
Design Document

OAM&P System

Version 1.0

Objective

Document Scope

The information provided in this document specifies the design details of Operations Administration Maintenance and Provisioning Sub Systems (OAM&P). For complete scope of OAM&P please see the Project Proposal.

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1. References & Abbreviations

References

Following is the 3GPP reference document list, which is related to the information present in this document:

- [1] 3GPP TS 32.101 V8.1.0: "Principles and High Level Requirements".
- [2] 3GPP TS 32.111-1 V7.0.0: "3G Fault Management Requirements".
- [3] 3GPP TS 32.409 V8.0.0 (Performance Management (PM): "Performance measurements IMS".
- [4] 3GPP TS 32.600 V7.0.0 (Configuration Management (CM): "Concept and High-Level Requirements."
- [5] 3GPP TS 32.611 V7.0.0: "Bulk CM Integration Reference Point (IRP); Requirements".

Abbreviations

Following are the abbreviations that have been used in the document:

IMS	IP-Multimedia Subsystem
OAM&P	Operations Administration Maintenance and Provisioning
SNMP	Simple Network Management Protocol
PDU	Protocol Data Unit
IRP	Integration Reference Point
API	Application Programming interface
AMPS	Asynchronous Middleware for Protocol Serve

2. Introduction

Network Management system is an essential part of IMS. 3GPP has standardized key components and the interfaces of a network management solution for IMS. These are collectively known as Operations, Administration, Maintenance and Provisioning (OAM & P) sub-system. Three categories or classes of management information have been defined by 3GPP for IMS,

- Configuration Management.
- Performance Management.
- Fault Management.

Interfaces have been defined for each category between information gathering agent (Element Manger) and information collecting agent (Network Manager). These interfaces are called Integration Reference Points (IRP).

3. OAM&P Architecture

Element Managers or Agents are deployed with the Network Elements or are embedded with the Network Elements. Network Manager requests the information about the Network Elements from their respective Agents and these Agents interact with Network Elements and respond to Network Manager's requests with requested information. Agents also monitor different parameters of Network Element and generate the Messages known as TRAPS or INFORMS for the Network Manager in case of some error, warning or to notify some event. The following diagram gives the overview architecture of the OAM&P solution.

