Network Management

Lecture 6

SNMP Management:

SNMPv2

Objectives

- Community-based security
- SNMPv2 enhancements
  - Additional messages
  - Formalization of SMI
- Get-bulk request and information-request
- SNMP MIB modifications
- Incompatibility with SNMPv1
- Proxy server
- Bilingual manager

Major Changes

- Bulk data transfer
- Manager-to-manager message
- Enhancements to SMI: SMIv2
    - Module definitions: MODULE-IDENTITY macro
    - Object definitions: OBJECT-TYPE macro
    - Trap definitions: NOTIFICATION-TYPE macro
- Textual conventions
- Conformance statements
- Row creation and deletion in table
- MIB enhancements
- Transport mappings

Notes

- Security features, originally to be in SNMPv2 moved to SNMPv3
- SNMPv2, like SNMPv1, is community-based administrative framework

SNMPv2 Internet Group

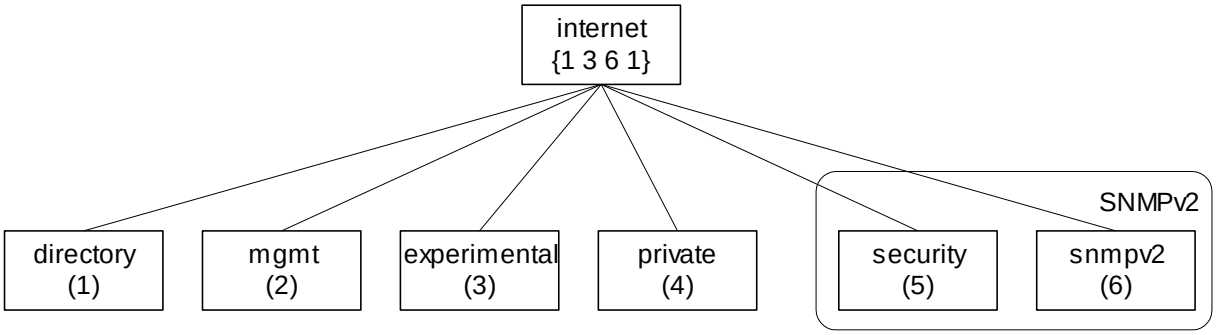


Figure 6.1 SNMPv2 Internet Group

Notes

- Objects added to System group
- Extensive modification of the SNMP group
- Additional SNMPv2 group added
- Security group is a placeholder

SNMPv2 NM Architecture

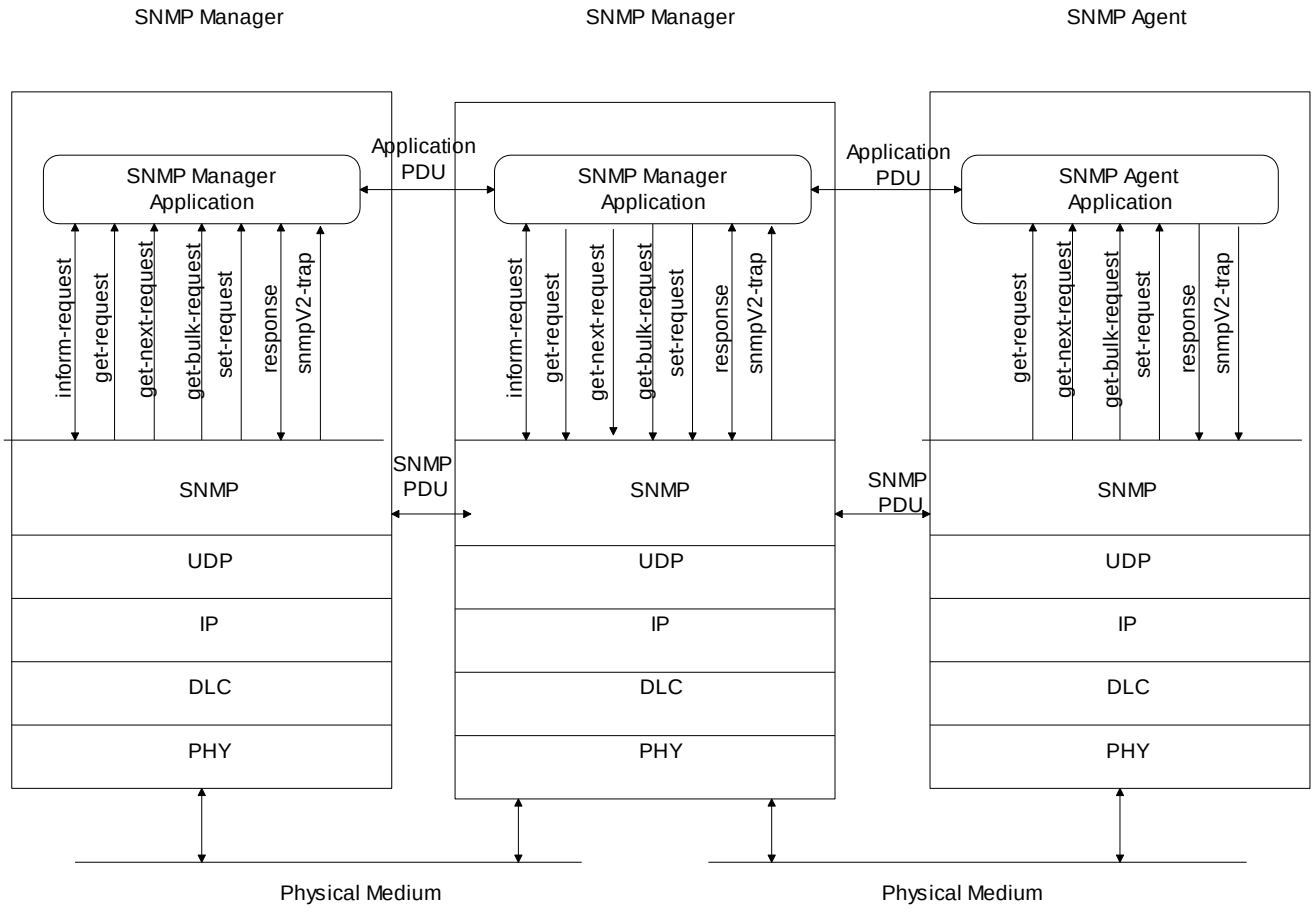


Figure 6.2 SNMPv2 Network Management Architecture

Notes

SNMPv2 New Messages

- inform-request
    - manager-to-manager message
- get-bulk-request
    - transfer of large data
- report
    - not used

Notes

Module Identity Macro

```
MODULE-IDENTITY MACRO ::=
BEGIN
        TYPE NOTATION ::=
                                "LAST-UPDATED" value (Update UTCTime)
                                "ORGANIZATION" Text
                                "CONTACT-INFO" Text
                                "DESCRIPTION" Text
                                RevisionPart
        VALUE NOTATION ::=
                                value (VALUE OBJECT IDENTIFIER)
        RevisionPart ::=        Revisions | empty
        Revisions ::= Revision | Revisions Revision
        Revision ::=
                "REVISION" value (UTCTime)
                "DESCRIPTION" Text
        -- uses the NVT ASCII character set
        Text ::= """" string """"
END
```

Figure 6.7 MODULE-IDENTITY Macro

Notes

- Module is a group of related assignments
- MODULE-IDENTITY macro defines the module definitions

```
isiMIBModule        MODULE-IDENTITY
        LAST-UPDATED    "9802101100Z"
        ORGANIZATION    "InfoTech Services Inc."
        CONTACT-INFO    "Mani Subramanian
                        Tele: 770-111-1111
                        Fax: 770-111-2222
                        email: manis@bellsouth.net"
        DESCRIPTION     " Version 1.1 of the InfoTech Services MIB module"
        Revision        "9709021500Z"
        DESCRIPTION     "Revision 1.0 on September 2, 1997 was a draft
                        version"
```

Figure 6.8 Example of MODULE-IDENTITY Macro

OBJECT ??

