Introduction to the Internet Standard Management Framework

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Introduction

Since its introduction, SNMP-based management has:

- Been accepted as the Internet-standard Management Framework
- Become deeply entrenched as the management framework of choice which is now in pervasive and continuous use
- Undergone extensive efforts to define follow-on efforts in response to demands of the market and a call for proposals for evolving the Internet-standard Management Framework

The SNMP Management Framework(s) are the result of those efforts and SNMPv1 has been the basis for the success story

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The Internet Standard Management Framework & the SNMP

- First defined, developed, deployed in the Dark Ages (during the summer of 1988 -- life was easier back then)
- Rapid and widespread acceptance
- Now has a **HUGE** entrenched installed base
- Many products in pervasive and continuous use
- But, more to be done and still much shelfware

SNMP -- Somewhat Misnamed

- The Simple Network Management Protocol is not just for managing networks
- Traditional network management
- Systems
- Applications
- Proxy management of legacy systems
- Manager-to-manager communications
- Other
Part 1: Introduction to The Internet-Standard Management Framework

- The Internet-Standard Management Framework
  - Components and Architecture
  - Standardization Processes and Status
The SNMP-based Internet-Standard Management Framework includes four types of components:
- Agents in managed elements (usually many)
- Management stations and applications (one or many)
- Management protocol
- Management information
  - Structure of Management Information (SMI)
  - Definition of Managed Objects (MIB Definitions)

That is, a pair of management entities communicate management information with one another via a shared management protocol

This is true for all versions of SNMP, including SNMPv1, SNMPv2c, and SNMPv3
Overall Architecture

Management System

SNMP Agent
Managed Objects

SNMP Agent
Managed Objects

SNMP Agent
Managed Objects

Framework Component 1:
Agents in Managed Network Elements

- Things like workstations, servers, routers, switches, printers, UPSs, etc.
- Four sub-parts
  - The “primary subsystem” which does the useful work, with instrumentation to keep track of management variables (“Knowing”)
  - A management agent which responds to queries and commands from management stations (“Telling”)
  - A network protocol stack (with instrumentation)
  - Inter-layer communications mechanism(s)
Each managed node must keep track of the values of its management variables (knowing is a prerequisite to telling).

These variables take several forms, including:
- counters, e.g.,
  \[ \text{ipForwDatagrams.0} = 4275 \]
- octet strings, e.g.,
  \[ \text{hrPartitionID.3} = \text{"C:"} \]
- state variables, e.g.,
  \[ \text{sysApplRunCurrentState.42} = \text{running (1)} \]
Management Instrumentation (Continued)

- These variables can be built into combinations in the form of lists and tables

Examples: a system’s routing table or a table identifying the current clients of a server application

- These tables can have multiple indices, e.g., repeaterPortState.2.3 = notAutoPartitioned(1)

Framework Component 2: Management Stations

- Execute management applications
- Monitor and control managed elements
- Communication is via SNMP messages
- Like an agent, a management station has a protocol engine
- Peer-to-peer communications between the engine in the management station and the engine in the agent
Management Stations (Continued)

- Usually based on a popular O.S., such as UNIX or Windows/NT
- May be fancy or useful
- May be character cell, windowed, scripted, or browser-based
- Shift burden to stations from devices for scalability and to minimize impact on the “primary subsystem(s)”

Framework Component 3: Management Protocol Itself (SNMP)

- Carries management information
- Logically remote communication between management stations and the agents in managed elements
- Management information inspected or altered via a remote debugging paradigm
  - monitor (read operations)
  - control (write operations)
- Notification capabilities
Management Protocol Itself (Continued)

- For SNMP application entities, communication is via SNMP messages
- Could be SNMPv1 or SNMPv2 or SNMPv3
- In SNMP, protocol messages consist of a message wrapper and a Protocol Data Unit (PDU)

Protocol Messages

- Self-contained units of information
- SNMPv1 and SNMPv2c messages consist of:
  - Version identifier
  - SNMP community name
  - Protocol Data Unit (PDU)
- SNMPv3 Messages consist of:
  - Version identifier
  - SNMPv3 message header
  - Protocol Data Unit (PDU)
- Message formats change from version to version but the PDUs are unchanged (minor oversimplification)
Protocol: SNMP PDUs
(more in protocol operations section)

◆ An SNMP PDU is one of the following:

- SNMPv2 & SNMPv3
- SNMPv1
- GetRequest-PDU
- GetNextRequest-PDU
- GetBulkRequest-PDU (NA)
- Response-PDU
- SetRequest-PDU
- SNMPv2Trap-PDU
- Trap-PDU
- InformRequest-PDU (NA)
- Report-PDU (NA)