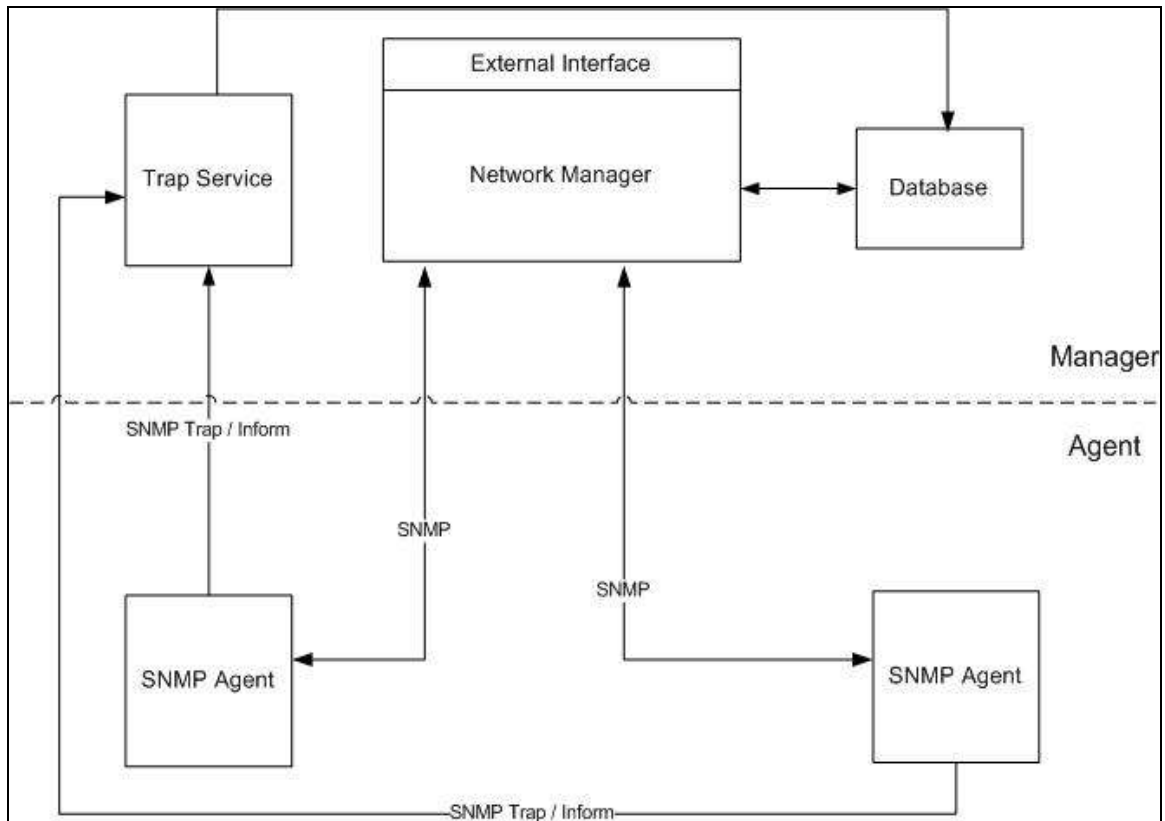


Figure 2 – OAM&P Architecture

4. Network Manager

Network Manager is responsible for the management of Network Elements by interacting with their respective Element Managers or Agents. Network Manager can manage multiple Agents in the network through SNMP protocol. The information or parameters of a Network Element that will be managed are defined in the form of MIB Variables using ASN notation.

4.1. Network Manager Components

The main components of Network Manager are:

- SNMP Manager
- MIB Module
- Database Module
- Data Model / Presentation Interface
- IRP Management
- Trap Service

The following diagram shows the logical placement of above mentioned components in the Network Manager:

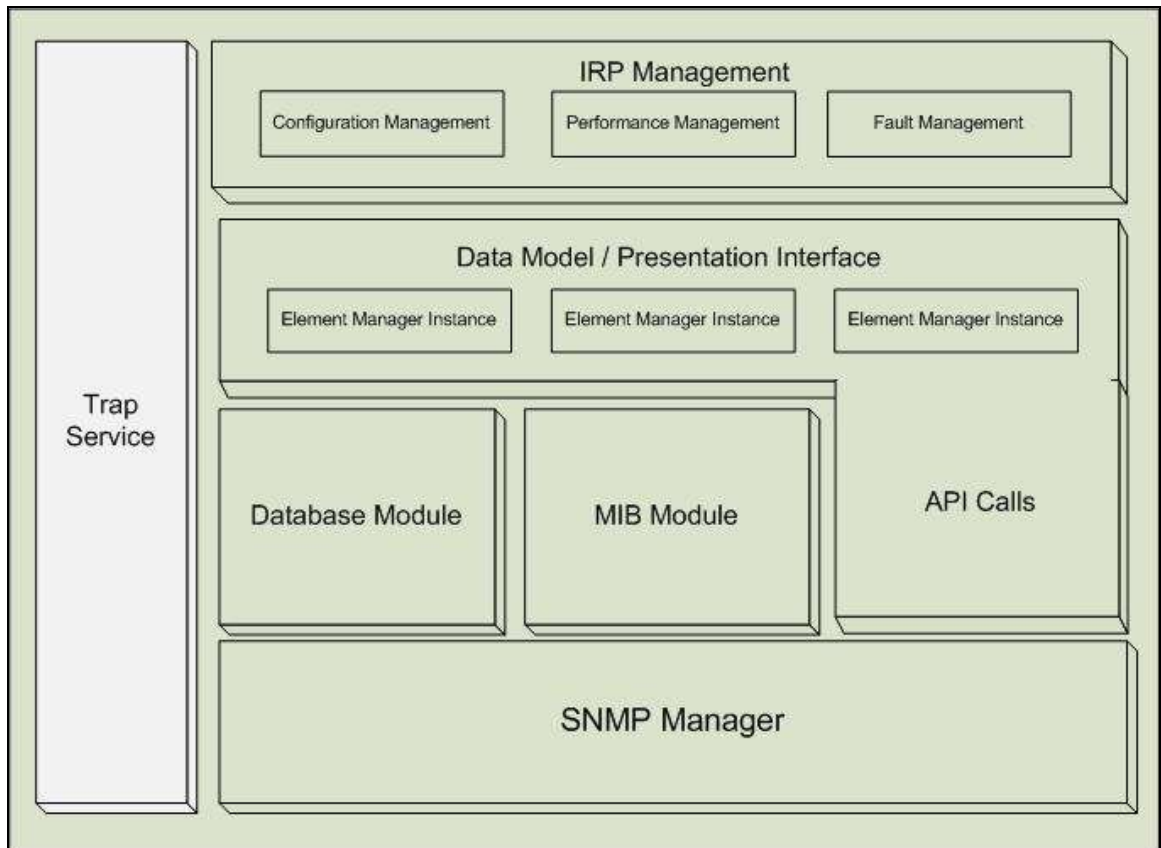


Figure 3 – Network Manager Components

4.1.1. SNMP Manager

SNMP Manager handles all the SNMP protocol specific operations, and directly communicates with the Agents hiding the SNMP protocol level details from the upper layers. All the management requests made by Network Manager to the Agents are translated into SNMP PDUs at this layer and the responses from the Agents are translated to simple and understandable management information for the upper layers.

4.1.2. MIB Module

MIB Module holds the MIB related data for the Network Manager. It loads the management information from the MIB files and arranges them in high performance data structures for fast retrieval.

4.1.3. Database Module

The Database Module provides the functionality for database interaction. Network Manager stores the management information in the database using the interfaces provided by Database Module.

4.1.4. Data Model / Presentation Interface

The Data Model / Presentation Interface is the layer that implements the Network Manager application logic. It holds the caches of the variable values fetched from the Agents and format the management information for presentation layer. This layer also implements the logic to communicate with the Agents.

4.1.5. IRP Management

IRP Management is a logical layer that logically separates the management information in Network Manager. There are three IRPs supported by OAM&P solution,

- Configuration Management
- Performance Management
- Fault Management

4.1.6. Trap Service

Trap Service is the component of Network Manager that listens for the TRAP or INFORM messages from the Agents. It is responsible for handling these messages and generating the response messages if necessary.

4.2. Network Manager Architecture

Following are the main classes that form the backbone of Network Manager:

- **ManagerBase**

ManagerBase is the convergence point that glues the different modules of Network Manager. It initializes all the modules and components of Network Manager and its lifespan continues until the Network Manager is running.

- **ElementManager**

ElementManager class represents the actual Agent or Element Manager. Each instance of ElementManager class represents a single Agent in the network. ManagerBase class contains the list that has ElementManager instances against each Agent in the network that is managed by this Network Manager. The ElementManager class contains the cache of management information retrieved by Agents on the network. This information is logically divided into three different categories,

- Performance Management
- Fault Management
- Configuration

The management information contained in this class is independent of any protocol.

- **LoggerModule**

The LoggerModule class provides the logging functionality in the NetworkManager. There is only one instance of LoggerModule inside the Network Manager and its lifespan is until the Network Manager is running. The LoggerModule is instantiated and initialized by the ManagerBase class.

- **ProtocolWrapper**

The ProtocolWrapper class is the wrapper over the SNMP protocol library. It provides the generalized methods and hides the complex protocol related initializations, SNMP library related initializations and the architecture of SNMP library.