- OBJECT IDENTIFIER defines the *administrative identification* of a node in the MIB
- OBJECT-IDENTITY macro *assigns* an object identifier to an object identifier in the MIB
- OBJECT-TYPE macro defines the *type* of a managed object

Notes

OBJECT-IDENTITY / OBJECT-TYPE

- OBJECT-IDENTITY is high level description
- OBJECT-TYPE details description needed for implementation

```
isiRouter  OBJECT-IDENTITY
        STATUS          current
        DESCRIPTION     "An 8-slot IP router in the IP router
                         family."
        REFERENCE  "ISI Memorandum No. ISI-R123 dated
                    January. 20, 1997"
        ::= {private.enterprises.isi 1}
```

Figure 6.10(a) Example of OBJECT-IDENTITY Macro

```
routerIsi123     OBJECT-TYPE
        SYNTAX          DisplayString
        MAX-ACCESS      read-only
        STATUS          current
        DESCRIPTION     "An 8-slot IP router that can
                         switch up to 100 million packets
                         per second."
        ::= {isiRouter 1}
```

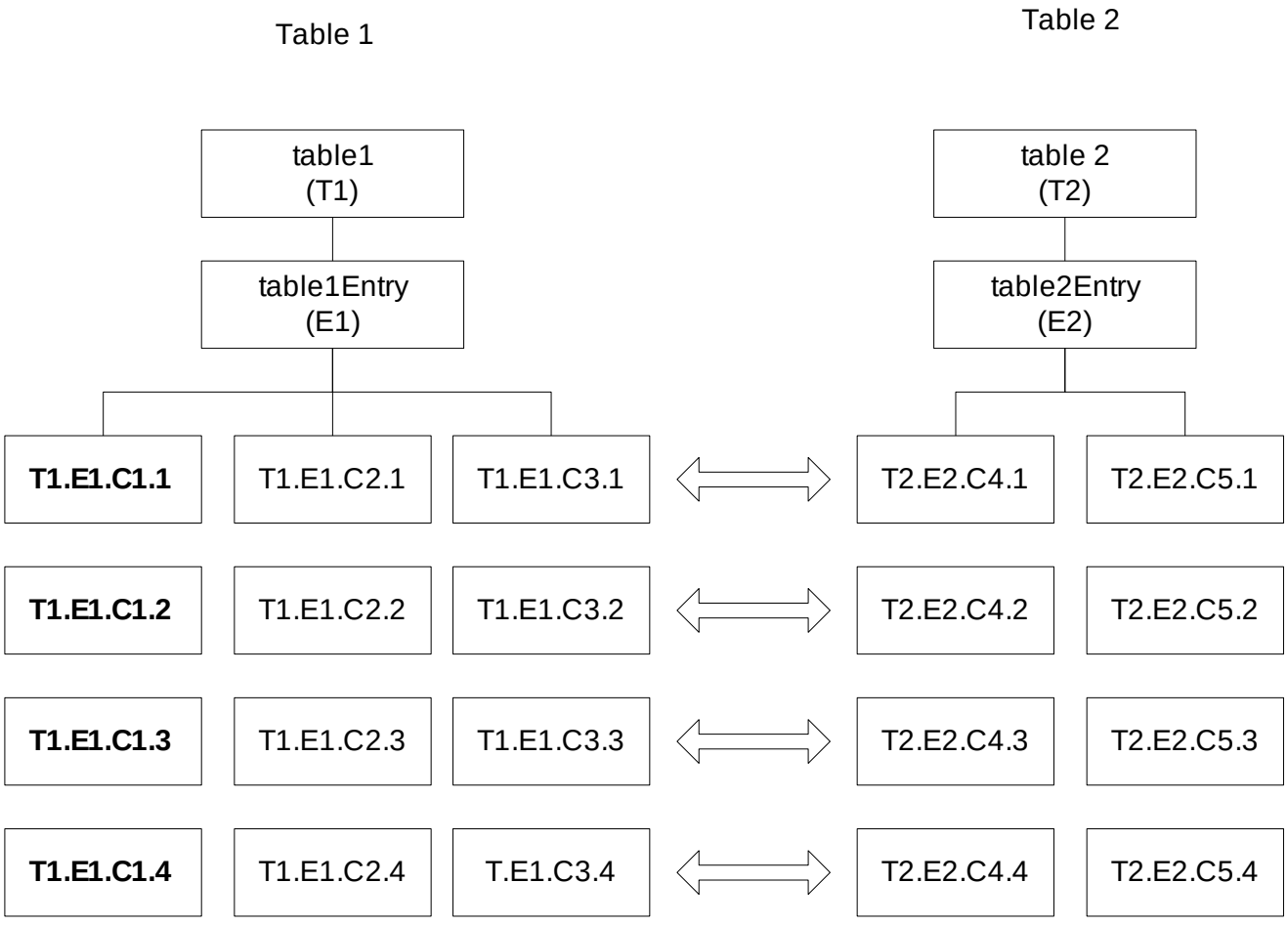
Figure 6.10(b) Example of OBJECT-TYPE Macro

Table Expansion

- Augmentation of a table (dependent table) adds additional columns to an existing table (base table)
- Dense table enables addition of more rows to base table
- Sparse table supplements less rows to a base table

Notes

Augmentation of Tables



Index:
First columnar object in Table 1

Conceptual rows:
1. T1.E1.C1.1
2. T1.E1.C1.2
3. T1.E1.C1.3
4. T1.E1.C1.4

Figure 6.11 Augmentation of Tables

Augmentation of Tables: Example

```
ipAddrTable     OBJECT-TYPE
        SYNTAX          SEQUENCE OF IpAddrEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION     "The table …"
        ::= {ip 20}

ipAddrEntry     OBJECT-TYPE
        SYNTAX          IpAddrEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION     "The addressing information…"
        INDEX           {ipAdEntAddr}
        ;;= {ipAddrTable 1}

ipAugAddrTable      OBJECT-TYPE
        SYNTAX          SEQUENCE OF IpAugAddrEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION     "The augmented table to IP
                        address table defining board and
                        port numbers"
        ::= {ipAug 1}

ipAugAddrEntry      OBJECT-TYPE
        SYNTAX          IpAugAddrEntry
        MAX-ACCESS      not-accessible
        STATUS          current
        DESCRIPTION     "The addressing information …"
        AUGMENTS        {ipAddrEntry}
        ::= {ipAugAddrTable 1}
```

Figure 6.13 Example of Augmentation of Tables

Textual Convention

- Enables defining new data types
- Makes semantics of data types consistent and human readable
- Creates new data types using existing ones and applies restrictions to them
- An important textual convention in SNMPv2, *RowStatus* creates and deletes rows

Notes

- SNMPV1:

```
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)
```

- SNMPv2:

```
DisplayString ::= TEXTUAL-CONVENTION
        DISPLAY-HINT      "255a"
        STATUS            current
        DESCRIPTION       "Represents textual
                          information taken from  the NVT
                          ASCII character set, as defined in
                          pages 4, 10-11 of RFC 854. …."
        SYNTAX            OCTET STRING (SIZE  (0..255) )
```

