



## Simple Network Management Protocol (SNMP)




## Motivation

- Large networks has too many components to be managed by human agents alone
- Needs automatic tools for remote monitoring and configuration
- Design of tools complicated since components from multiple vendors
- Needs standards to specify entities to be monitored and configured, type of data in the entities, protocol to access the entities
- Any network element may be monitored – hosts, routers, printers,...



## Network Management System Components

- Management Station
- Agent
- Management Information Base
- Network Management Protocol

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- Management Station
    - Interface with the human network manager to the NMS
      - Interface for human manager to give commands for monitoring and control
      - Database of information gathered from the managed entities in the network
      - Higher level management applications to analyse collected data, recover from faults etc.
  - Agent
    - Software/Firmware on managed entities
    - Responds to requests for information/action from management station



- MIB

- Collection of objects
- Each object is a variable identifying one aspect of a managed entity
- Objects for a particular entity are standardized
  - (ex. all managed IP routers must have MIB with a specific set of object, irrespective of manufacturer)
- Management station requests agents for values of MIB objects, or change the values to configure the entity



- Network Management Protocol

- Protocol between management station and agent
- Defines messages exchanged, format etc.
- Basic methods:
  - Get: for management station to get object values from agent
  - Set: for management station to set object values at agent
  - Notify: for agent to notify management station of some event
- Ex., SNMP for TCP/IP networks, CMIP for OSI-based networks etc.



## SNMP

- Provides infrastructure for network management, not network management itself
- Current version is SNMPv3, which is mainly SNMPv2 + security
- Runs on UDP port 161 (mostly) and 162 (only for Trap message from agent to manager)
- RFC 1157, many others



- Local MIB database at each managed station, accessible through SNMP agents at the station
- SNMP specifies structure of MIB and data types – format in which to define objects to be monitored (SMI – Structure of Management Information)
- Provides definitions for about 100 MIBs (for ex., TCP MIB, IP MIB etc.), other MIBs can be defined by vendors/user groups
- Specifies the protocol for communication between management station and SNMP agent

## MIB Module

- Specify what is contained in the MIB database for a particular entity
- Specifies name of the variables, their data types, other identifiers etc.
  - Ex. – TCP MIB defines variables for all TCP-related parameters that we may want to monitor (RFC 2012)
- Structure of Management Information (SMI) – defines how to specify MIB modules, uses ASN.1 syntax

## Example from IP MIB (RFC 2011)

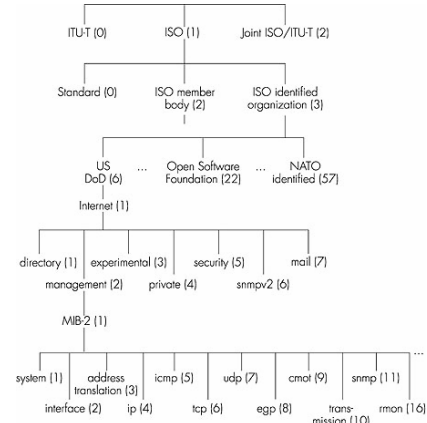
```

ipDefaultTTL OBJECT-TYPE
    SYNTAX      INTEGER (1..255)
    MAX-ACCESS  read-write
    STATUS      current
    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      Counter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The total number of input datagrams received from
        interfaces, including those received in error."
    ::= { ip 3 }
    
```

## Object Identifier

- Main identifier of objects
- Namespace tree to name any object
  - Each node has a number assigned
  - OID of object represented by node = concatenation of numbers (similar to DNS) starting from root to that node
- OID namespace – administered by central authority to remove conflicts
- Root = unnamed
- Three children of root – ISO, ITU-T, and Joint-ISO-ITU-T – entities in charge of the corresponding namespace branches
- Further subdivisions below





- Important for Internet : 1.3.6.1.2.1 – Internet Standard MIB – MIB II – contains objects grouped under System, Interface, TCP, IP, ICMP etc.
- Vendor-specific MIBs are under 1.2.6.1.4. (...US DoD.Internet.private.enterprise.)
  - Ex. CISCO MIB

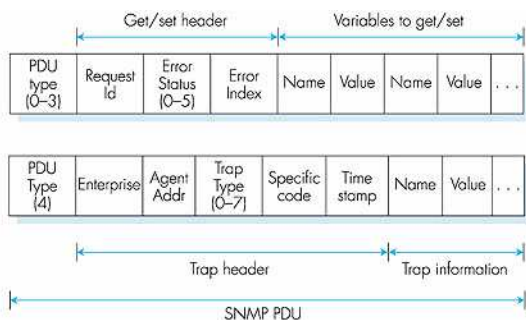


## SNMP Protocol

- Important Messages
  - GetRequest – manager to agent, get value of objects specified in message
  - GetNextRequest – manager to agent, get value of next object for each object specified in the message
  - SetRequest – manager to agent, set value of objects specified in the message
  - SNMPv2-Trap – agent to manager, inform manager of some events
  - Response – response to above message, except Trap which has no response
  - Others...
- All message sent to port 161, except Trap, which is sent to 162



## SNMP Message Structure



- Messages specified using ASN.1 syntax, encoded using BER (Basic Encoding Rule) before transmission
- Complex, we will not cover here
- Name = OID
- Name value pairs are TLV encoded in BER