- **SnmManager**

The SnmpManager class is responsible for doing the SNMP operations. It communicates with the Agents in the network using the instance of ProtocolWrapper class. This class hides the SNMP protocol related details from the upper layer and provides protocol independent management interfaces for upper layers. The instance of SnmpManager class is created by the ManagerBase class and its lifespan is until the Network Manager is running.

The instance of ElementManager class registers itself with the instance of SnmpManager class. It provides security and destination related information to SnmpManager instance about the Agent that is represented by this instance of ElementManager. SnmpManager holds the destination and security information of all the ElementManager instances that are registered to it. All the management requests made by ElementManager instance are translated into SNMP PDUs by SnmpManager and the response from the Agent is again translated to protocol independent management information by SnmpManager and then it is given back to ElementManager instance.

- **MibModule**

The MibModule class holds the MIB related data to be used by Network Manager. There is only one instance of MibModule class in Network Manager and that is instantiated by the ManagerBase class. The SnmpManager use the instance of MibModule class to translate the MIB

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symbols into MIB OIDs and vice versa. The MibModule class loads the MIB files and populates the Tree structure for faster processing.

- **DatabaseManager**

The DatabaseManager class provides the functionality to interact with database system. Network Manager uses the DatabaseManager to store and retrieve the management information and other parameters in database. The DatabaseManager is instantiated by the ManagerBase class.

- **TrapReceiver**

The TrapReceiver class provides the functionality to receive the traps or Informs from the Agents. It uses the ProtocolWrapper class to listen for the messages from the remote Agents. TrapReceiver class also generates the response messages for the Agents if required. Once the Trap or Inform message is received, after properly handling the message is written to the database using DatabaseManager Instance.

The following class diagram shows the main classes and their interaction in Network Manager :