Creation of Row: RowStatus

Table 6.4 RowStatus Textual Convention

State	Enumer-ation	Description
active	1	Row exists and is operational
notInService	2	Operation on the row is suspended
notReady	3	Row does not have all the columnar objects needed
createAndGo	4	This is a one-step process of creation of a row; immediately goes into active state
createAndWait	5	Row is under creation and should not be commissioned into service
destroy	6	Same as Invalid in EntryStatus. Row should be deleted

Notes

- Status: A new column is added to the conceptual table
- SYNTAX of Status is RowStatus
- Value of RowStatus is Enumerated INTEGER

Row Creation and Deletion

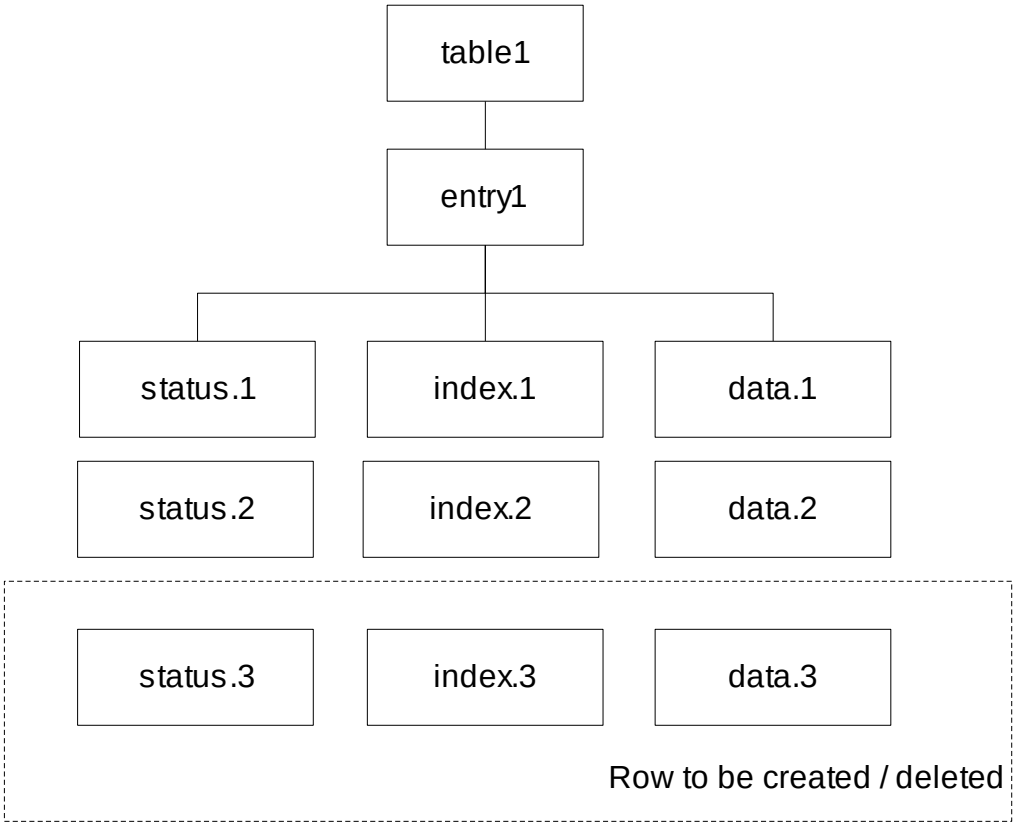