Framework Component 4a:
A Management Information Model (the SMI)

◆ Structure of Management Information or SMI
◆ The Data Definition Language
◆ An object information model defining how
  information is structured
◆ A basic management information tree structure
◆ Generic types including INTEGER, OCTET
  STRING, OBJECT IDENTIFIER, NULL
◆ Application specific types including Counter32,
  Counter64, Gauge32, TimeTicks, and IpAddress
A Management Information Model: SMI and SMIV2 (Continued)

- Rules for describing objects in the Management Information Base
  (Rules for writing MIB documents)
- Rules for defining new objects to be added to the Management Information Base
  (Rules for revising MIB documents)
Framework Component 4b: A Management Information Model: MIB

Management Information Base or MIB
◆ Describes what information is managed
◆ Defines objects in the “primary subsystem(s)” and the network protocol stack
◆ Places information in the tree (virtual information store) defined by the SMI
◆ Extensible
  ○ start small, grow with experience
  ○ expands range of applications and lowers marketing and engineering barriers

An Overly Simplistic View
◆ This vocabulary (agents, managers, protocol, management information) is a bit too simplistic
◆ Some nodes are both agents and managers
◆ This is a good starting place
◆ SNMPv3 clarifies the vocabulary
Introduction to The Internet-Standard Management Framework: Outline

- The Internet-Standard Management Framework
  - Components and Architecture
  - Standardization Processes and Status

Two Standardization Processes

- Standards Bodies and Pseudo-Standards Bodies
  - Internet Engineering Task Force (IETF)
  - Desktop Management Task Force (DMTF)
  - etc.
  - ATM Forum
  - ANSI
  - IEEE
  - ISO
  - etc.

- The Market: *de facto* market standards
- Ideally, these two processes are complementary
Internet Engineering Task Force

- Internet Engineering Steering Group (IESG) primarily consists of Chair plus Area Directors (ADs)
  - IETF oversight
  - Standardization decisions
- About three meetings per year / most work done between meetings and via electronic mail
- IETF subcommittees called Working Groups
- Work products are documents -- a small proportion eventually become RFCs and some of which become Internet standards

IETF Standards Documents

- Documents can be
  - On the standards track
    - Proposed or Draft or Full
    - 6 months minimum between elevations
    - Required or Recommended or Not Recommended
  - Off the standards track
    - Informational
    - Experimental
    - Historic
    - Prototype
MIB Versions and Protocol
Versions -- Decoupled

- In general, there is no need for the version of the protocol to match the version number of the format of a MIB document
- With few exceptions, can use any MIB object, regardless of the version of the grammar of the MIB document, with any version of the protocol
- The only noteworthy exception is MIB documents containing MIB objects with a datatype of Counter64 (this datatype is not supported by version 1 of the protocol)

SNMPv1: The Right Architecture, in part, for the Wrong Reason

- This architecture which was designed to ease the shortening of the life of SNMP has actually allowed it to age gracefully and to evolve, thereby extending its useful life
- SNMP to SNMPv2 to SNMPv3
Brief Introduction to the Internet Standard Management Framework

The Good News

- SNMP and its framework filled the void
- Multiple reference implementations
- Reduced to products at record speed
- The Internet became manageable, then grew and grew
- The Internet Standard Management Framework, based on SNMP, the SMI, and MIB became both a de facto (market) standard and an open IETF standard

The SNMP-based Internet-Standard Management Framework: Summary

Modular (3 part) specification architecture:

1. A data definition language
   - The Internet-standard Structure of Management Information (SMI)
     - First specified in RFC 1155 (Early SNMPv1)
     - Revised and refined in RFC 1212 and 1215 (Late SNMPv1)
     - Expanded and enhanced in SMIv2 (RFC 1902, 1903, 1904, Promoted to Full Standard in RFC 2578, 2579, 2580)
     - Incorporated by reference in SNMPv3
The SNMP-based Internet-Standard Management Framework: Summary

Modular (3 part) specification architecture:

2. Definitions of management information
   - Instrumentation described in the [Internet-standard] Management Information Base (MIB)
   - Standard or non-standard
   - Protocol independent
   - Has undergone constant revision (mostly expansion) since first defined in 1988

3. Protocol definition
   - MIB independent
   - The Simple Network Management Protocol
     - Protocol operations
     - Transport mappings
     - Security and administration
   - First defined in RFC 1157 (SNMPv1)
   - Separate documents beginning in SNMPv2
   - Security and administration completed in SNMPv3