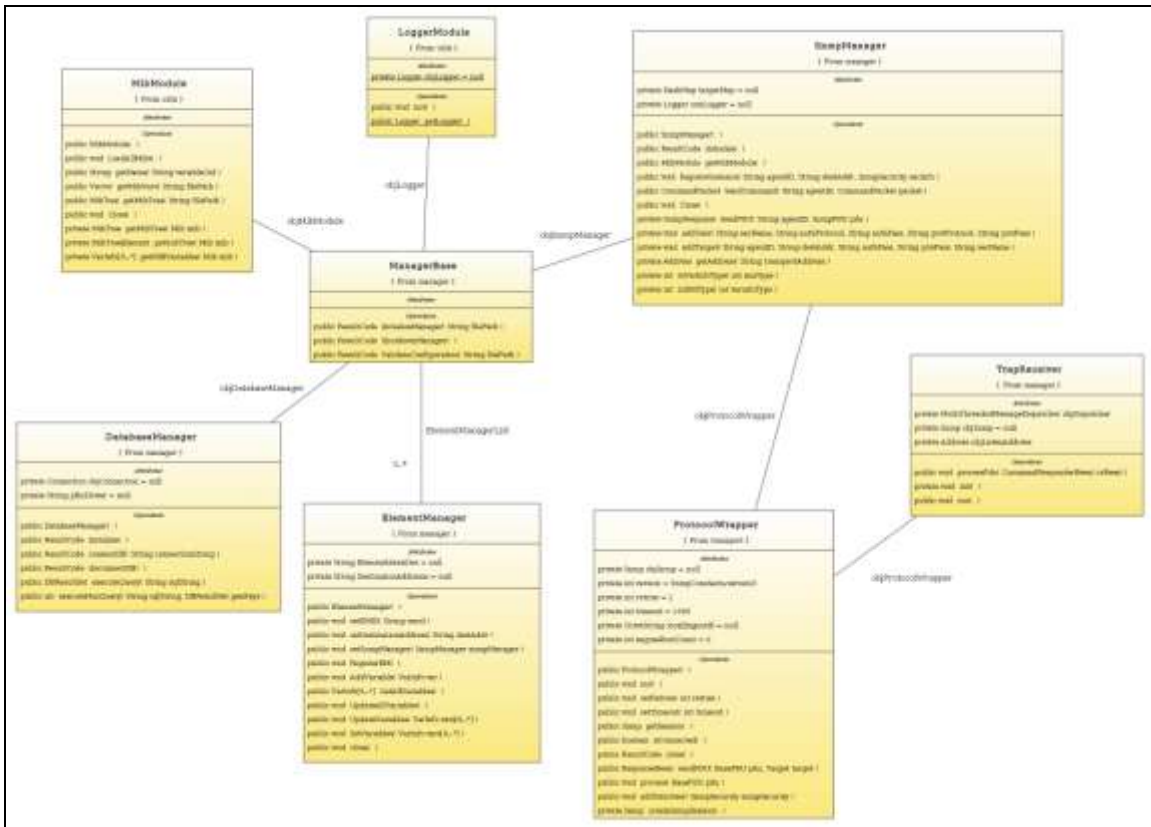


Figure 4 –Network Manager Class Diagram

5. Agent Architecture and Components

The Agent or Element Manager is implemented as Sub-Agent that connects with the Master Agent through AgentX protocol to provide the complete functionality. The Master Agent handles the entire SNMP related task and the management of Network Element is delegated to the Sub-Agent. The Sub-Agent communicates with the Network Element through AMPS events.

Following are the main architectural components and their responsibility in Sub-Agent:

- **MIB Handlers**

Implements the Callback functions against MIB OIDs that are called when Agent receives a request for that OID.

- **Element Monitoring**

Monitor different parameters of Network Element when requested by Network Manager or configured otherwise. These parameters are analyzed by Network Manager and then performance reports are generated. All the SNMP GET requests are processed by this component.

- **Policy Enforcement**

It enforces the requested settings on the Network Element. All the SNMP SET requests are handled by Policy Enforcement component of Agent. So this component logically groups the Configuration Management functionality in Agent.

- **Trap Generation**

It generates Traps and Notifications for the Manager when some fault or reportable event occurs in Network Element. Trap Generation component groups the Fault Management related functionality of the Agent.

- **Element Interaction**

Interacts with the Network Element through AMPS events on behalf of other components of Agent i.e. Element Monitoring, Policy Enforcement, Trap Generation

