mask	Network Address	Link Address
23	LEC.1.0	192.168.3.1	255.255.255.0	192.168.3.0	0x00000C3920B4
25	LEC.3.9	192.168.252.15	255.255.255.0	192.168.252.0	0x00000C3920B4
13	Ethernet2/0	172.16..46.1	255.255.255.0	172.16..46.0	0x00000C3920AC
16	Ethernet2/3	172.16.49.1	255.255.255.0	172.16.49.0	0x00000C3920AF
17	Ethernet2/4	172.16.52.1	255.255.255.0	172.16.52.0	0x00000C3920B0
9	Ethernet1/2	172.16.55.1	255.255.255.0	172.16.55.0	0x00000C3920A6
2	Ethernet0/1	172.16.56.1	255.255.255.0	172.16.56.0	0x00000C39209D
15	Ethernet2/2	172.16.57.1	255.255.255.0	172.16.57.0	0x00000C3920AE
8	Ethernet1/1	172.16.58.1	255.255.255.0	172.16.58.0	0x00000C3920A5
14	Ethernet2/1	172.16.60.1	255.255.255.0	172.16.60.0	0x00000C3920AD

# Internet SNMP Management

- 1970      Advanced Research Project Agency Network (ARPANET)  
              Internet control Message Protocol (ICMP)
  - Internet Engineering Task Force (IETF)
    - 1990            SNMPv1
    - 1995            SNMPv2
    - 1998            SNMPv3
  - Internet documents:
    - Request for Comments (RFC)
    - IETF STD Internet Standard
    - FYI For your information
  - Source for RFCs
    - <http://www.nic.mil/dodnic/RFC/>
    - <http://www.rfc-editor.org/rfc.html>
-

# SNMPv1 & SNMPv2 Documents

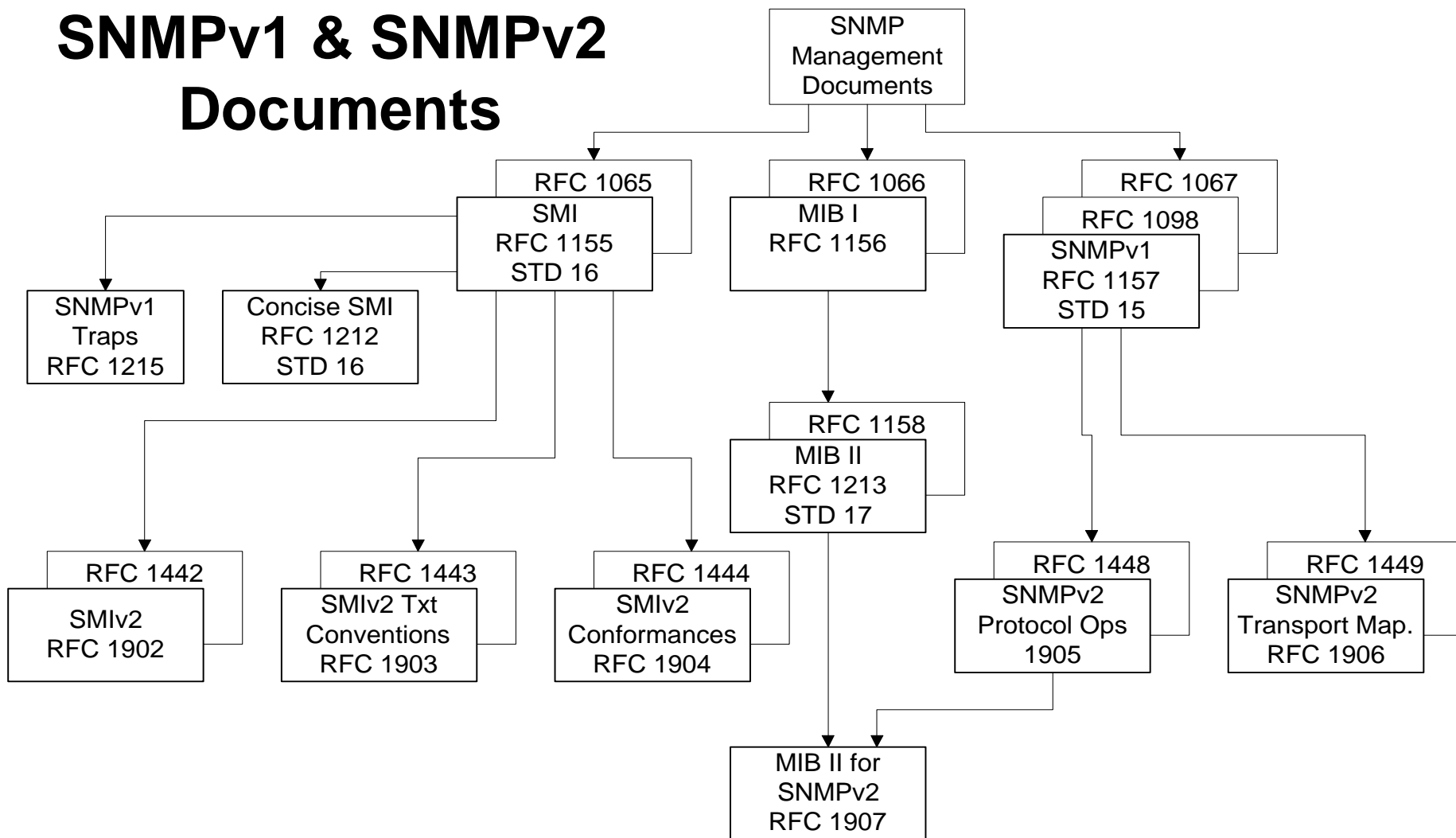


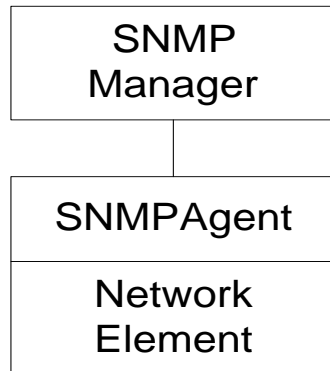
Figure 4.4 SNMP Document Evolution



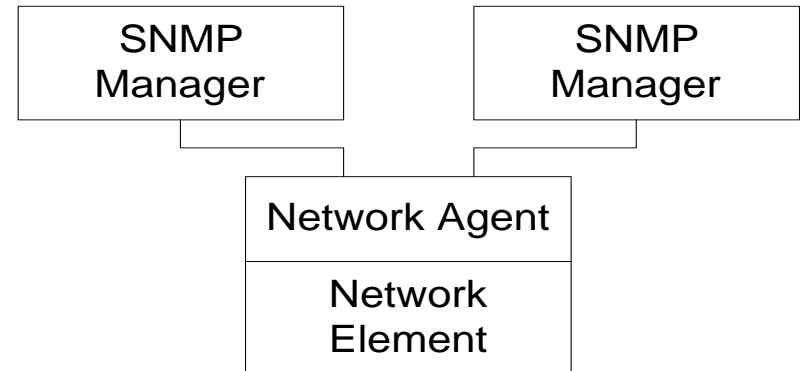
# SNMP Model

- Organization Model
    - Relationship between network element, agent, and manager
    - Hierarchical architecture
  - Information Model
    - Uses ASN.1 syntax
    - SMI (Structure of Management Information)
    - MIB ( Management Information Base)
  - Communication Model
    - Transfer syntax
    - SNMP over TCP/IP
    - Communication services addressed by messages
    - Security framework community-based model
-