Figure 6.19 Conceptual Table for Creation and Deletion of Row

Notes

Create-and-Go Row Creation

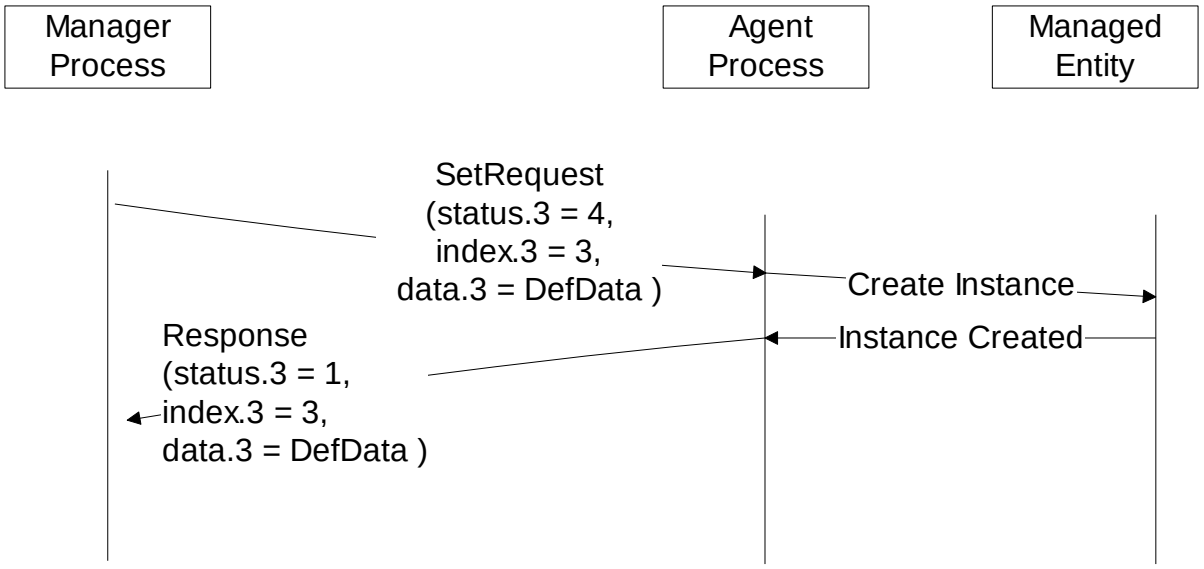


Figure 6.20 Create-and-Go Row Creation

Create-and-Wait: Row Creation

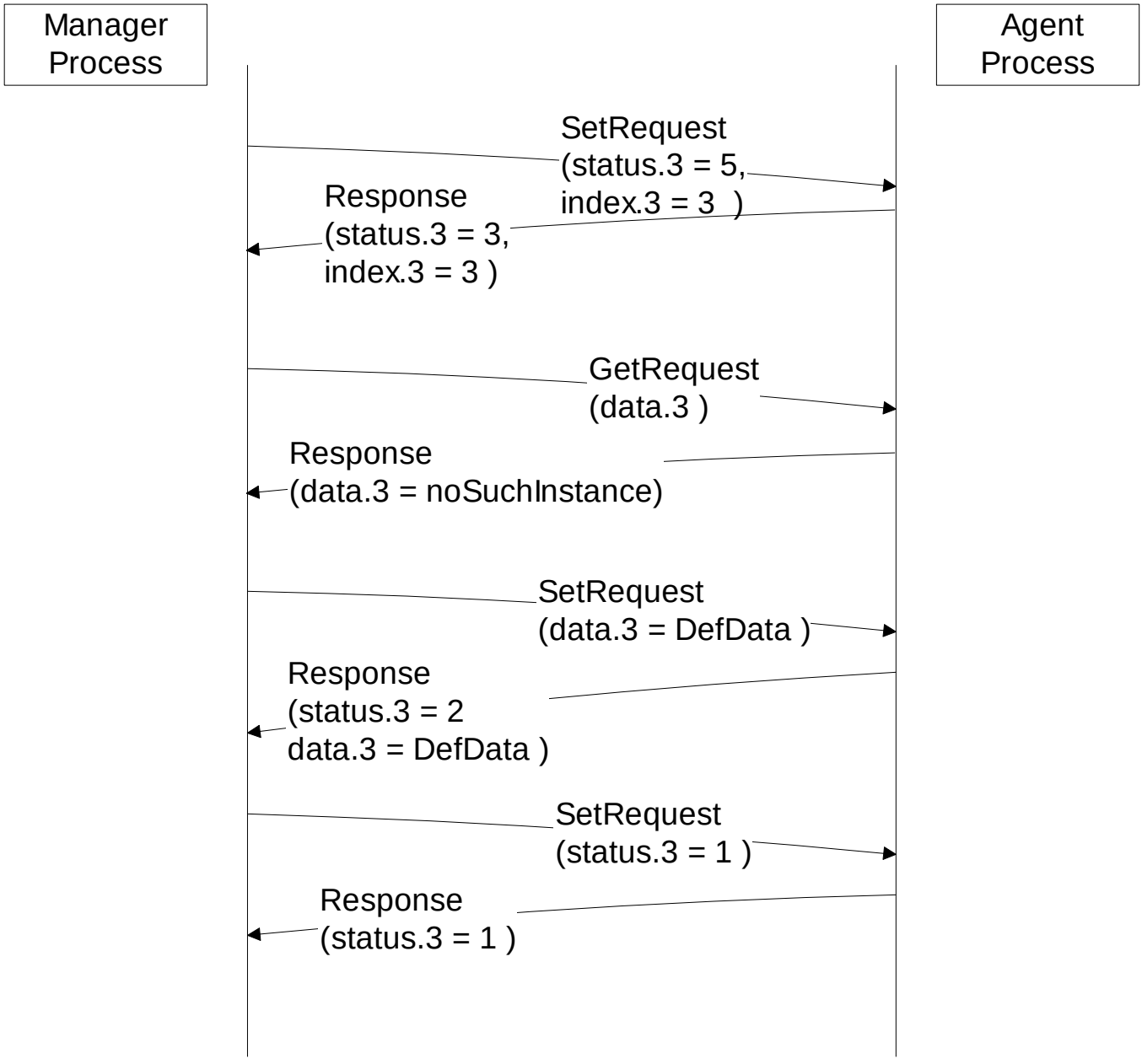


Figure 6.21 Create-and-Wait Row Creation

Row Deletion

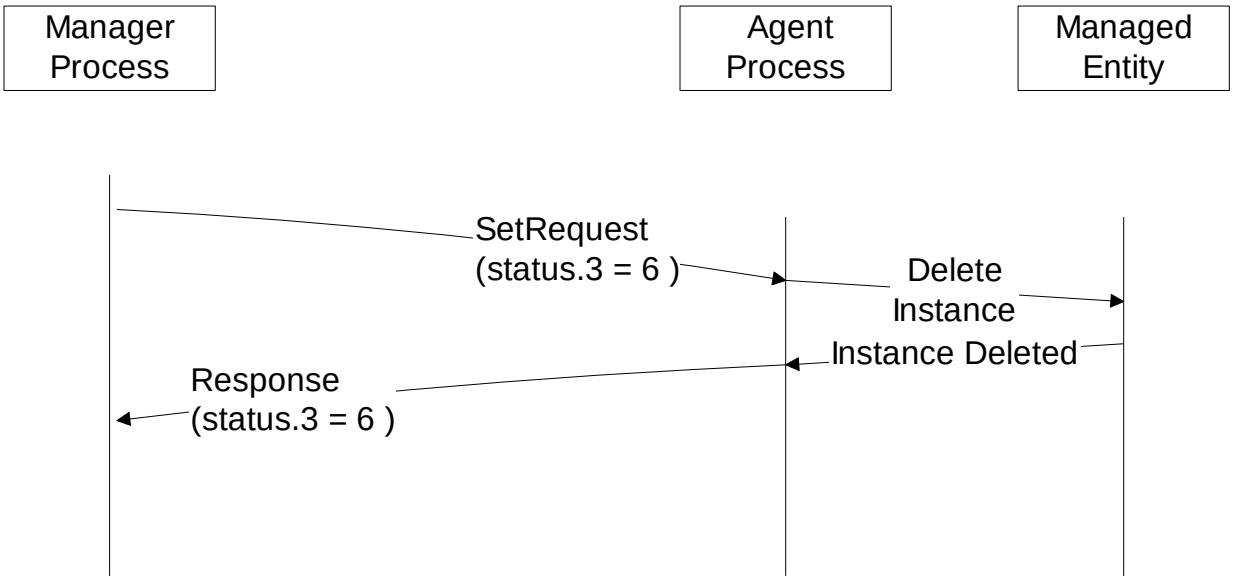


Figure 6.22 Row Deletion

SNMPv2 MIB

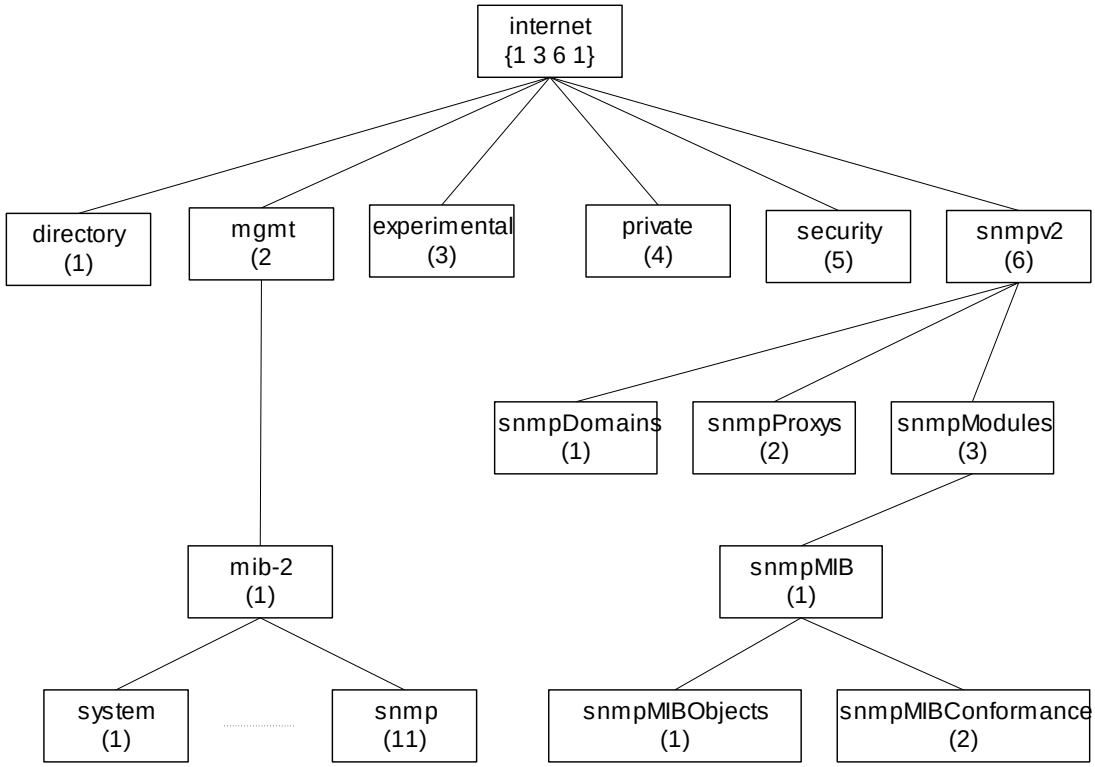


Figure 6.31 SNMPv2 Internet Group

Notes

- Security is a placeholder
- System group: A table sysORTable added that lists resources that the agent controls; NMS configures NE through the agents.
- Most of the objects in the SNMPv1 obsoleted
- Object Groups and Notification Groups defined for conformance specifications.

Conformance: OBJECT-GROUP

- Conformance defined by
  - OBJECT-GROUP macro
  - NOTIFICATION-GROUP macro
- OBJECT-GROUP
  - Compiled during implementation, not at run time
  - OBJECTS clause names each object
  - Every object belongs to an OBJECT-GROUP
  - Access defined by MAX-ACCESS, the maximum access privilege for the object

Notes

```
systemGroup         OBJECT-GROUP
        OBJECTS     {sysDescr, sysObjectID, sysUpTime, sysContact, sysName,
                    sysLocation, sysServices, sysORLastChange, sysORID,
                    sysORUptime, sysORDesc}
        STATUS      current
        DESCRIPTION     "The system group defines objects which are common
                        to all managed systems."
        ::= {snmpMIBGroups 6}
```

Figure 6.25 Example of OBJECT-GROUP Macro

Conformance: NOTIFICATION-GROUP

- NOTIFICATION-GROUP
  - Contains trap entities defined in SMIv1
  - NOTIFICATIONS clause identifies the notifications in the group
  - NOTIFICATIONS-GROUP macro compiled during implementation, not at run time

Notes

```
snmpBasicNotificationsGroup NOTIFICATION-GROUP
        NOTIFICATIONS           {coldStart, authenticationFailure}
        STATUS                  current
        DESCRIPTION     "The two notifications which an SNMP-2 entity is
                         required to implement."
        ::= {snmpMIBGroups 7}
```

Figure 6.27 Example of NOTIFICATION-GROUP Macro

Compliance

- Compliance has two classes of groups
  - MANDATORY-GROUPS ... Required
  - GROUP …Optional

Notes

```
-- compliance statements

snmpBasicCompliance MODULE-COMPLIANCE
        STATUS      current
        DESCRIPTION
                    "The compliance statement for SNMPv2 entities which
                    implement the SNMPv2 MIB."
        MODULE      -- this module
                MANDATORY-GROUPS  {snmpGroup, snmpSetGroup,
                                   systemGroup,
                                   snmpBasicNotificationsGroup}
                GROUP       snmpCommunityGroup
                DESCRIPTION
                    "This group is mandatory for SNMPv2 entities which support
                    community-based authentication."
        ::=  {snmpMIBCompliances  2 }

-- units of conformance
snmpGroup   OBJECT-GROUP    ::= {snmpMIBGroups 8}
snmpCommunityGroup      OBJECT-GROUP ::= {snmpMIBGroups 9}
snmpObsoleteGroup OBJECT-GROUP ::=  {snmpMIBGroups 10}
        …               …               …               …
```

Agent Capabilities

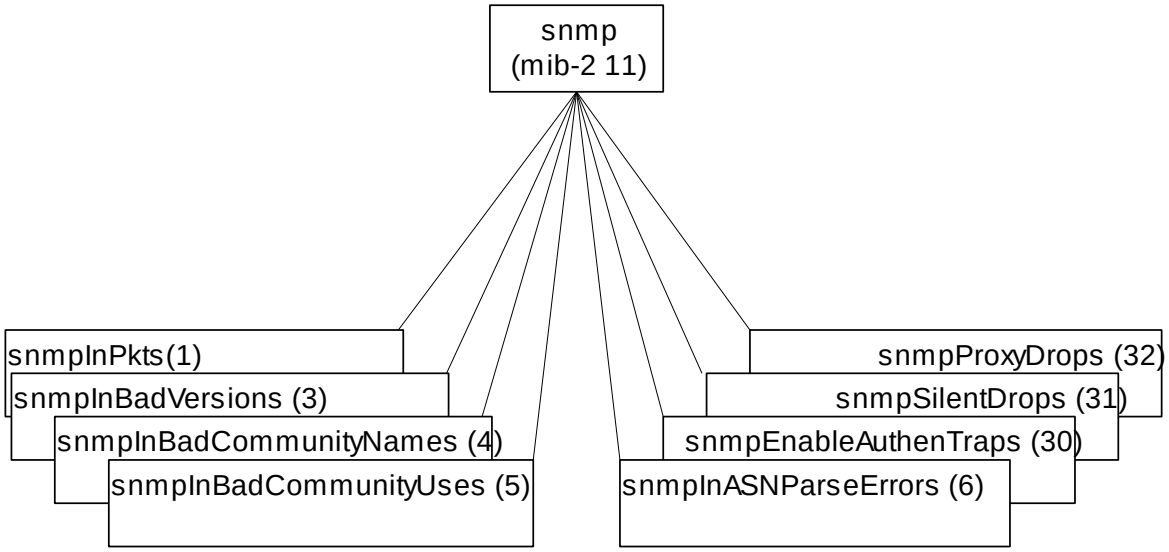
- AGENT-CAPABILITIES macro
  - SUPPORTS modules and includes groups
  - VARIATION identifies additional features

Notes

```
routerIsi123 AGENT-CAPABILITIES
        PRODUCT-RELEASE     "InfoTech Router isiRouter123 release 1.0"
        STATUS              current
        DESCRIPTION         "InfoTech High Speed Router"
        SUPPORTS            snmpMIB
                INCLUDES    {systemGroup, snmpGroup, snmpSetGroup,
                            snmpBasicNotificationsGroup  }
                VARIATION   coldStart
                        DESCRIPTION     "A coldStart trap is generated on all
                                        reboots."
        SUPPORTS                        IF-MIB
                INCLUDES                {ifGeneralGroup, ifPacketGroup}
        SUPPORTS                        IP MIB
                INCLUDES                {ipGroup, icmpGroup}
        SUPPORTS                        TCP-MIB
                INCLUDES                {tcpGroup}
        SUPPORTS                        UDP-MIB
                INCLUDES                {udpGroup}
        SUPPORTS                        EGP-MIB
                INCLUDES                {egpGroup}
        ::= {  isiRouter 1  }
```

Figure 6.30 Example of AGENT-CAPABILITIES Macro

SNMPv2 SNMP MIB



SNMP Group Objects	
1,3,6,30,31,32	snmpGroup
4,5	snmpCommunity Group
7,23	not used
2,8-23, 24-29	snmpObsoleteGroup

Figure 6.33 SNMPv2 SNMP Group

Notes

- Compare this to SNMPv1 MIB!

snmpMIBObjects MIB

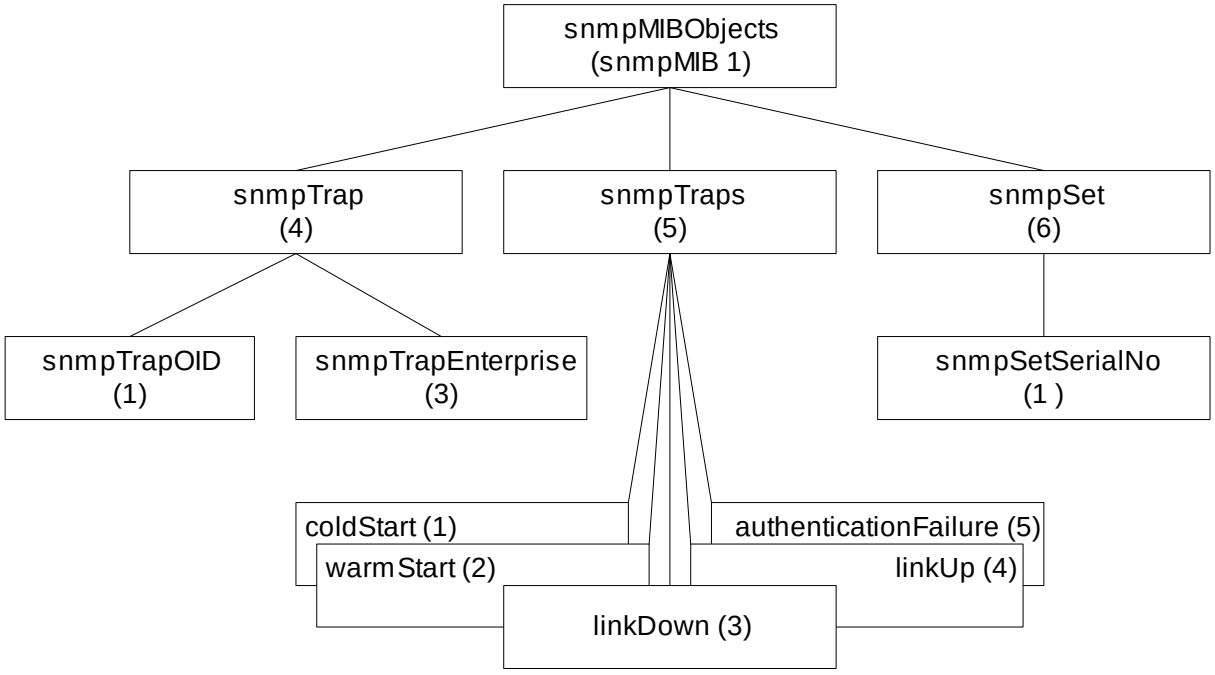


Figure 6.34 MIB Modules under snmpMIBObjects

Notes

SNMPv2 PDU

PDU Type	RequestID	Error Status	Error Index	VarBind 1 name	VarBind 1 value	...	VarBind n name	VarBind n value

Figure 6.37 SNMPv2 PDU (all but Bulk)

Notes

- Standardized format for all messages
- Interpretation of error status and error index fields; In v1, if error occurs status and index field filled, but varBindList blank

Interpretation in v2	Status	Index
varBindList ignored	x	
varBind of index field ignored	x	x

SNMPv2 PDU and Error Status

Table 6.11 Values for Types of PDU and Error-status Fields in SNMPv2 PDU

Field	Type	Value
PDU	0	Get-Request-PDU
	1	GetNextRequest-PDU
	2	Response-PDU
	3	Set-Request- PDU
	4	obsolete
	5	GetBulkRequest-- PDU
	6	InformRequest- PDU
	7	SNMPv2 - Trap- PDU
Error Status	0	noError
	1	tooBig
	2	noSuchName
	3	badValue
	4	readOnly
	5	genErr
	6	noAccess
	7	wrongType
	8	wrongLength
	9	wrongEncoding
	10	wrongValue
	11	noCreation
	12	inconsistentValue
	13	resourceUnavailable
	14	commitFailed
	15	undoFailed
	16	authorizationError
	17	notWritable
	18	inconsistentName

SNMPv2 GetBulkRequest PDU

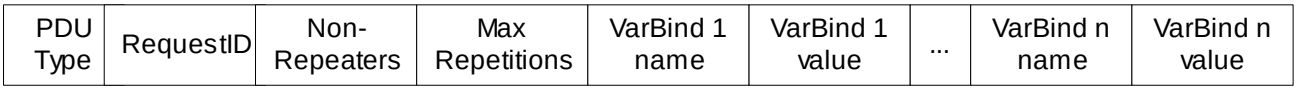


Figure 6.38 SNMPv2 GetBulkRequest PDU

Notes

- *Error status* field replaced by *Non-repeaters*
- *Error index* field replaced by *Max repetitions*
- No one-to-one relationship between request and response

Get-Bulk-Request: Generic MIB

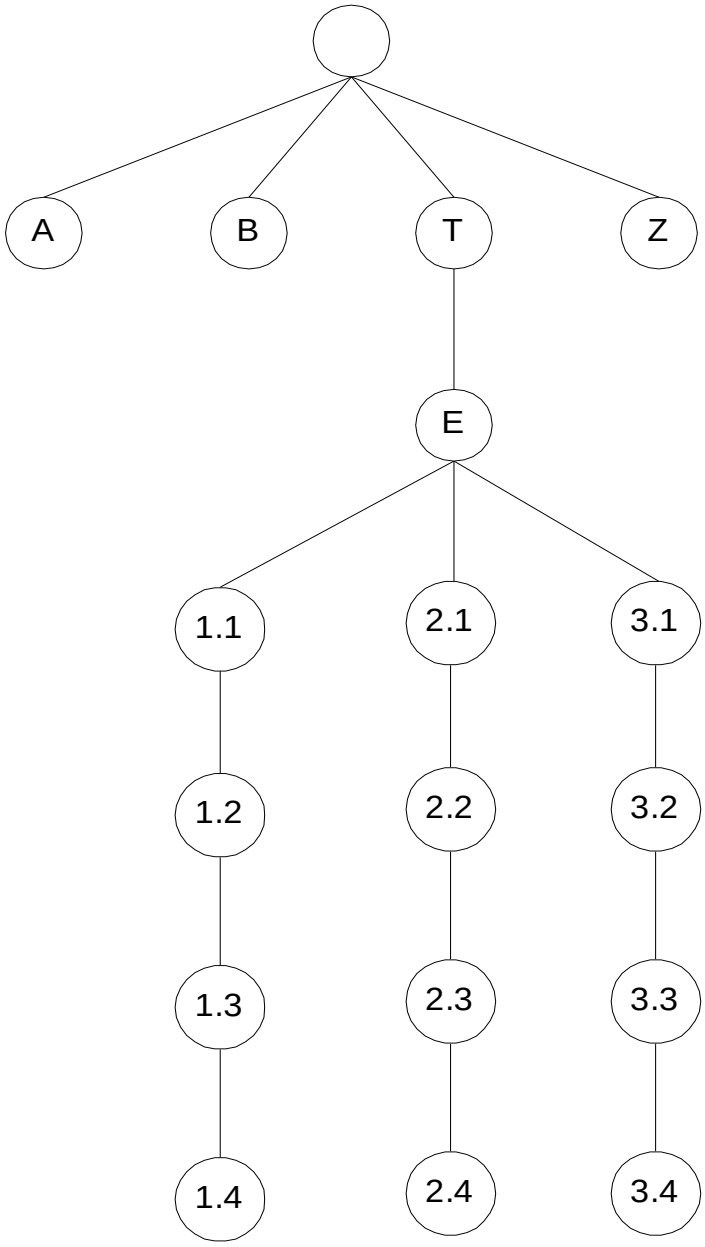


Figure 6.39 MIB for Operation Sequences in Figures 6.40 and 6.41

Get-Next-Request Operation

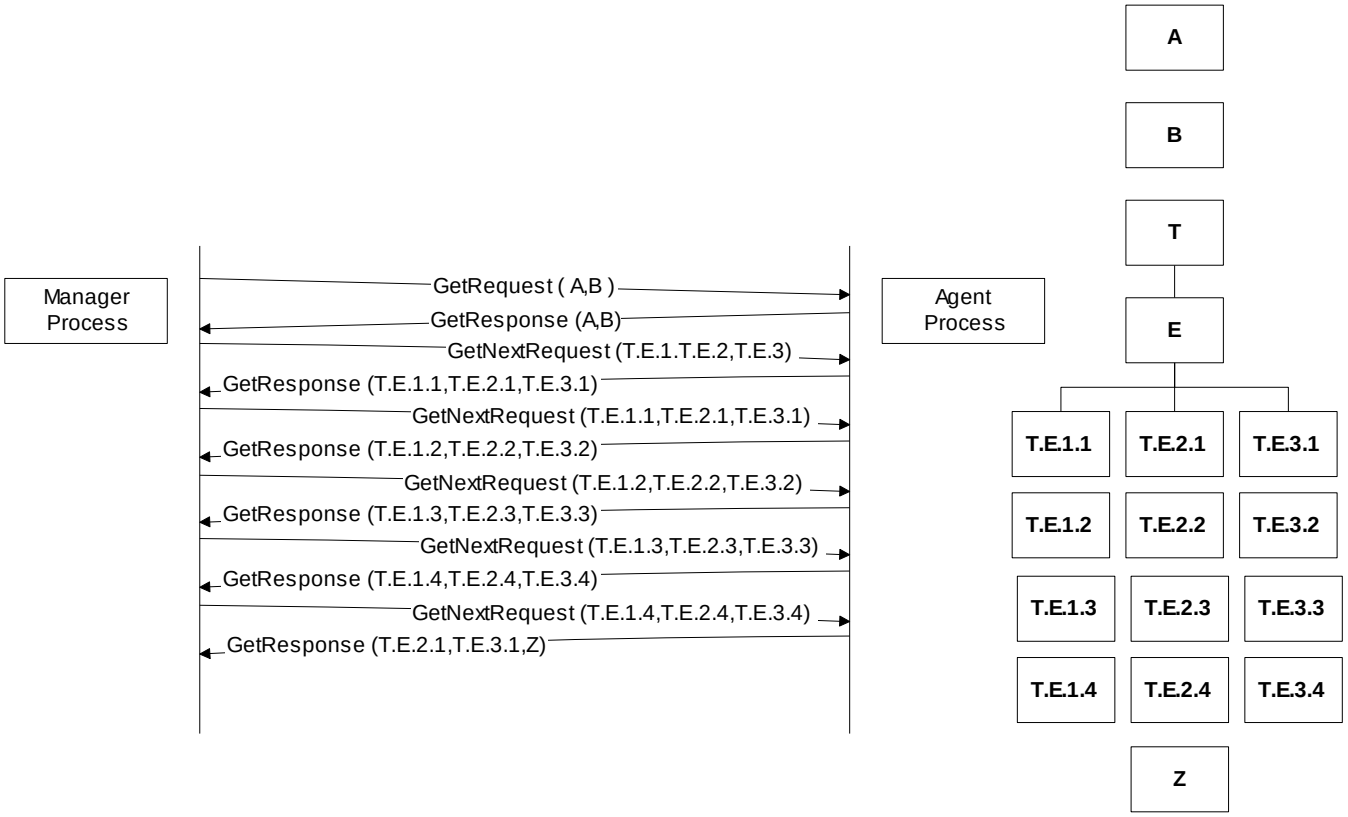


Figure 6.40 Get-Next-Request Operation for MIB in Figure 6.39

Notes

Get-Bulk-Request Operation

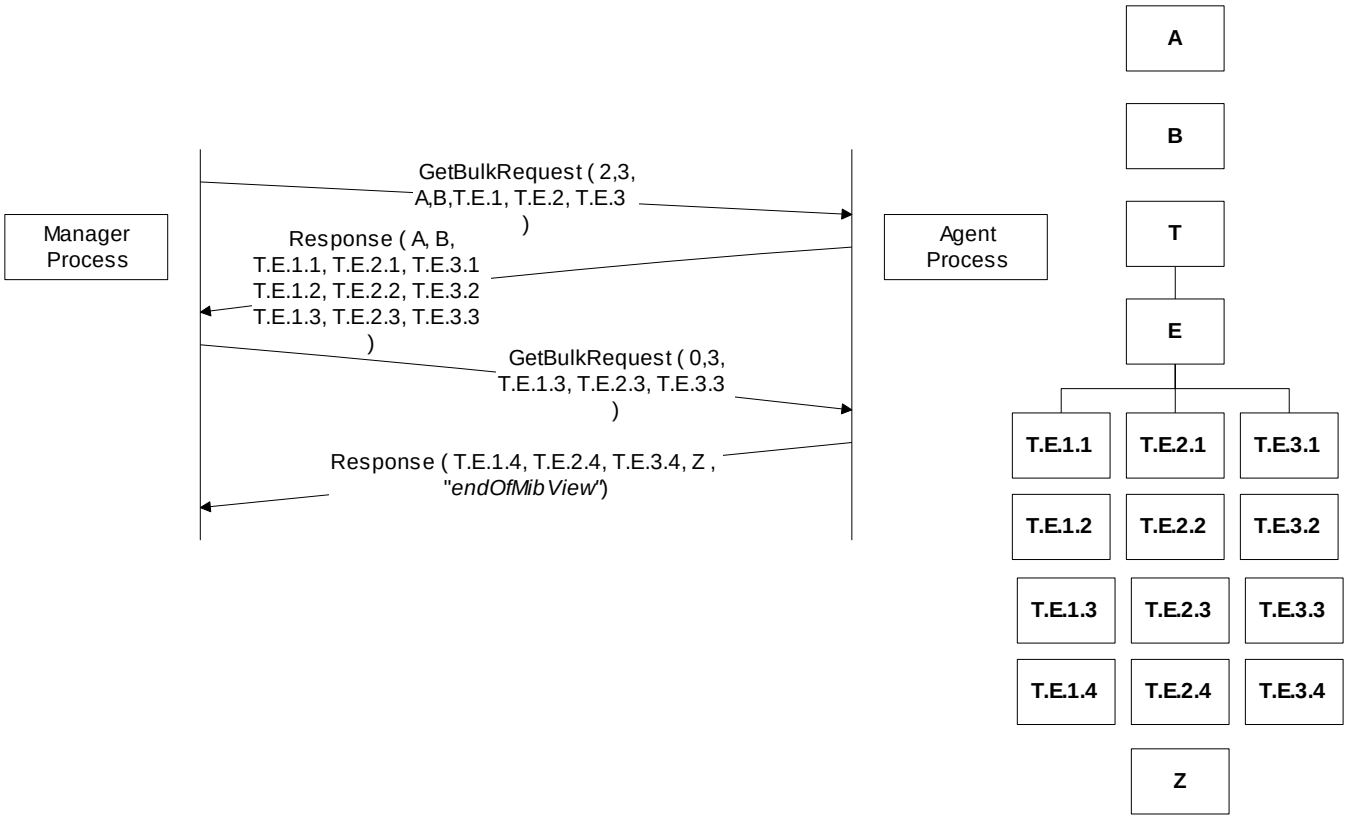
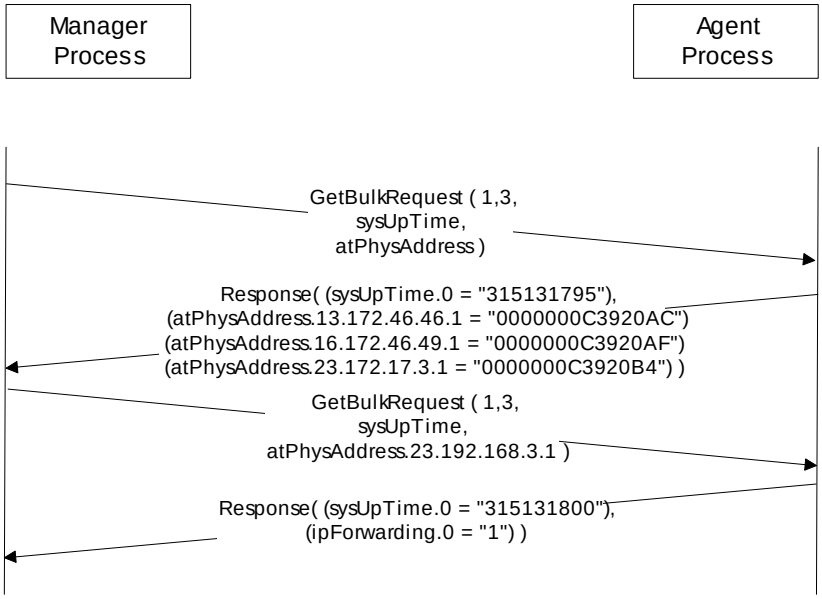


Figure 6.41 Get-Bulk-Request Operation for MIB in Figure 6.39

Notes

Get-Bulk-Request Example



atIfIndex	atPhysAddress	atNetAddress
23	0000000C3920B4	192.68.3.1
13	0000000C3920AC	172.46.46.1
16	0000000C3920AF	172.46.49.1

Figure 6.42 Get-Bulk-Request Example

Notes

SNMPv2 Trap

PDU Type	RequestID	Error Status	Error Index	VarBind 1 sysUpTime	VarBind 1 value	VarBind 2 snmpTrapOID	VarBind 2 value	...

Figure 6.43 SNMPv2 Trap PDU

Notes

- Addition of NOTIFICATION-TYPE macro
- OBJECTS clause, if present, defines order of variable bindings
- Positions 1 and 2 in VarBindList are sysUpTime and snmpTrapOID

```
linkUp NOTIFICATION-TYPE
        OBJECTS         {  ifIndex  }
        STATUS          current
        DESCRIPTION     "A linkUp trap signifies that the SNSMPv2 entity,
                        acting in an agent role, recognizes that one of the
                        communication links represented in its configuration
                        has come up."
```

Figure 6.44 Example of OBJECTS Clause in NOTIFICATION-TYPE

Inform-Request

PDU Type	RequestID	Error Status	Error Index	VarBind 1 sysUpTime	VarBind 1 value	VarBind 2 snmpTrapOID	VarBind 2 value	.. .

Figure 6.43 SNMPv2 Trap PDU

Notes

- Inform-Request behaves as trap in that the message goes from one manager to another unsolicited
- The receiving manager sends response to the sending manager

Bilingual Manager

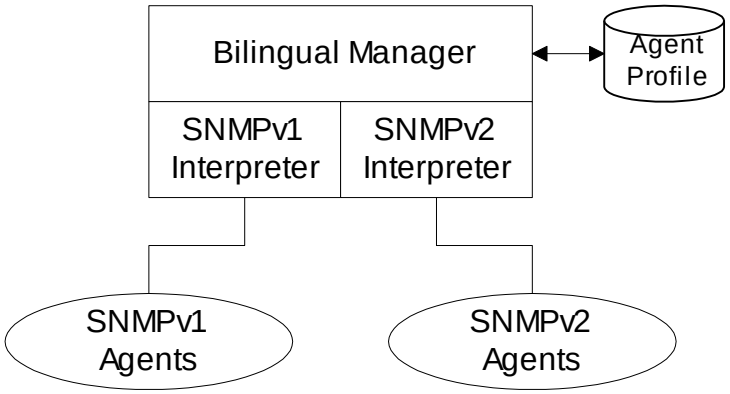


Figure 6.45 SNMP Bilingual Manager

Notes

- Compatibility with SNMPv1
  - Bilingual Manager
  - Proxy Server
- Bilingual Manager expensive in resource and operation

SNMP Proxy Server

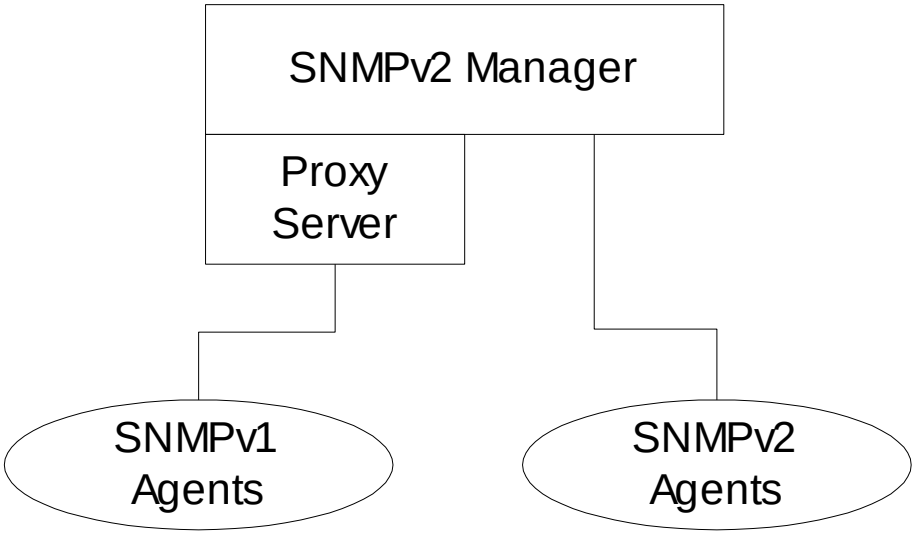


Figure 6.46 SNMPv2 Proxy Server Configuration

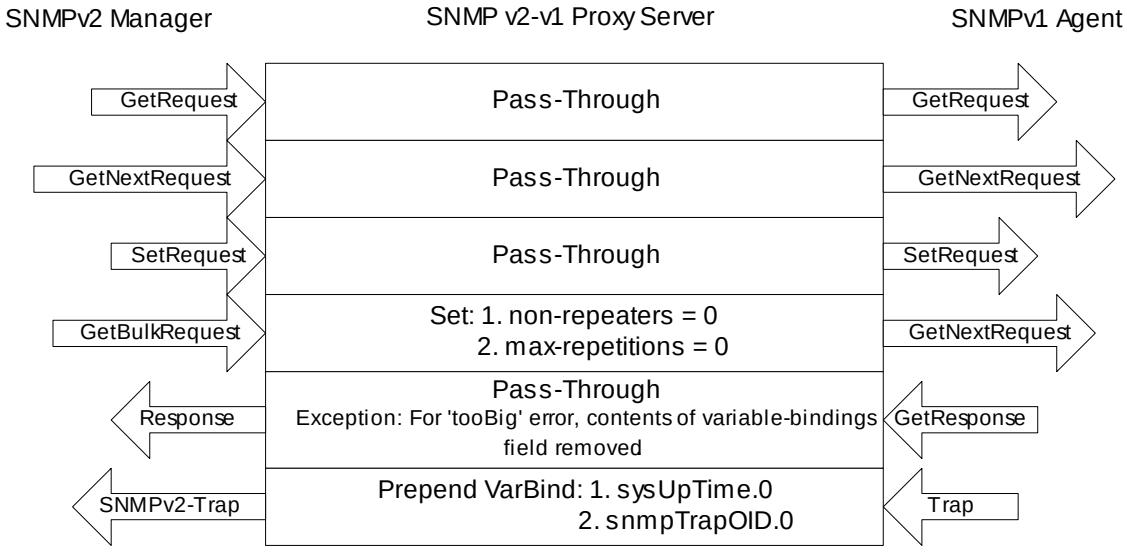


Figure 6.47 SNMP v2-v1 Proxy Server