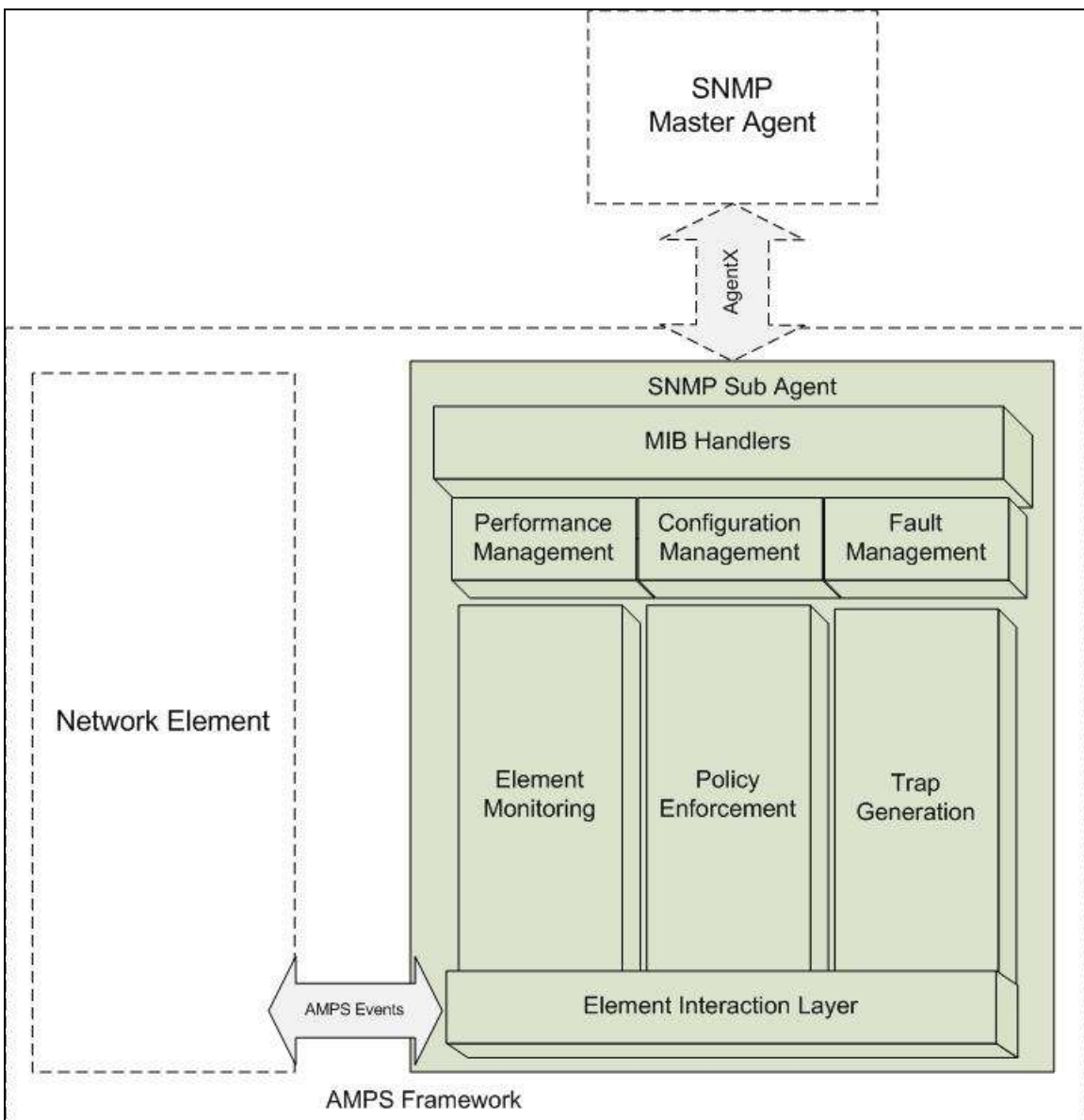


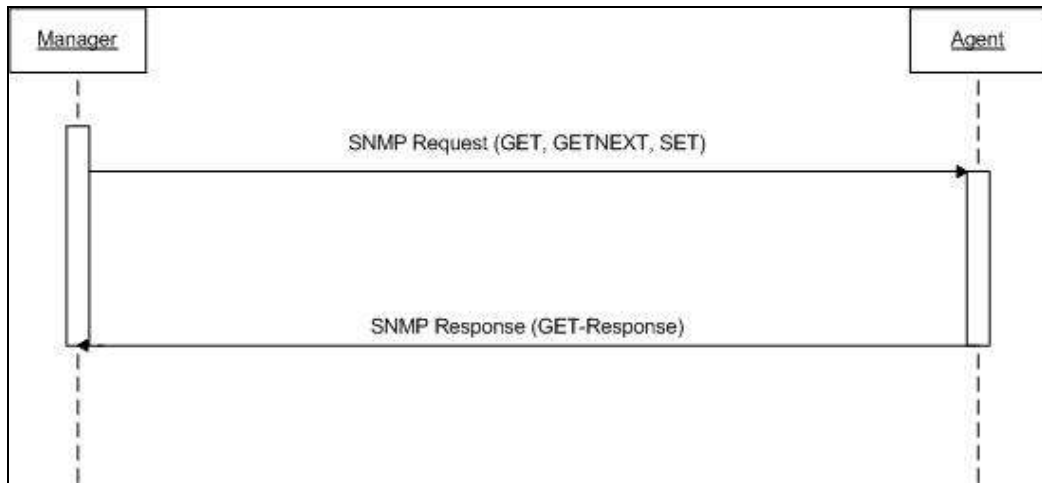
Figure 5 – Agent Architecture and Components

6. Manager-Agent Communication

The communication between Agent and Network Manager is done through the SNMP protocol. The SNMP session can be initiated by either Network Manager or the Agent. The Network Manager communicates with Agent using version 3 of SNMP, but for incoming messages (TRAPS or INFORMS) it also accept SNMP version 1 and SNMP version 2c along with SNMP version 3.