# Two-Tier Organization Model

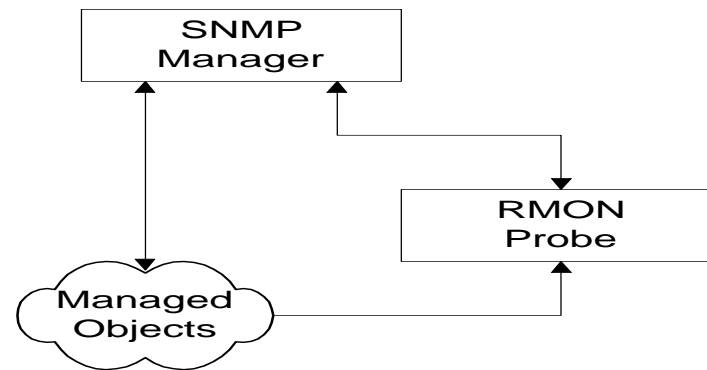


**(a) One Manager - One Agent Model**

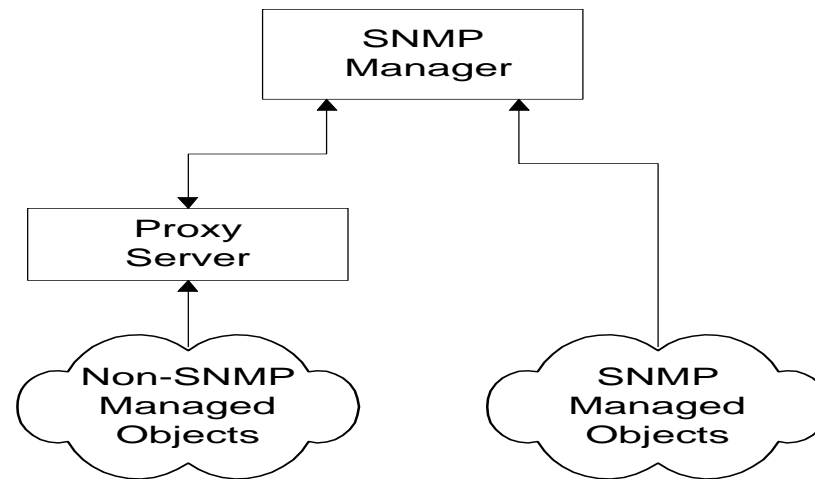


**(b) Multiple Managers - One Agent Model**

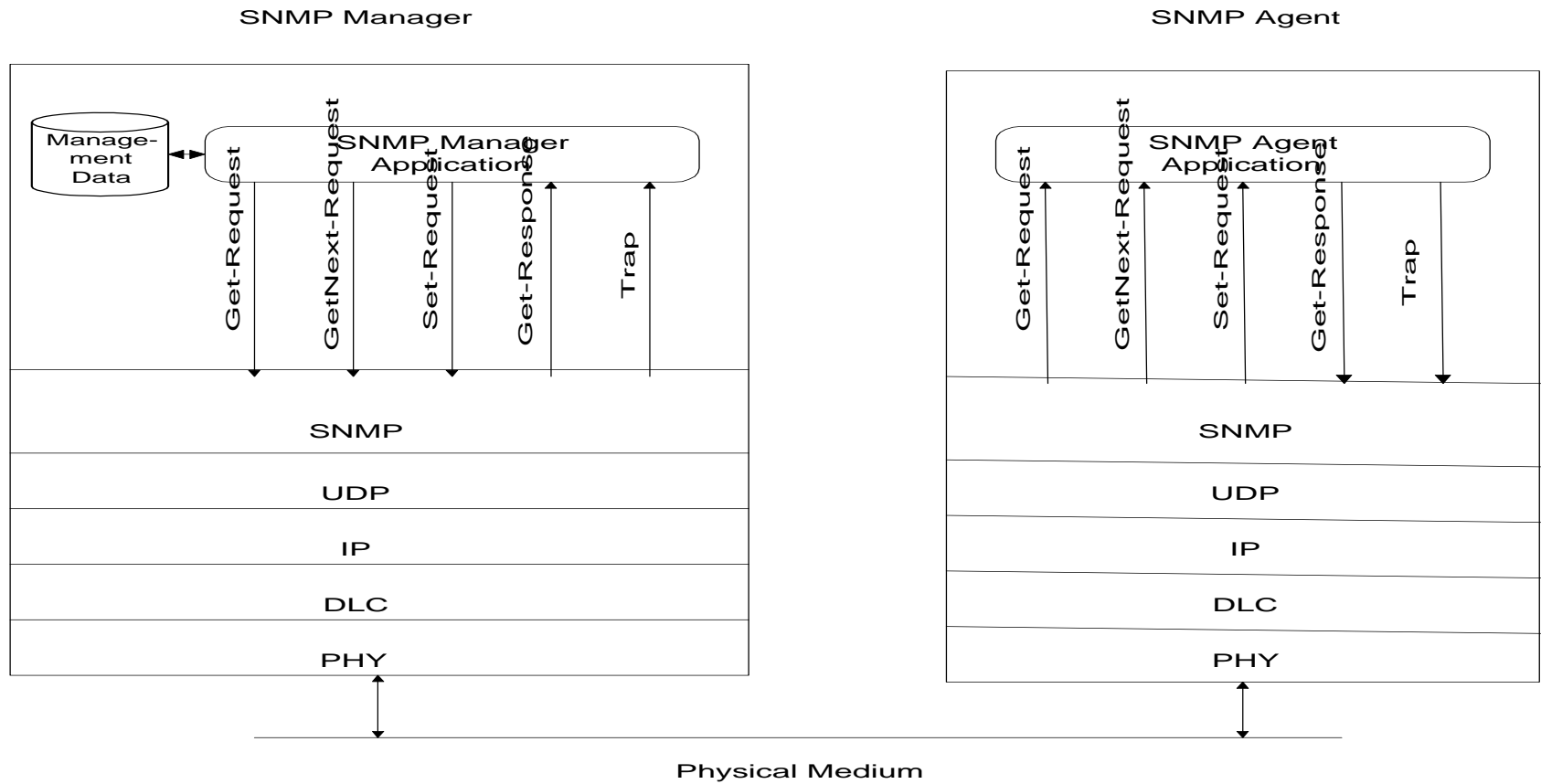
# Three-Tier Organization Model: RMON



# Three-Tier Organization Model: Proxy Server



# System Architecture



**Figure 4.9 SNMP Network Management Architecture**

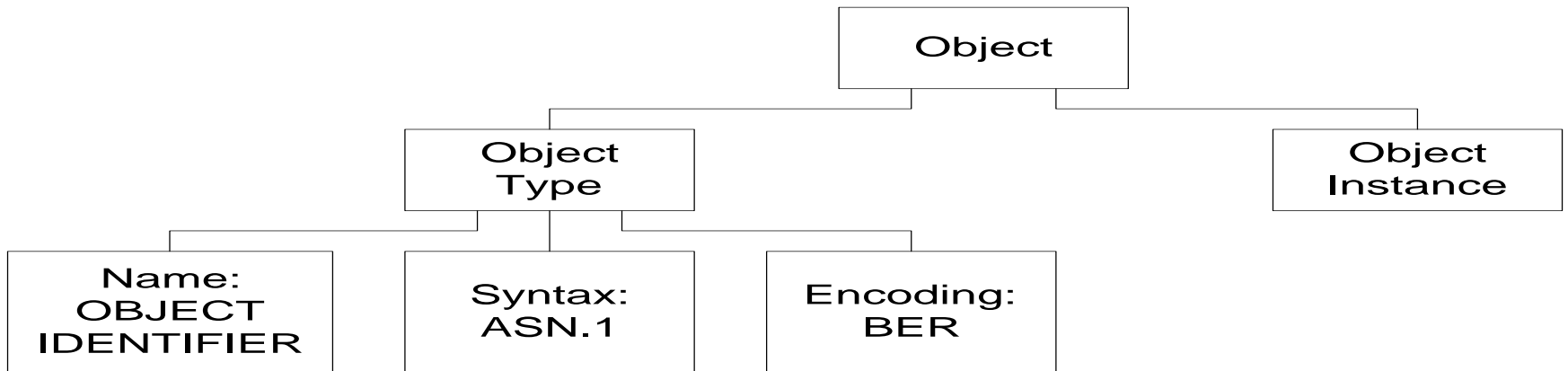
# SNMP Messages

- **Get-Request**
    - Sent by manager requesting data from agent
  - **Get-Next-Request**
    - Sent by manager requesting data on the next object to the one specified
  - **Set-Request**
    - Initializes or changes the value of network element
  - **Get-Response**
    - Agent responds with data for get and set requests from the manager
  - **Trap**
    - Alarm generated by an agent
-

# Information

- Structure of Management Information (SMI) (RFC 1155)
  - Managed Object
    - Scalar
    - Aggregate or tabular object
  - Management Information Base (RFC 1213)
-

# Managed Object

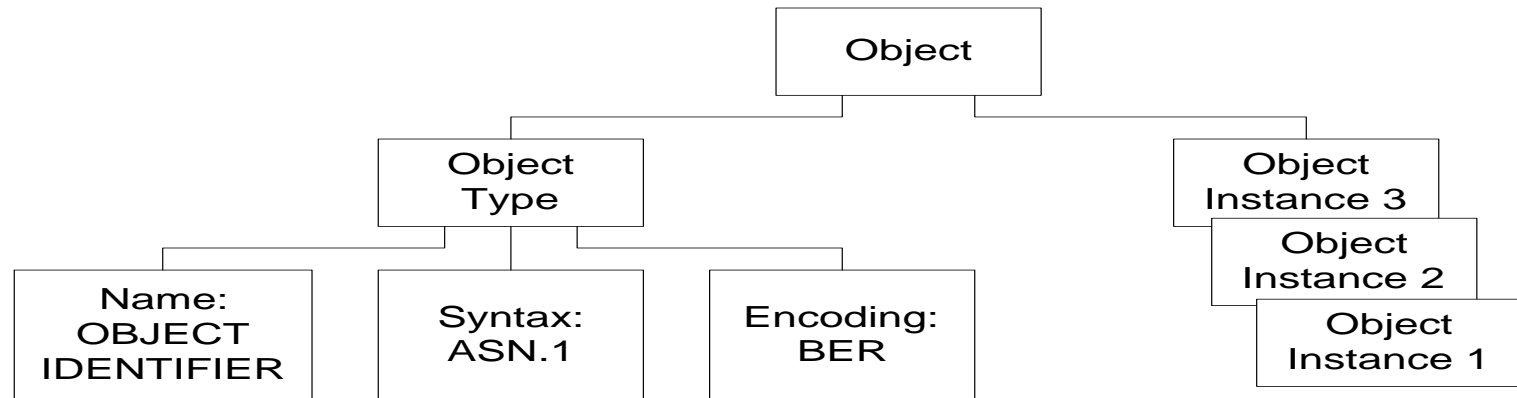


**Figure 4.10 Managed Object : Type and Instance**





# Managed Object: Multiple Instances



**Figure 4.11 Managed Object : Type with Multiple Instances**

# Name

Uniquely defined by

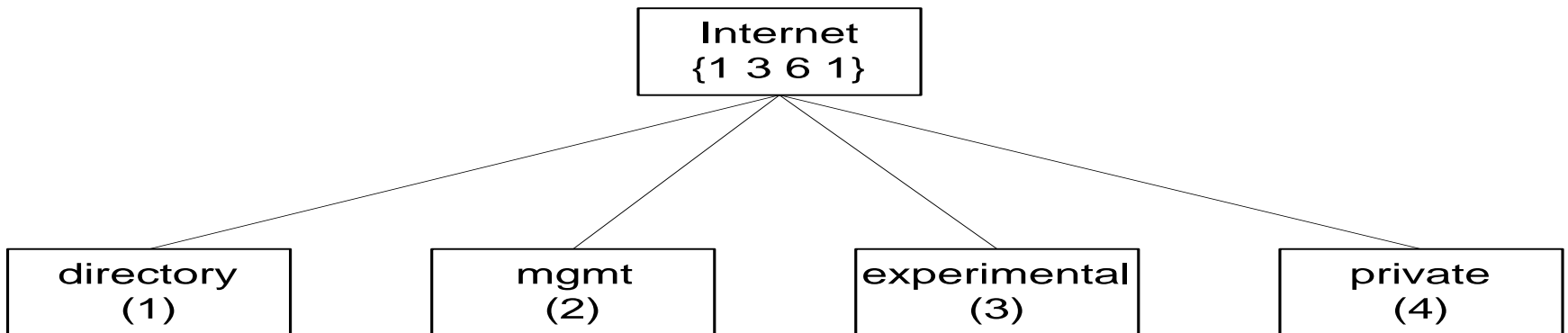
- DESCRIPTOR AND
- OBJECT IDENTIFIER

```
internet OBJECT IDENTIFIER ::=
    { iso org (3) dod (6) 1 }.
```

```
internet OBJECT IDENTIFIER ::= { iso (1) standard (3) dod (6) internet (1) }
internet OBJECT IDENTIFIER ::= { 1 3 6 1 }
internet OBJECT IDENTIFIER ::= { iso standard dod internet }
internet OBJECT IDENTIFIER ::= { iso standard dod (6) internet (1) }
internet OBJECT IDENTIFIER ::= { iso (1) standard (3) 6 1 }
```

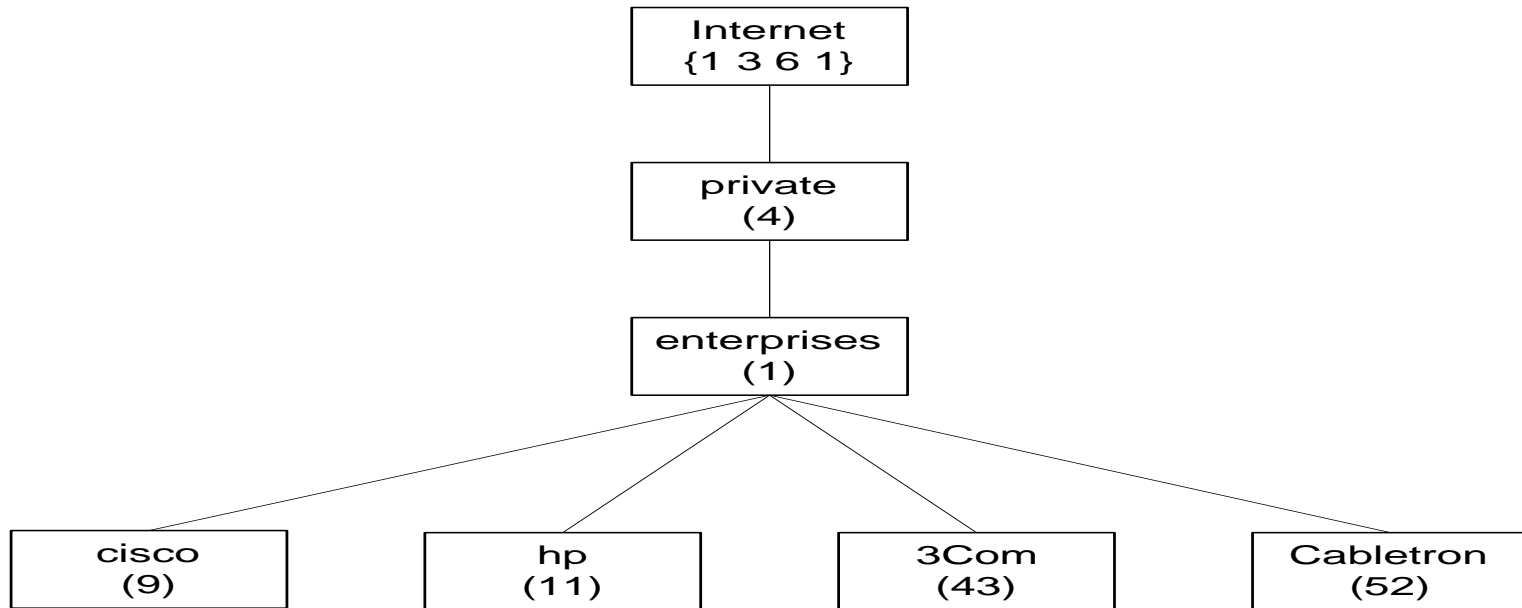
---

# Internet Subnodes



**Figure 4.13 Subnodes under Internet Node in SNMPv1**

# Private MIB Example



**Figure 4.14 Private Subtree for Commercial Vendors**

# SNMP ASN.1 Data Type

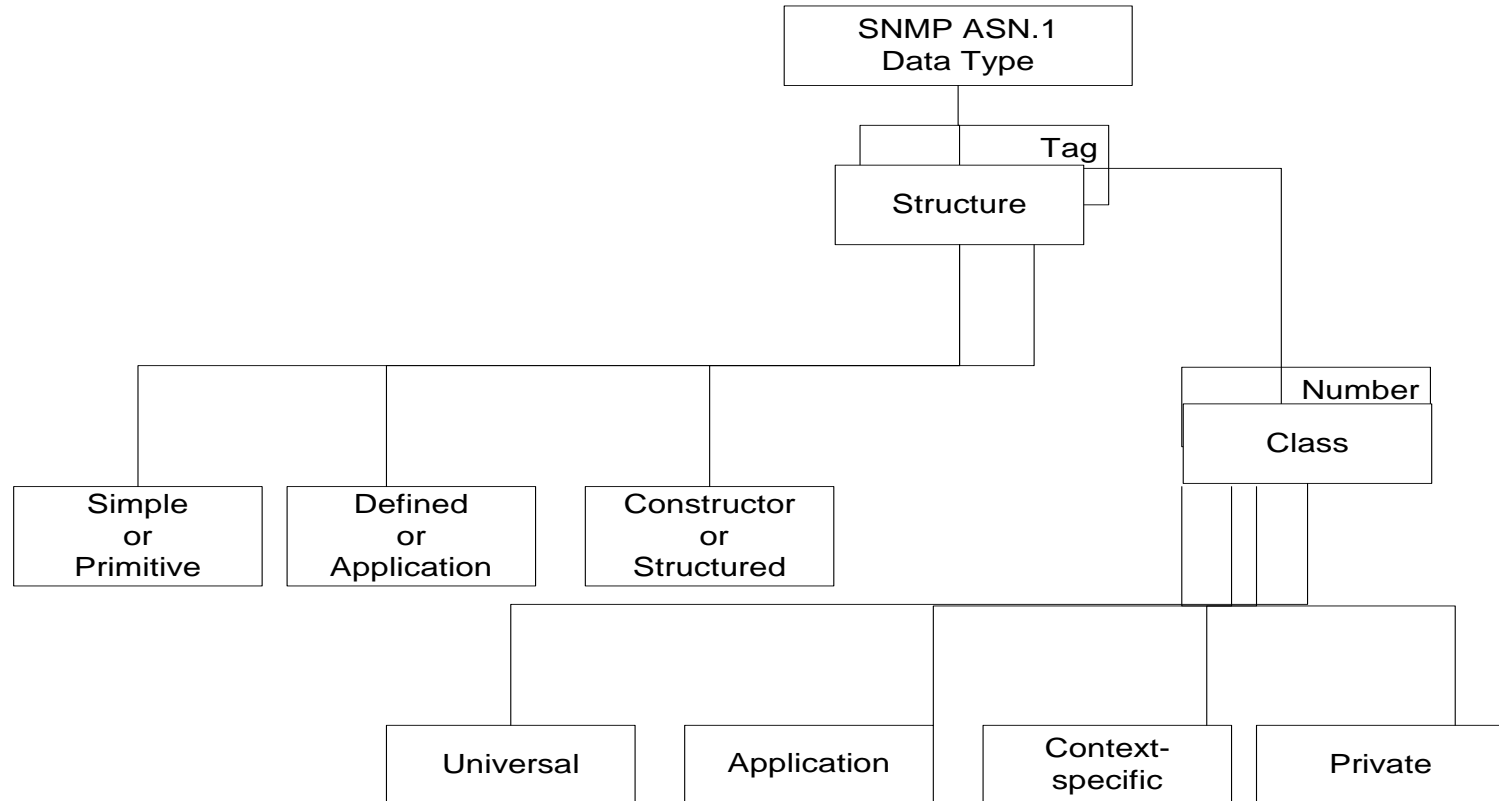


Figure 4.15 SNMP ASN.1 Data Type

## Primitive Data Types

Structure	Data Type	Comments
Primitive types	INTEGER	Subtype INTEGER (n1..nN) Special case: Enumerated INTEGER type
	OCTET STRING	8-bit bytes binary and textual data Subtypes can be specified by either range or fixed
	OBJECT IDENTIFIER	Object position in MIB
	NULL	Placeholder

---

# Enumerated

- Special case of INTEGER data type

```
error-status INTEGER {  
    noError(0)  
    tooBig(1)  
    genErr(5)  
    authorizationError(16)  
}
```

---

## Defined or Application Data Type

Defined types	NetworkAddress	Not used
	IpAddress	Dotted decimal IP address
	Counter	Wrap-around, non-negative integer, monotonically increasing, max $2^{32} - 1$
	Gauge	Capped, non-negative integer, increase or decrease
	TimeTicks	Non-negative integer in hundredths of second units
	Opaque	Application-wide arbitrary ASN.1 syntax, double wrapped OCTET STRING

---



# Constructor or Structured Data Type: SEQUENCE

- List maker

SEQUENCE { <type1>, <type2>, ..., <typeN> }

	Object	OBJECT IDENTIFIER	ObjectSyntax
1	ipAdEntAddr	{ ipAddrEntry 1 }	IpAddress
2	ipAdEntIfIndex	{ ipAddrEntry 2 }	INTEGER
3	ipAdEntNetMask	{ ipAddrEntry 3 }	IpAddress
4	ipAdEntBcastAddr	{ ipAddrEntry 4 }	INTEGER
5	ipAdEntReasmMaxSize	{ ipAddrEntry 5 }	INTEGER
6	ipAddrEntry	{ ipAddrTable 1 }	SEQUENCE

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

**Managed Object IpAddrEntry as a list**

# Constructor or Structured Data Type: SEQUENCE OF

SEQUENCE OF <entry>  
where <entry> is a list constructor

	Object Name	OBJECT IDENTIFIER	Syntax
7	ipAddrTable	{ip 20}	SEQUENCE OF

```
Table: IpAddrTable ::=
    SEQUENCE OF IpAddrEntry
```

**Managed Object ipAddrTable as a table**

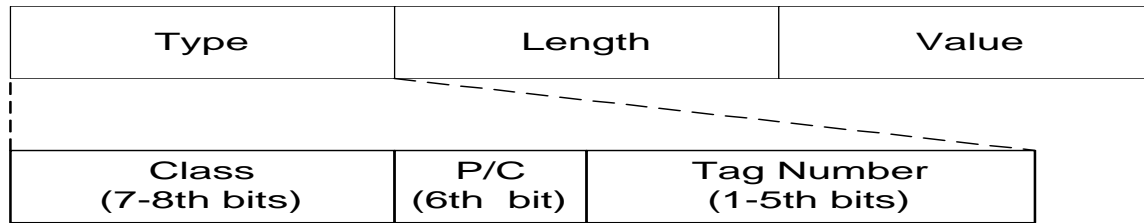
# SEQUENCE OF Example

Title: System Information : router1.gatech.edu  
 Name or IP Address: 172.16252.1

Index	Interface	IP address	Network Mask	Network Address	Link Address
23	LEC.1.0	192.168.3.1	255.255.255.0	192.168.3.0	0x00000C3920B4
25	LEC.3.9	192.168.252.15	255.255.255.0	192.168.252.0	0x00000C3920B4
13	Ethernet2/0	172.16..46.1	255.255.255.0	172.16..46.0	0x00000C3920AC
16	Ethernet2/3	172.16.49.1	255.255.255.0	172.16.49.0	0x00000C3920AF
17	Ethernet2/4	172.16.52.1	255.255.255.0	172.16.52.0	0x00000C3920B0
9	Ethernet1/2	172.16.55.1	255.255.255.0	172.16.55.0	0x00000C3920A6
2	Ethernet 0/1	172.16.56.1	255.255.255.0	172.16.56.0	0x00000C39209D
15	Ethernet2/2	172.16.57.1	255.255.255.0	172.16.57.0	0x00000C3920AE
8	Ethernet1/1	172.16.58.1	255.255.255.0	172.16.58.0	0x00000C3920A5
14	Ethernet2/1	172.16.60.1	255.255.255.0	172.16.60.0	0x00000C3920AD

# Encoding

- Basic Encoding Rules (BER)
  - Tag, Length, and Value (TLV)



- SNMP Data Types and Tags

Type	Tag
OBJECT IDENTIFIER	UNIVERSAL 6
SEQUENCE	UNIVERSAL 16
IpAddress	APPLICATION 0
Counter	APPLICATION 1
Gauge	APPLICATION 2
TimeTicks	APPLICATION 3
Opaque	APPLICATION 4

00000110 00000011 00101011 00000110 00000001

would be the BER for the object identifier {1 3 6 1}

Type = 6, length = 3, and the value is {1 3 6 1} where {1 3} is represented by the octet 43 (00101011)

# Managed Object: Structure

## OBJECT:

sysDescr:	{ system 1 }
Syntax:	OCTET STRING
Definition:	"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."
Access:	read-only
Status:	mandatory

**Figure 4.17 Specifications for System Description**

---

# Managed Object: Macro

```
OBJECT-TYPE MACRO ::=
BEGIN
    TYPE NOTATION ::= "SYNTAX" type (TYPE ObjectSyntax)
        "ACCESS" Access
        "STATUS" Status
    VALUE NOTATION ::= value (VALUE ObjectName)

    Access ::= "read-only" | "write-only" | "not-accessible"
    Status ::= "mandatory" | "optional" | "obsolete"

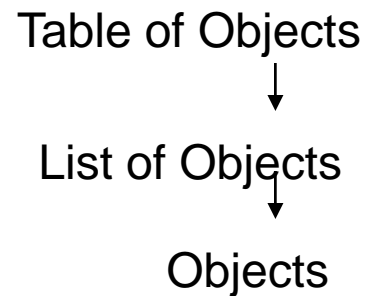
END
```

**Figure 4.18(a) OBJECT-TYPE Macro [RFC 1155]**



# Aggregate Object

- A group of objects
- Also called tabular objects
- Can be represented by a table with
  - Columns of objects
  - Rows of instances



# Aggregate M.O. Macro: Table Object

```
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 }
```

---



---

# Aggregate M.O. Macro: Entry Object

```
ipAddrEntry OBJECT-TYPE
    SYNTAX IpAddrEntry
    ACCESS not-accessible
    STATUS mandatory
    DESCRIPTION
        "The addressing information for one of this
entity's IP addresses."

    INDEX { ipEntAddr }
    ::= { ipAddressTable 1 }

IpAddrEntry ::=
    SEQUENCE {
        ipEntAddr
            IpAddress,
        ipEntIfIndex
            INTEGER,
        ipEntNetMask
            IpAddress,
        ipEntBroadcastAddr
            INTEGER,
        ipEntReasmMaxSize
            INTEGER (0..65535)
```

---

# Aggregate M.O. Macro: Columnar Objects

```
ipAdEntAddr OBJECT-TYPE
```

```
SYNTAX IpAddress
```

```
ACCESS read-only
```

```
STATUS mandatory
```

```
DESCRIPTION
```

```
"The IP address to which this entry's  
addressing information pertains."
```

```
::= { ipAddrEntry 1 }
```

```
ipAdEntReasmMaxSize OBJECT-TYPE
```

```
SYNTAX INTEGER (0..65535)
```

```
ACCESS read-only
```

```
STATUS mandatory
```

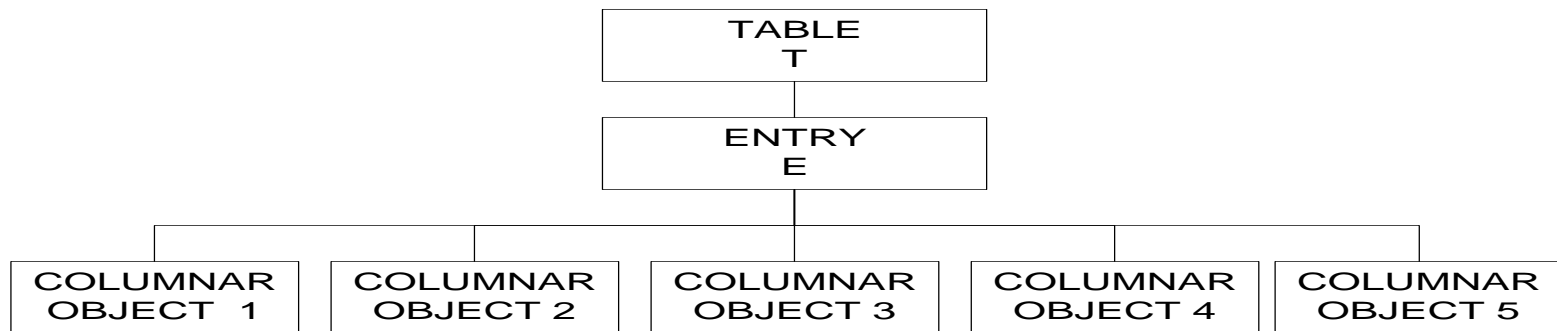
```
DESCRIPTION
```

```
"The size of the largest IP datagram which this  
entity can re-assemble from incoming IP  
fragmented datagrams received on this interface."
```

```
::= { ipAddrEntry 5 }
```

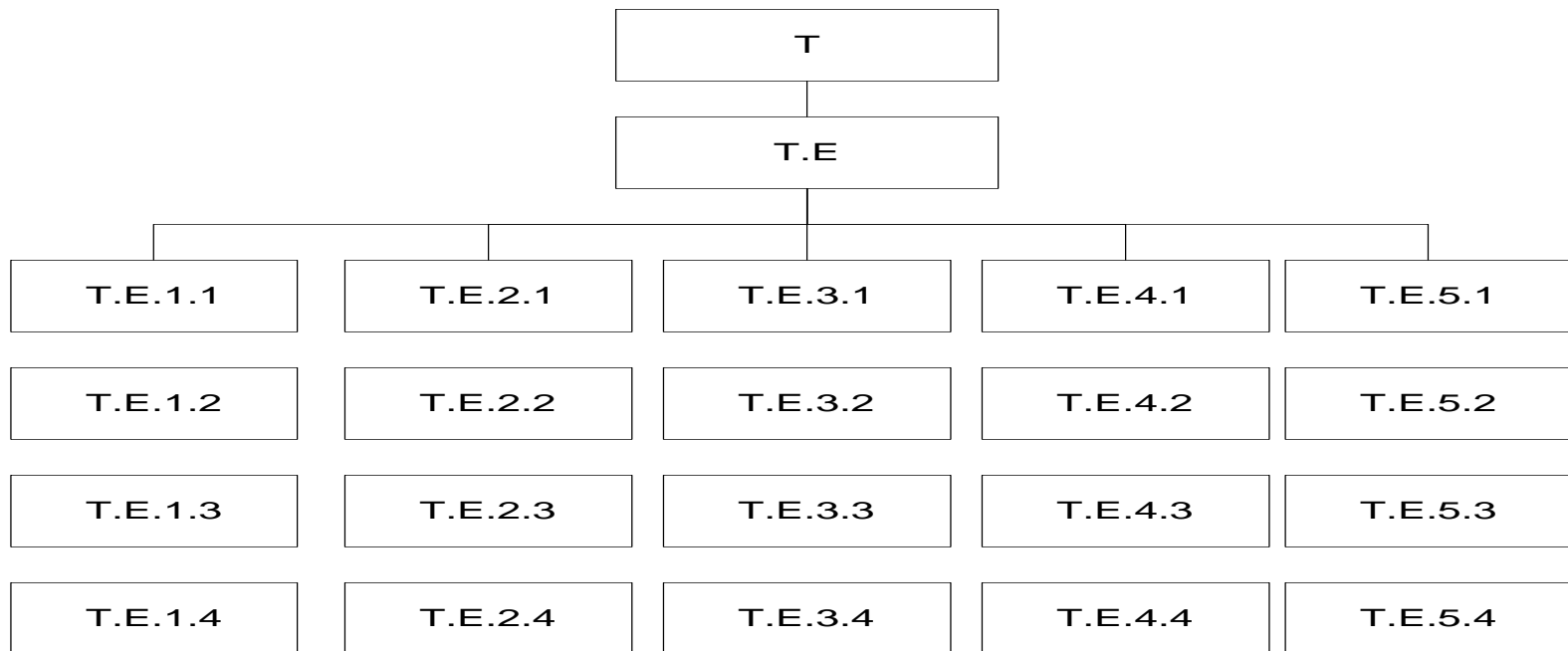
---

# Tabular Representation of Aggregate Object



**Figure 4.22(a) Multiple Instance Managed Object**

# Tabular Representation of Aggregate Object



**Figure 4.22(b) Example of 5 Columnar Object with 4 Instances (rows)**

# Multiple Instances of Aggregate Managed Object

```

ipAddrTable {1.3.6.1.2.1.4.20}
  ipAddrEntry (1)
    ipAddr (1)
    ipAddrEntIfIndex (2)
    ipAddrEntNetMask (3)
    ipAddrEntBroadcastAddr (4)
    ipAddrEntReasmMaxSize (5)

Columnar object ID of ipAddrEntBroadcastAddr is (1.3.6.1.2.1.4.20.1.4):

iso org dod internet mgmt mib ip ipAddrTable ipAddrEntry ipAddrEntBroadcastAddr
 1   3   6       1       2       1       4       20       1       4
Figure 4.23(a) Columnar objects under ipAddrEntry

```

Row	ipAddrEntAddr	ipAddrEntIfIndex	ipAddrEntNetMask	ipAddrEntBroadcastAddr	ipAddrEntReasmMaxSize
1	123.45.2.1	1	255.255.255.0	0	12000
2	123.45.3.4	3	255.255.0.0	1	12000
3	165.8.9.25	2	255.255.255.0	0	10000
4	9.9.6.8.138	4	255.255.255.0	0	15000

**Figure 4.23(b) Object instances of ipAddrTable (1.3.6.1.2.1.4.20)**

Columnar Object	Row # in (b)	Object Identifier
ipAddrEntAddr 1.3.6.1.2.1.4.20.1.1	2	{1.3.6.1.2.1.4.20.1.1.123.45.3.4}
ipAddrEntIfIndex 1.3.6.1.2.1.4.20.1.2	3	{1.3.6.1.2.1.4.20.1.2.165.8.9.25}
ipAddrEntBroadcastAddr 1.3.6.1.2.1.4.20.1.4	1	{1.3.6.1.2.1.4.20.1.4.123.45.2.1}
ipAddrEntReasmMaxSize 1.3.6.1.2.1.4.20.1.5	4	{1.3.6.1.2.1.4.20.1.5.9.9.6.8.138}

**Figure 4.23(c) Object Id for specific instance**

# SMI Definition STD 16 / 1155 RFC

```
RFC1155-SMIDEFINITIONS ::= BEGIN
```

```
EXPORTS -- EVERYTHING
```

```
internet, directory, mgmt, experimental, private, enterprises,  
OBJECT-TYPE, ObjectName, ObjectSyntax, SimpleSyntax,  
ApplicationSyntax, NetworkAddress, IpAddress, Counter, Gauge,  
TimeTicks, Opaque;
```

```
-- the path to the root
```

```
internet    OBJECT IDENTIFIER ::= { iso org(3) dod(6) 1 }
```

```
directory   OBJECT IDENTIFIER ::= { internet 1 }
```

```
mgmt        OBJECT IDENTIFIER ::= { internet 2 }
```

```
experimental OBJECT IDENTIFIER ::= { internet 3 }
```

```
private     OBJECT IDENTIFIER ::= { internet 4 }
```

```
enterprises OBJECT IDENTIFIER ::= { private 1 }
```

---

# SMI Definition STD 16 / 1155 RFC

-- definition of object types

```
OBJECT-TYPE MACRO ::=
BEGIN
  TYPE NOTATION ::= "SYNTAX" type (TYPE ObjectSyntax)
                  "ACCESS" Access
                  "STATUS" Status
  VALUE NOTATION ::= value (VALUE ObjectName)

  Access ::= "read-only" | "read-write" | "write-only" | "not-accessible"
  Status  ::= "mandatory" | "optional" | "obsolete"
END
```

---

# SMI Definition STD 16 / 1155 RFC

```
-- names of objects in the MIB
ObjectName ::=
    OBJECT IDENTIFIER

-- syntax of objects in the MIB
ObjectSyntax ::=
    CHOICE {
        simple
            SimpleSyntax,

        application-wide
            ApplicationSyntax
    }
```

---



---

# SMI Definition STD 16 / 1155 RFC

```
SimpleSyntax ::=
    CHOICE {
        number
        string
        object
        empty
        INTEGER,
        OCTET STRING,
        OBJECT IDENTIFIER,
        NULL
    }
```

```
ApplicationSyntax ::=
    CHOICE {
        address
        counter
        gauge
        ticks
        arbitrary
        NetworkAddress,
        Counter,
        Gauge,
        TimeTicks,
        Opaque
    }
```

```
defined, -- other application-wide types, as they are
          will be added here
          }
```



---

# SMI Definition STD 16 / 1155 RFC

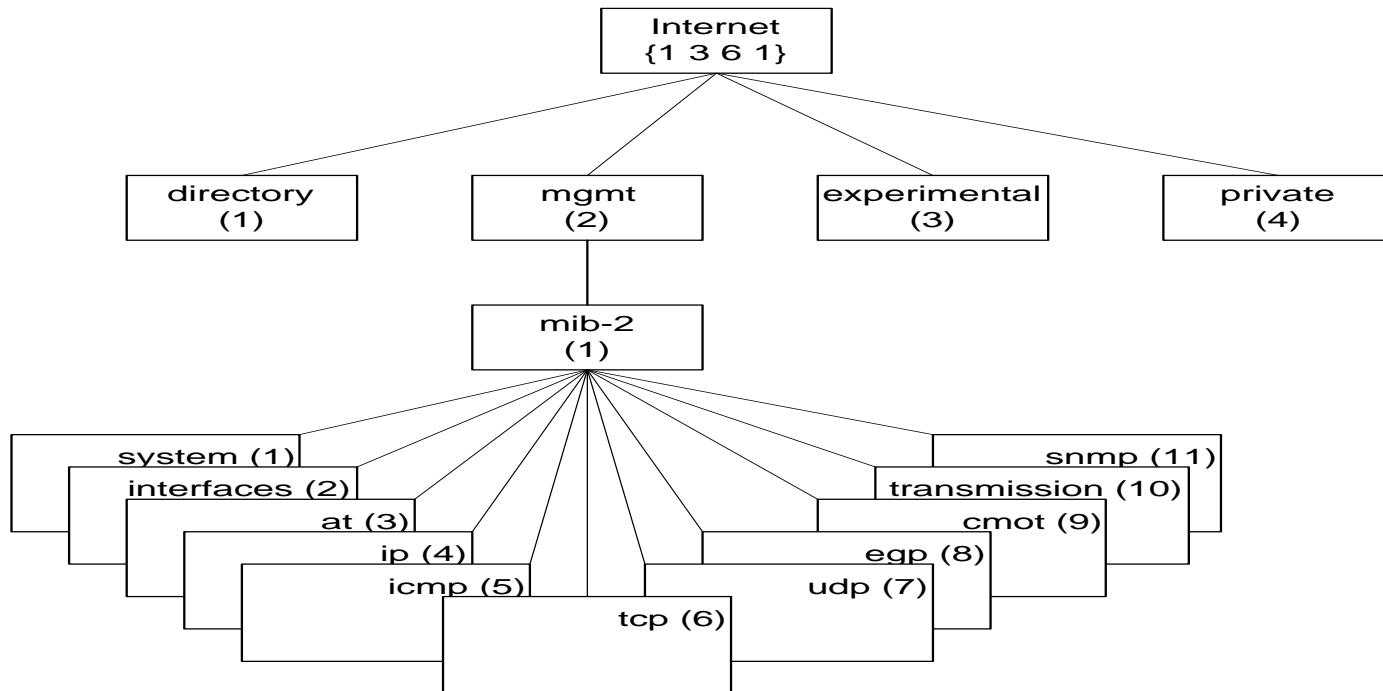
```
-- application-wide types

NetworkAddress ::=
    CHOICE {
        internet
            IpAddress
    }
IpAddress ::=
    [APPLICATION 0]          -- in network-byte order
        IMPLICIT OCTET STRING (SIZE (4))
Counter ::=
    [APPLICATION 1]
        IMPLICIT INTEGER (0..4294967295)
Gauge ::=
    [APPLICATION 2]
        IMPLICIT INTEGER (0..4294967295)
TimeTicks ::=
    [APPLICATION 3]
        IMPLICIT INTEGER (0..4294967295)
Opaque ::=
    [APPLICATION 4]          -- arbitrary ASN.1 value,
        IMPLICIT OCTET STRING -- "double-wrapped"

END
```

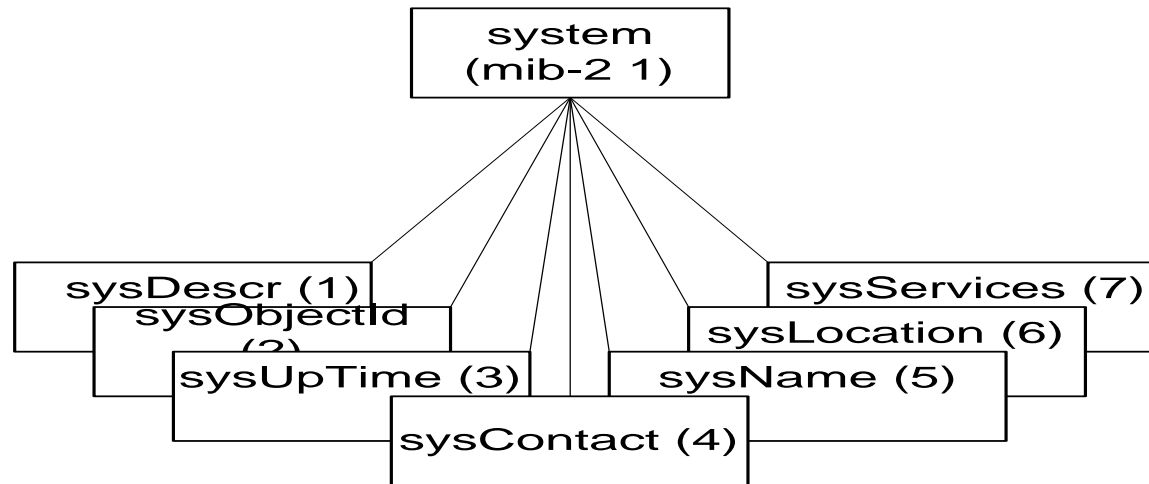
---

# MIB



**Figure 4.26 Internet MIB-II Group**

# System Group



**Figure 4.27 System Group**

Entity	OID	Description (brief)
sysDescr	system 1	Textual description
sysObjectID	system 2	OBJECT IDENTIFIER of the entity
sysUpTime	system 3	Time (in hundredths of a second since last reset)
sysContact	system 4	Contact person for the node
sysName	system 5	Administrative name of the system
sysLocation	system 6	Physical location of the node
sysServices	system 7	Value designating the layer services provided by the entity

---

# sysServices

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

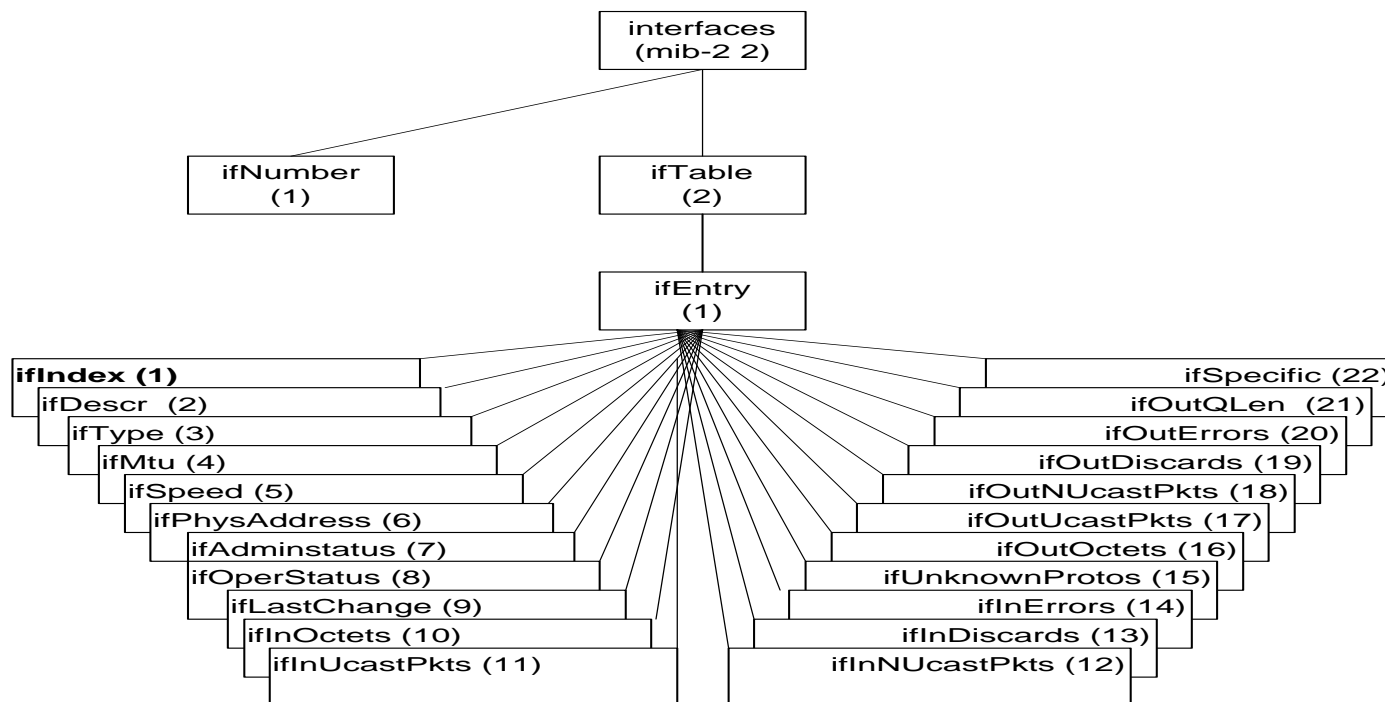
- 1 physical (e.g., repeaters)
- 2 datalink/subnetwork (e.g., bridges)
- 3 internet (e.g., IP gateways)
- 4 end-to-end (e.g., IP hosts)
- 7 applications (e.g., mail relays)

For systems including OSI protocols, layers 5 and 6 may also be counted."

::= { system 7 }

---

# Interfaces Group



Legend: INDEX in bold

Figure 4.28 Interfaces Group

---

# ifEntry

```
IfE n try  O B J E C T - T Y P E
           S Y N T A X      I f E n t r y
           A C C E S S     n o t - a c c e s s i b l e
           S T A T U S     m a n d a t o r y
           D E S C R I P T I O N
           "A n i n t e r f a c e e n t r y c o n t a i n i n g
           o b j e c t s a t t h e s u b n e t w o r k l a y e r a n d
           b e l o w f o r a p a r t i c u l a r i n t e r f a c e . "
           I N D E X   { i f I n d e x }
           ::= { i f T a b l e 1 }
```

- ifEntry specifies the objects in a row in the ifTable
  - Each interface is defined as a row in the table
-

---

# ifType

```
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),
        ... .. .
```

---



# IP Group

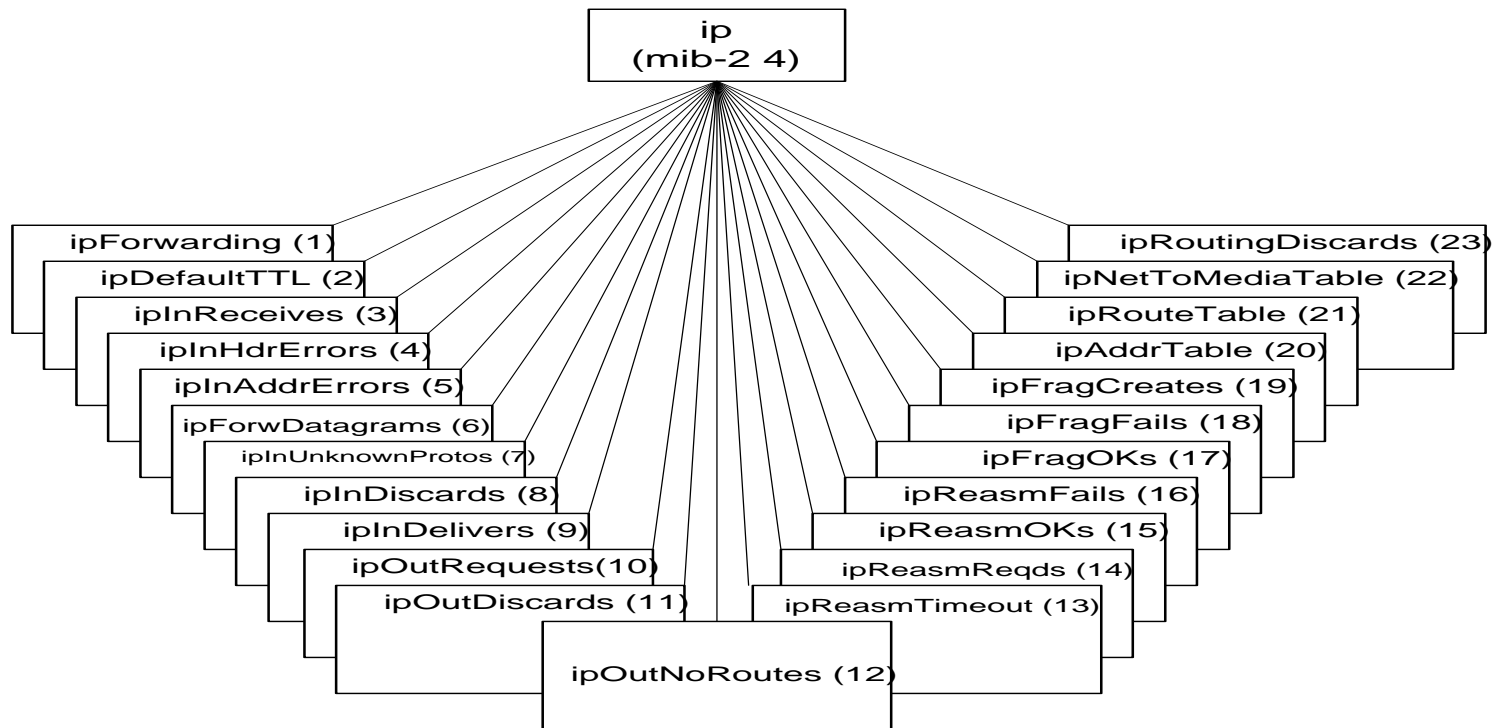
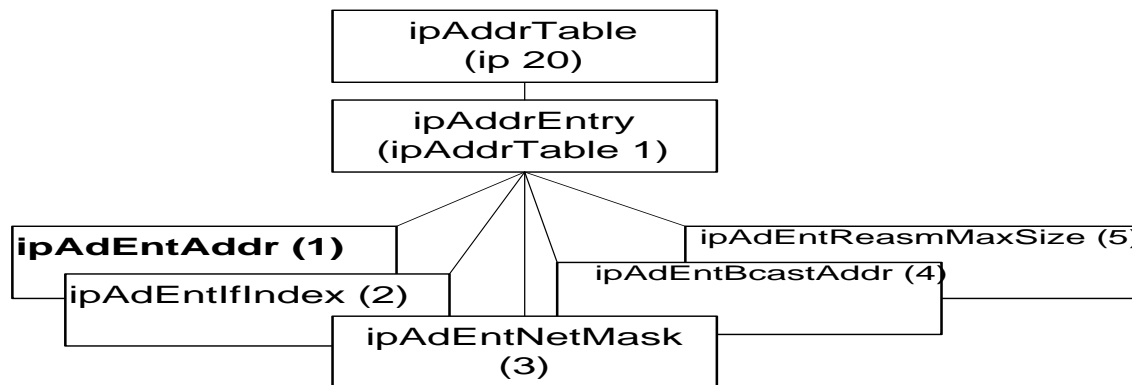


Figure 4.29 IP Group

# IP Address Table



Legend: INDEX in bold

**Figure 4.30 IP Address Table**

Entity	O ID	Description (brief)
ipAddrTable	ip 20	Table of IP addresses
ipAddrEntry	IpAddrTable 1	One of the entries in the IP address table
<b>ipAdEntAddr</b>	IpAddrEntry 1	The IP address to which this entry's addressing information pertains
ipAdEntIfIndex	IpAddrEntry 2	Index value of the entry, same as ifIndex
ipAdEntNetMask	IpAddrEntry 3	Subnet mask for the IP address of the entry
ipAdEntBcastAddr	IpAddrEntry 4	Broadcast address indicator bit
ipAdEntReasmMaxSize	IpAddrEntry 5	Largest IP datagram that can be reassembled on this interface

# IP Routing Table

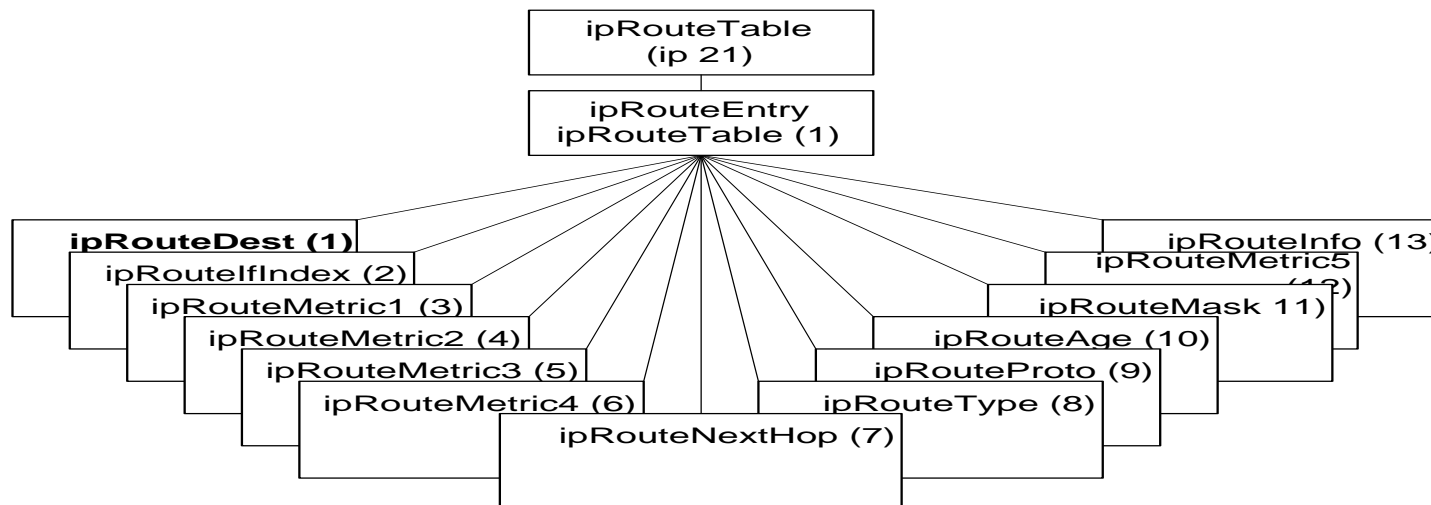


Figure 4.31 IP Routing Table

Entity	O ID	Description (brief)
ipRouteTable	ip 21	IP routing table
ipRouteEntry	ipRouteTable 1	Route to a particular destination
<b>ipRouteDest</b>	ipRouteEntry 1	Destination IP address of this route
ipRouteIfIndex	ipRouteEntry 2	Index of interface, same as ifIndex
ipRouteMetric1	ipRouteEntry 3	Primary routing metric for this route
ipRouteMetric2	ipRouteEntry 4	An alternative routing metric for this route
ipRouteMetric3	ipRouteEntry 5	An alternative routing metric for this route
ipRouteMetric4	ipRouteEntry 6	An alternative routing metric for this route
ipRouteNextHop	ipRouteEntry 7	IP address of the next hop
ipRouteType	ipRouteEntry 8	Type of route
ipRouteProto	ipRouteEntry 9	Routing mechanism by which this route was learned
ipRouteAge	ipRouteEntry 10	Number of seconds since routing was last updated
ipRouteMask	ipRouteEntry 11	Mask to be logically ANDed with the destination address before comparing with the ipRouteDest field
ipRouteMetric5	ipRouteEntry 12	An alternative metric for this route
ipRouteInfo	ipRouteEntry 13	Reference to MIB definition specific to the routing protocol

# IP Address Translation Table

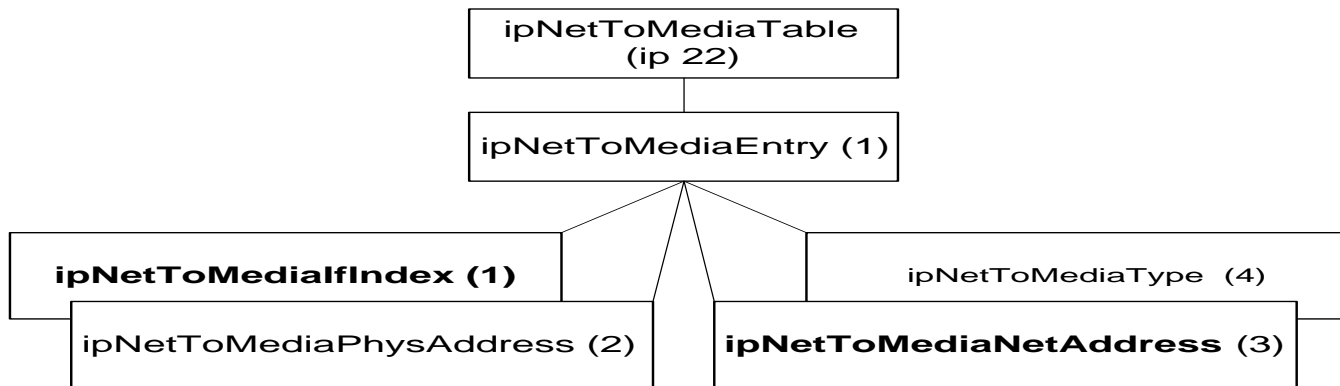


Figure 4.32 IP Address Translation Table

Entity	OID	Description (brief)
ipNetToMediaTable	ip 22	Table mapping IP addresses to physical addresses
ipNetToMediaEntry	ipNetToMediaTable 1	IP address to physical address for the particular interface
ipNetToMediaIfIndex	ipNetToMediaEntry 1	Interfaces on which this entry's equivalence is effective; same as ifIndex
ipNetToMediaPhysAddress	ipNetToMediaEntry 2	Media dependent physical address
ipNetToMediaNetAddress	ipNetToMediaEntry 3	IP address
ipNetToMediaType	ipNetToMediaEntry 4	Type of mapping

# ICMP Group

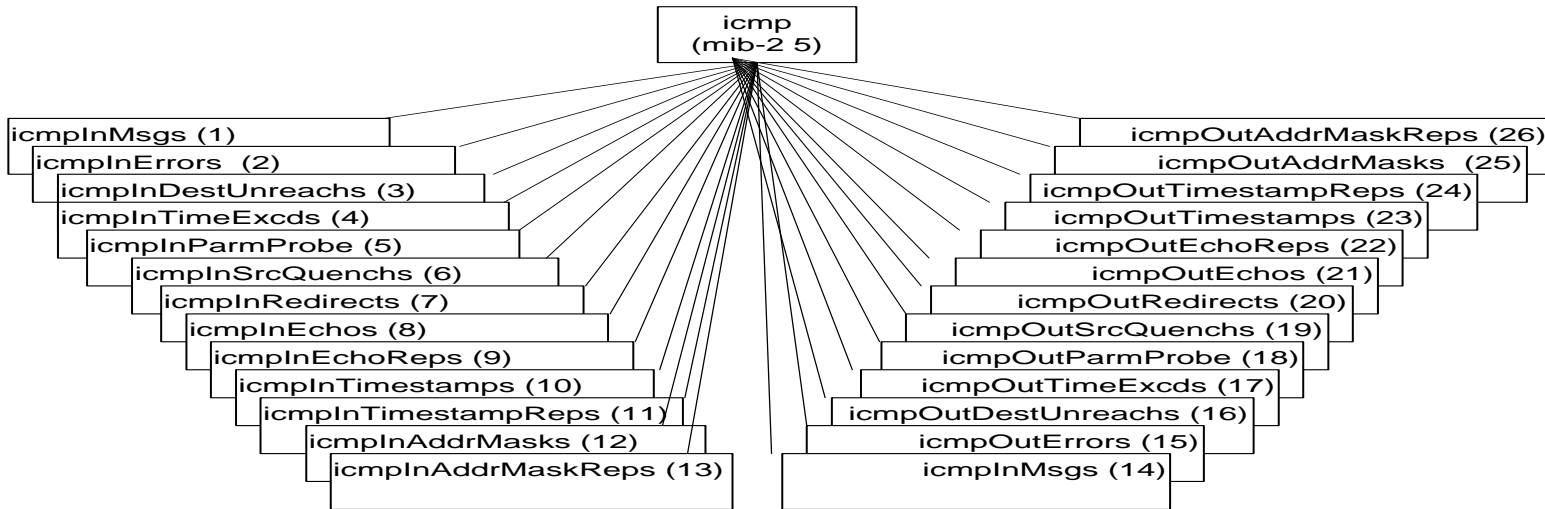


Figure 4.34 ICMP Group

- Objects associated with *ping*
  - icmpOutEchos # ICMP echo messages sent
  - icmpInEchoReps # ICMP echo reply messages received
- Objects associated with *traceroute/tracert*
  - icmpInTimeExcs # ICMP time exceeded messages received

# TCP Group

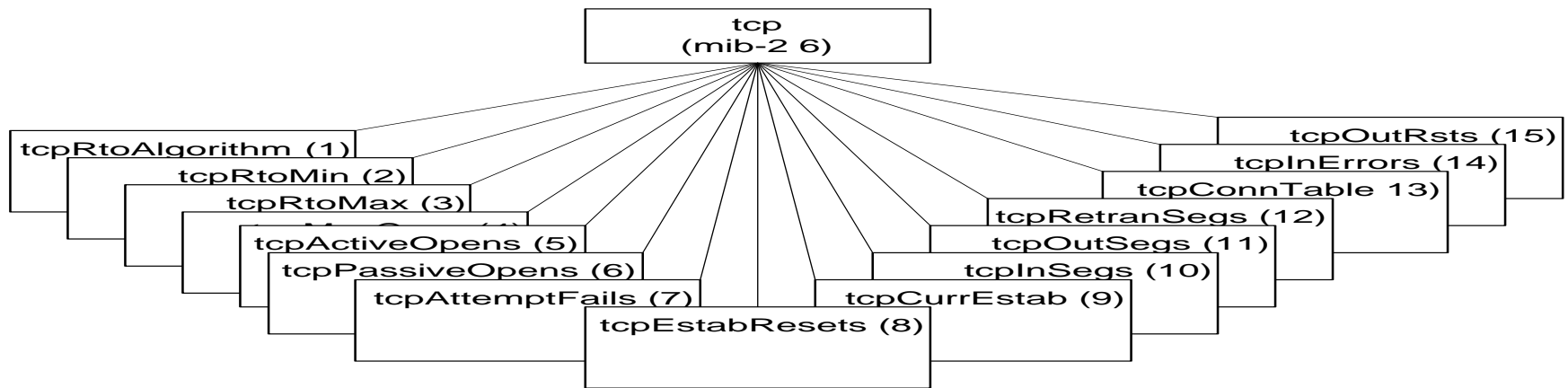


Figure 4.35 TCP Group

# TCP Connection Table

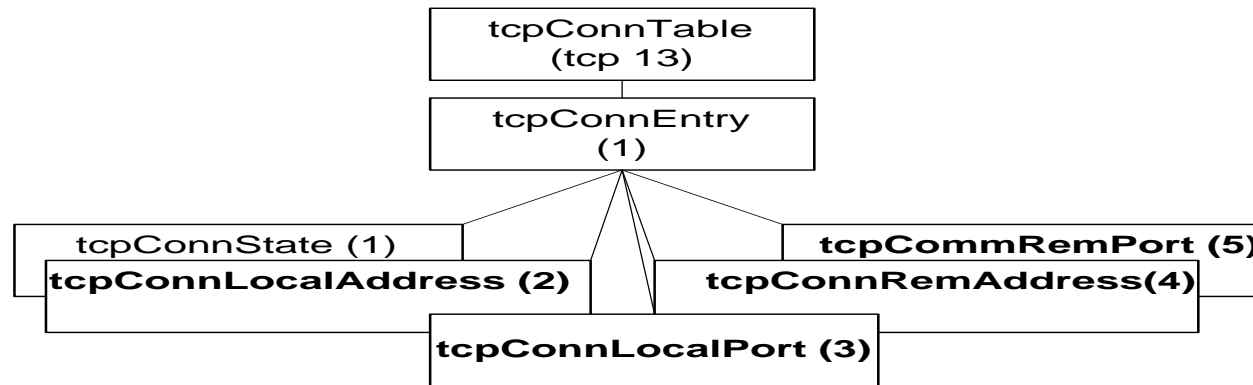
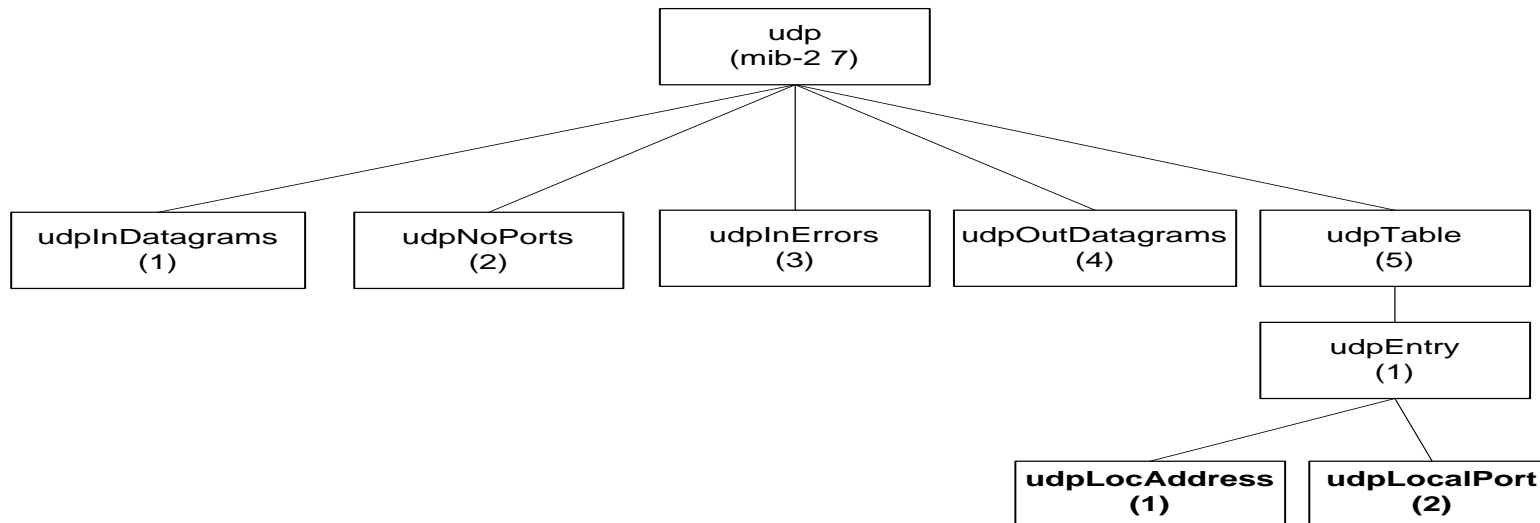


Figure 4.36 TCP Connection Table

Entity	OID	Description (brief)
tcpConnTable	tcp 13	TCP connection table
tcpConnEntry	TcpConnTable 1	Information about a particular TCP connection
tcpConnState	TcpConnEntry 1	State of the TCP connection
tcpConnLocalAddress	TcpConnEntry 2	Local IP address
tcpConnLocalPort	TcpConnEntry 3	Local port number
tcpConnRemAddress	TcpConnEntry 4	Remote IP address
tcpConnRemPort	TcpConnEntry 5	Remote port number

# UDP Group



**Figure 4.37 UDP Group**

Entity	O ID	Description (brief)
udpInDatagrams	udp 1	Total number of datagrams delivered to the users
udpNoPorts	udp 2	Total number of received datagrams for which there is no application
udpInErrors	udp 3	Number of received datagrams with errors
udpOutDatagrams	udp 4	Total number of datagrams sent
udpTable	udp 5	UDP Listener table
udpEntry	udpTable 1	Information about a particular connection or UDP listener
udpLocalAddress	udpEntry 1	Local IP address
udpLocalPort	udpEntry 2	Local UDP port