6.1. SNMP Request

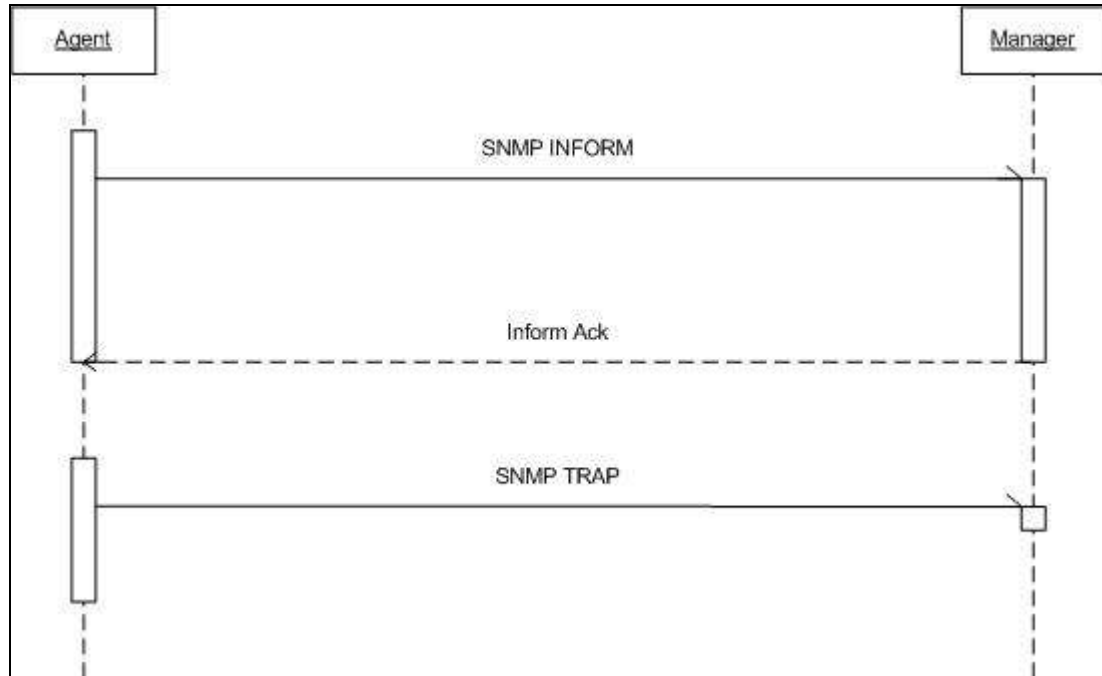
SNMP Request is generated by Network Manager and responded by the SNMP capable Agent. There are three different types of SNMP request that are generated by Network Manager i.e. GET, GETNEXT, SET. The agent generates GET-Response against all these requests; following is the sequence diagram of SNMP Request.



6.2. SNMP Trap

SNMP Trap or SNMP Inform is the message sent by the Agent to the Network Manager. These messages are generated asynchronously by the Agent triggered by different events that are defined in MIB files. These messages are used to notify some event to the Network Manager. Network doesn't send any response against the SNMP Trap, but an acknowledgement is generated by Network Manager when it receives SNMP Inform.

Following is the sequence diagram of SNMP Traps or SNMP Informs.



7. Deployment

The OAM&P Solution will contain three different executable packages.

- Network Manager
- Trap Service
- Element Manager (Agent)

The Trap Service is also the part of Network Manager Component but packaged in a different executable package hence the Network Manager and Trap Service will be deployed on Manager Node, and the Element Manager or Agent will be deployed on Agent Nodes. There can be multiple Agent Nodes in the Network and all Agent nodes in the network can communicate with single Network Manager.

The following is the deployment diagram of OAM&P Solution:

