Creating Standards-Based Management Solutions for HP-UX

InterWorks 2001 Conference

Presentation #: 104

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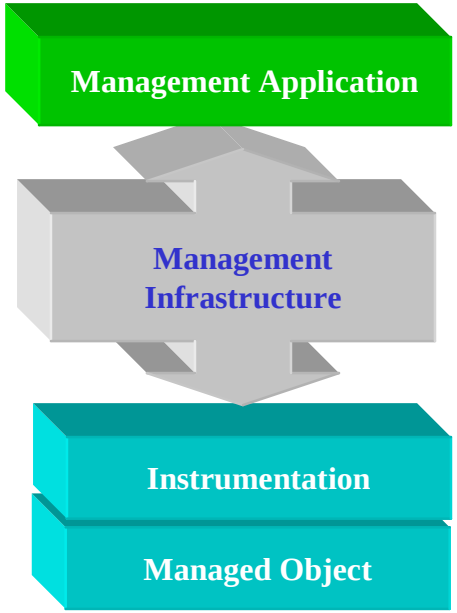
Management Framework

Agenda

- Management Framework Characterization
  - Data Model
  - Data Language
  - Communication Protocol
- Management Framework Comparison
  - IETF SNMP
  - DMTF DMI
  - HP-UX EMS
  - DMTF WBEM
- Management Framework Interoperability



IETF SNMP

HP-UX EMS

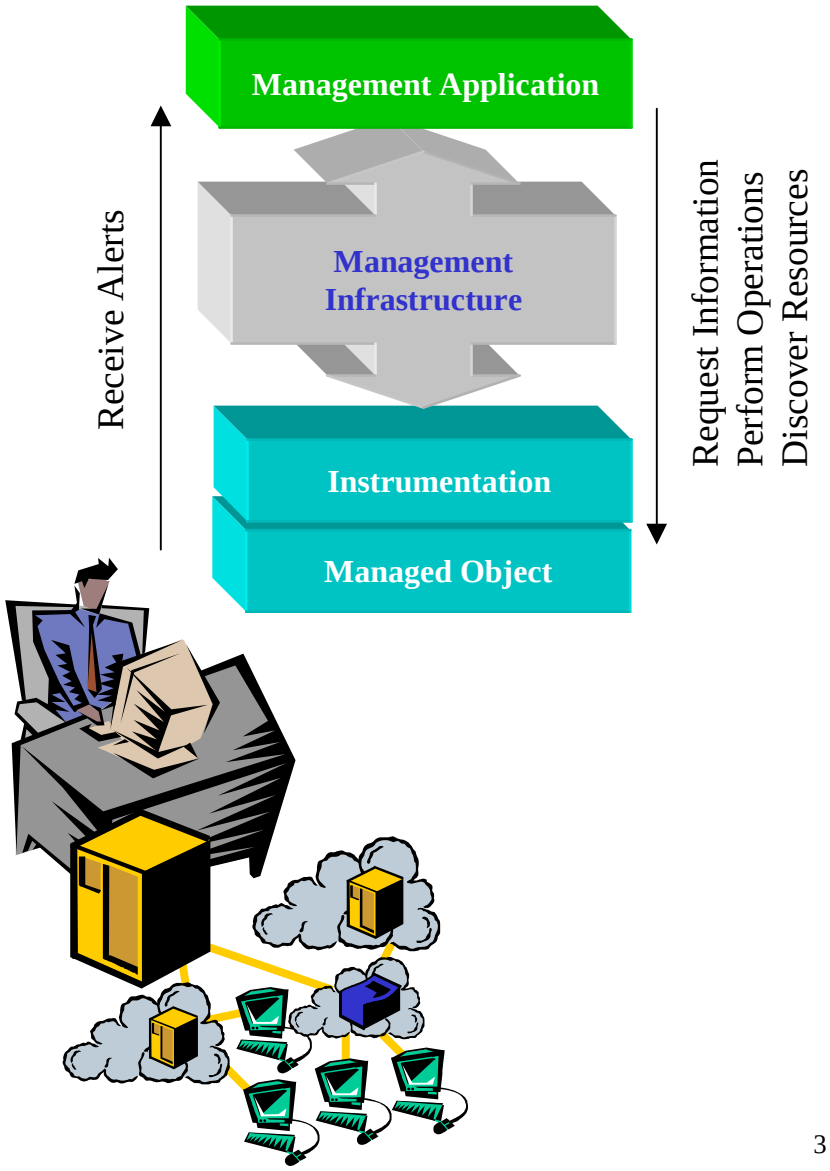
DMTF DMI

DMTF WBEM

Management Framework Overview

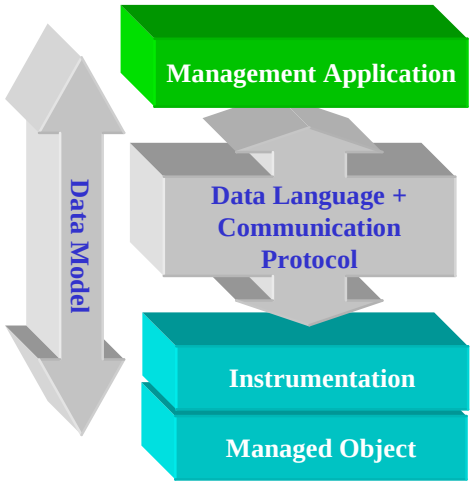
Definition

- Management middleware that provides a standard mechanism to discover, monitor and control manageable resources.
  - Discover
    - Discover Resources (e.g., “What disks are available in my network?”)
  - Monitor
    - Receive Alerts (e.g., “Your disk is full”; “Your disk is on fire!”)
    - Request Information (e.g., How much space is available on my disk?)
  - Control
    - Perform Operations (e.g., “Format my disk”)

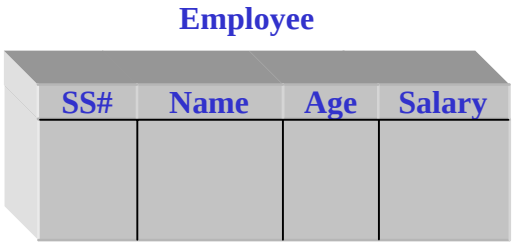


Management Framework Overview

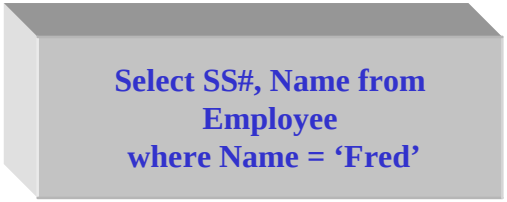
Key Components



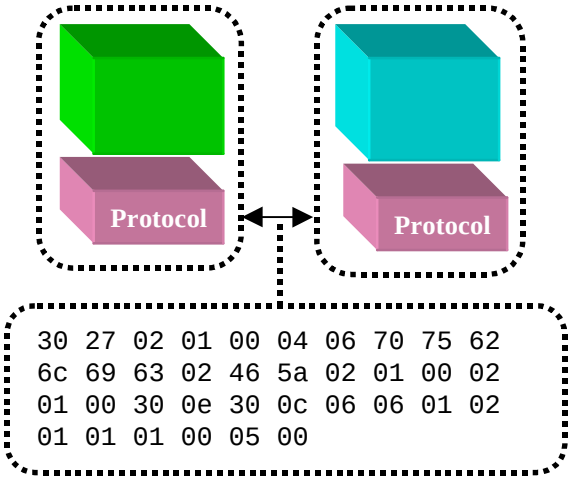
A ***data model*** that defines a standard, enterprise-wide format for describing the manageable characteristics of a managed object.



A ***data language*** that defines a standard set of operations for defining, monitoring and assessing management data.

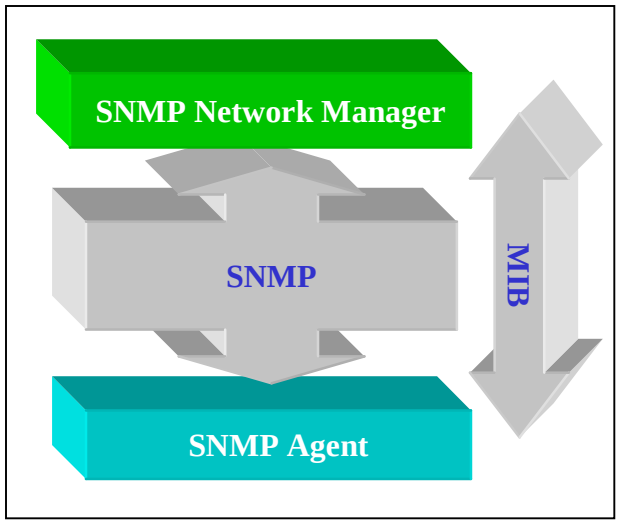


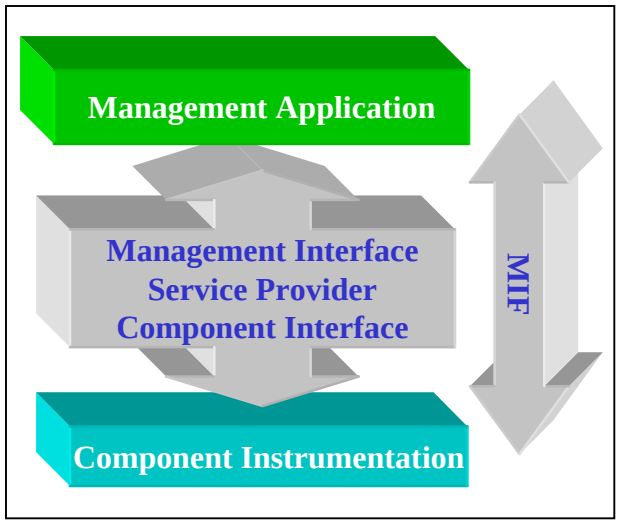
A ***communication protocol*** that defines a standard encoding and communication protocol between the management application and the object being managed.



HP Management Frameworks

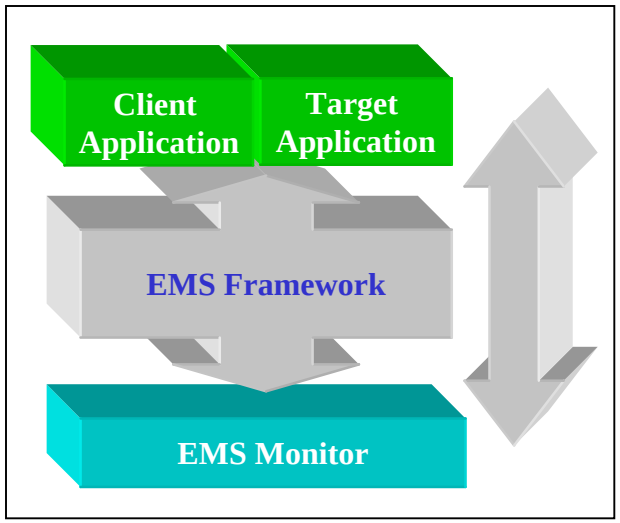
IETF SNMP

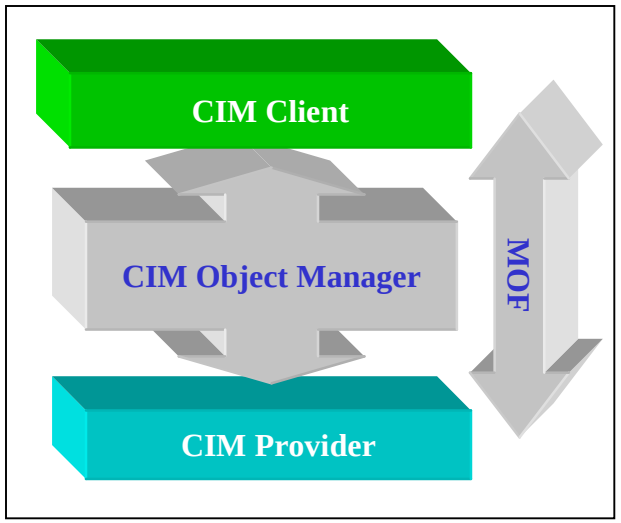




DMTF DMI

HP-UX EMS





DMTF WBEM

HP Management Frameworks

IETF SNMP

Network Management+

Simple Network Management Protocol (SNMP)

www.ietf.org

A network management framework for monitoring and controlling networks – used primarily with UDP/IP

SNMPv1, STD 16, 1990
SNMPv2, STD 58, 1999

Desktop Management Interface (DMI)

www.dmtf.org

A standard framework for managing and tracking components in a desktop pc, notebook or server.

DMI Specification, Version 2.0s, June 24, 1998.

DMTF DMI

System Management

HP-UX EMS

Fault Monitoring

HP-UX Event Monitoring Service (EMS)

www.unix.hp.com/management

Real-time monitoring and error detection – used to monitor system behavior and typically not used to modify system behavior

Writing monitors for EMS, 3rd edition, December, 1999.

Web-Based Enterprise Management (WBEM)

www.dmtf.org

A set of management and Internet standard technologies developed to unify the management of enterprise computing environments.

CIM Operations over HTTP, V1.0

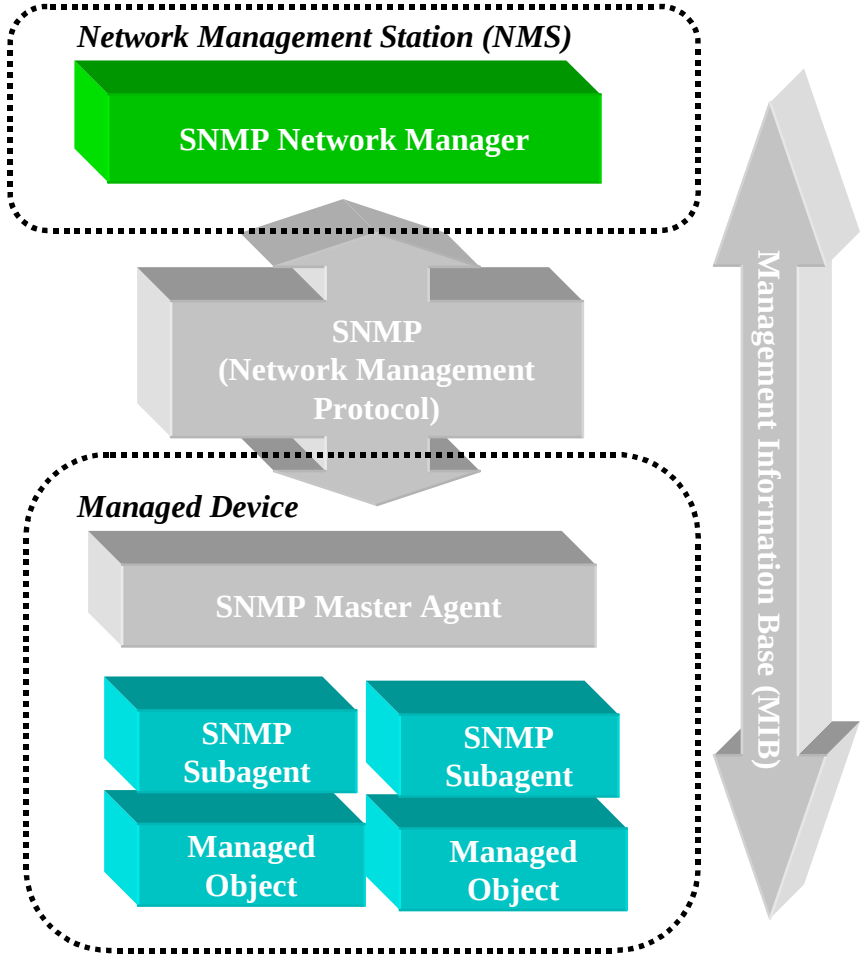
DMTF WBEM

Management Unification

SNMP

Functional Block Diagram

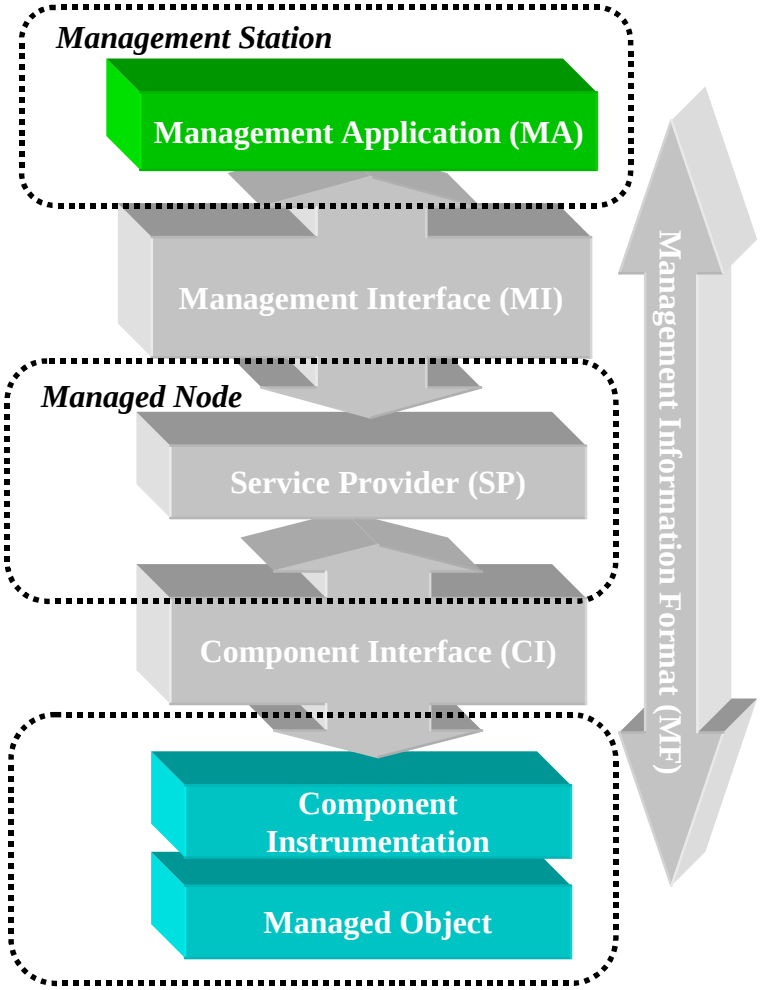
- Manager – Agent Model
- SNMP
  - Defines the protocol used for network access to managed objects and event notification.
- SNMP manager
  - Requests and receives responses from agents
  - Acknowledge asynchronous events (i.e., traps) from agents
- SNMP agent
  - Stores and retrieves management data as defined by the MIB
  - Can asynchronously signal an event (i.e.,traps) to the manager
  - Can be a proxy for some non-SNMP manageable network node.



DMI

Functional Block Diagram

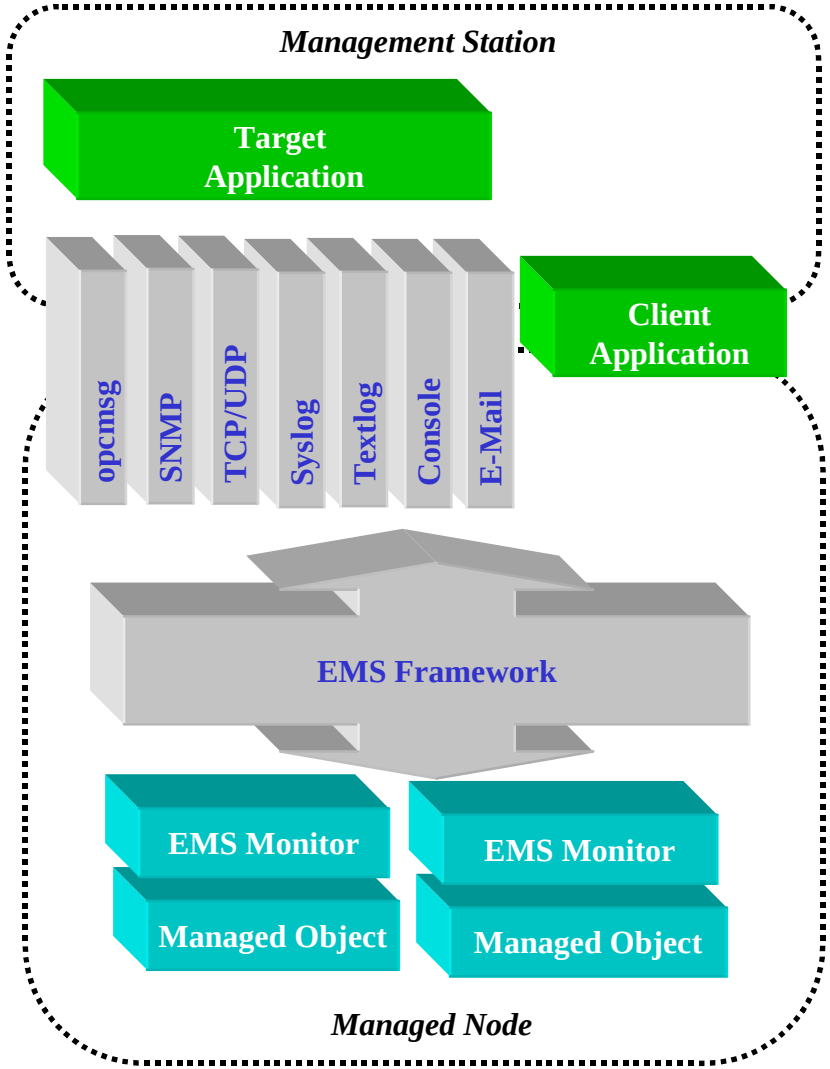
- Manager – Agent Model
- Management Application (MA)
  - Requests and receives responses from agents
  - Acknowledge asynchronous events (i.e., traps) from agents
- Component Instrumentation
  - Stores and retrieves management data as defined by the MIF
  - Can asynchronously signal an event (i.e.,traps) to the manager
- Service Provider (SP)
  - Mediates between CI and MI
  - Performs services on behalf of management application and component instrumentation



HP-UX EMS

Functional Block Diagram

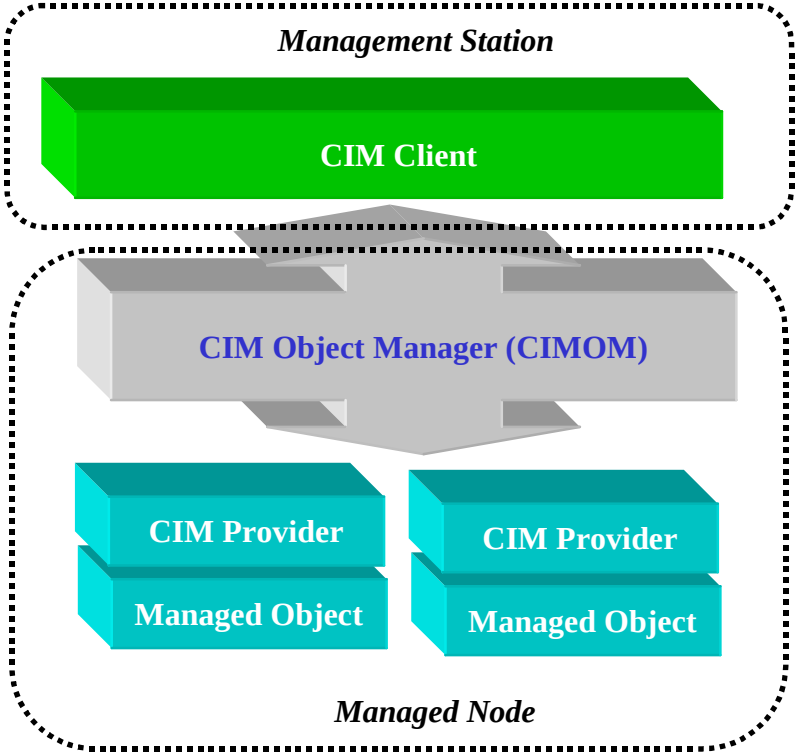
- Manager – Agent Event Model
- EMS Client Application
  - Sets, modifies or deletes monitoring requests (i.e., description of events of interest)
- EMS Target Application
  - Receives asynchronous event notifications (i.e., traps) from monitors
- EMS Monitor
  - Observes and reports values and events back to EMS framework.
- EMS Framework:
  - Provides the interfaces between the client applications, monitors, and target applications.



WBEM (CIM-XML)

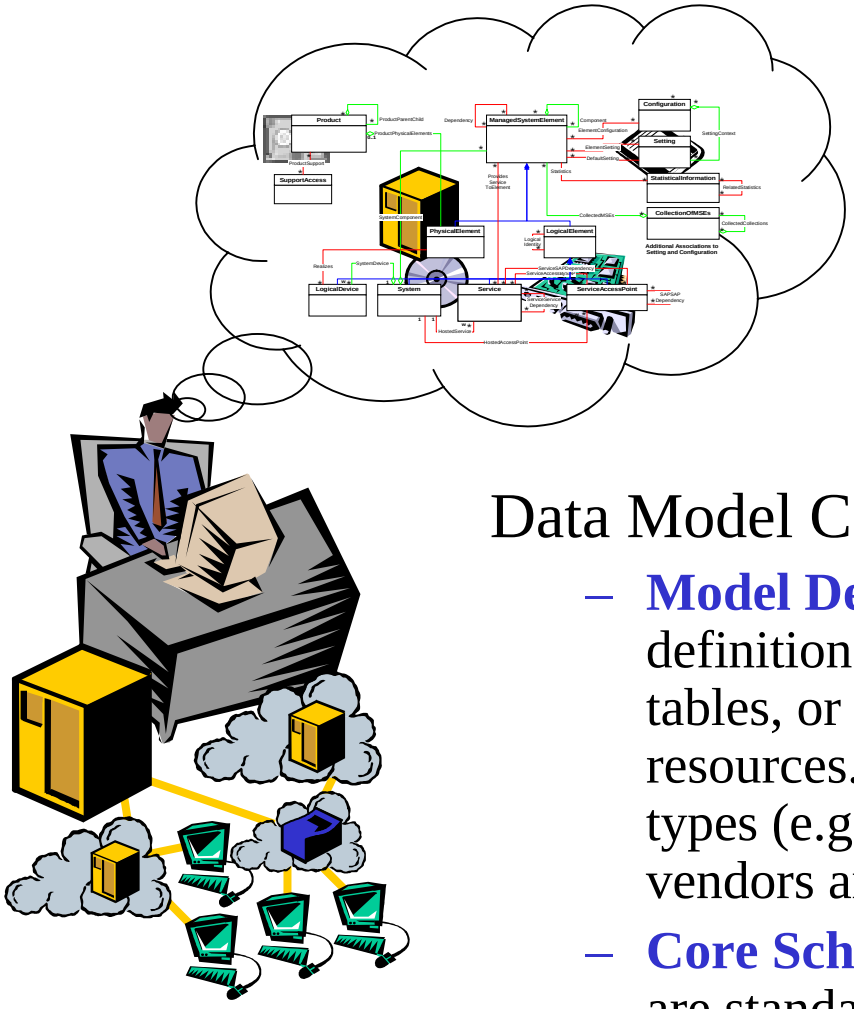
Functional Block Diagram

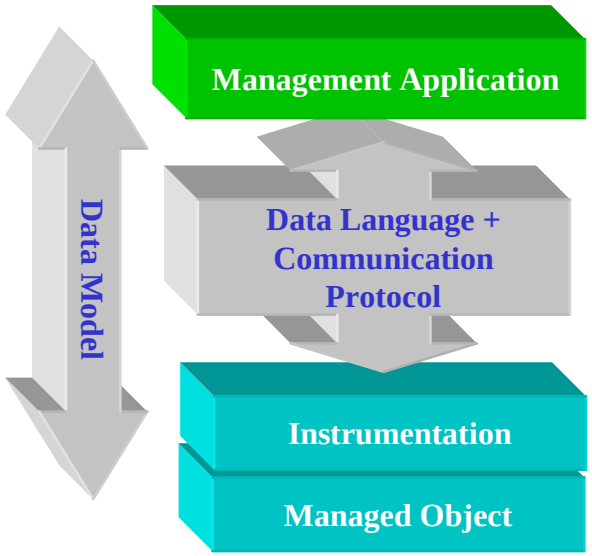
- Manager – Agent Model
- CIM Client
  - Application that issues CIM Operation Requests, receives and processes CIM Operation Responses, and receives asynchronous event notifications.
- CIM Server
  - Server that receives and processes CIM Operation Requests and issues CIM Operation Responses
  - CIM Object Manager (CIMOM)
    - Mediates between CIM clients and CIM providers.
    - Performs services on behalf of CIM clients and CIM providers.
  - CIM Provider
    - Supplies object-specific data to the CIMOM.



Management Framework

Data Model





Data Model Components

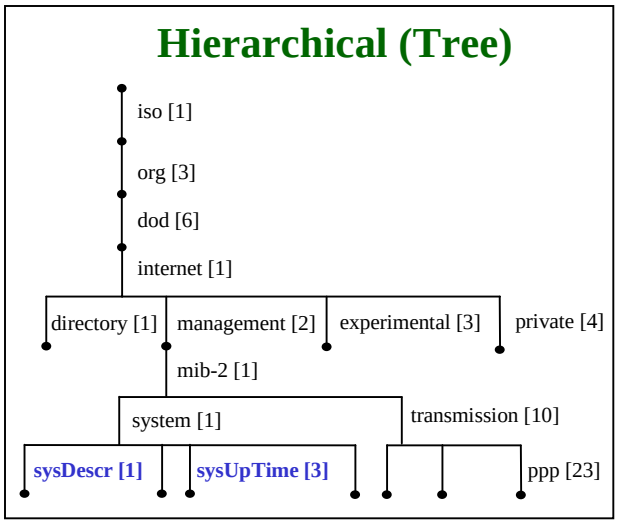
- **Model Definition (Meta Schema):** Formal definition of a model (e.g., hierarchical, tables, or objects) for describing “real world” resources. Model needs to spans resource types (e.g., systems, networks, applications) vendors and platforms.
- **Core Schema:** Core set of definitions that are standard across all implementations.

Management Framework

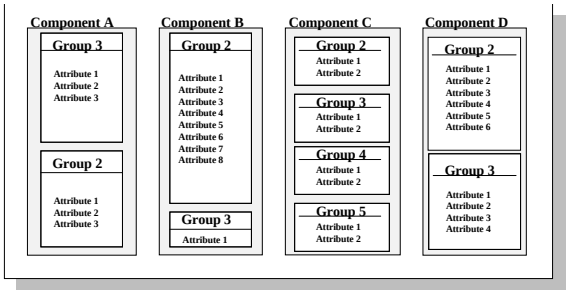
Data Model Definition

IETF SNMP

Hierarchical (Tree)



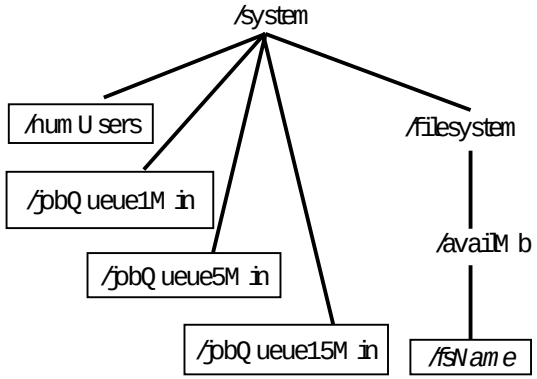
Relational (Tables)



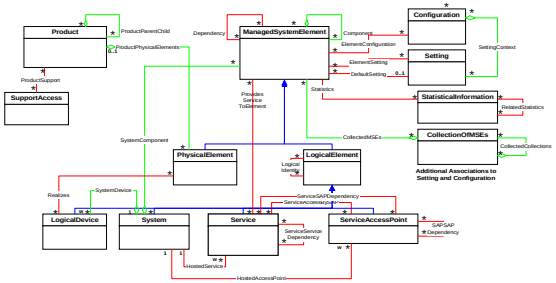
DMTF DMI

HP-UX EMS

Hierarchical (Tree)



Object-Oriented (Classes)



DMTF WBEM

Data Model

SNMP MIB

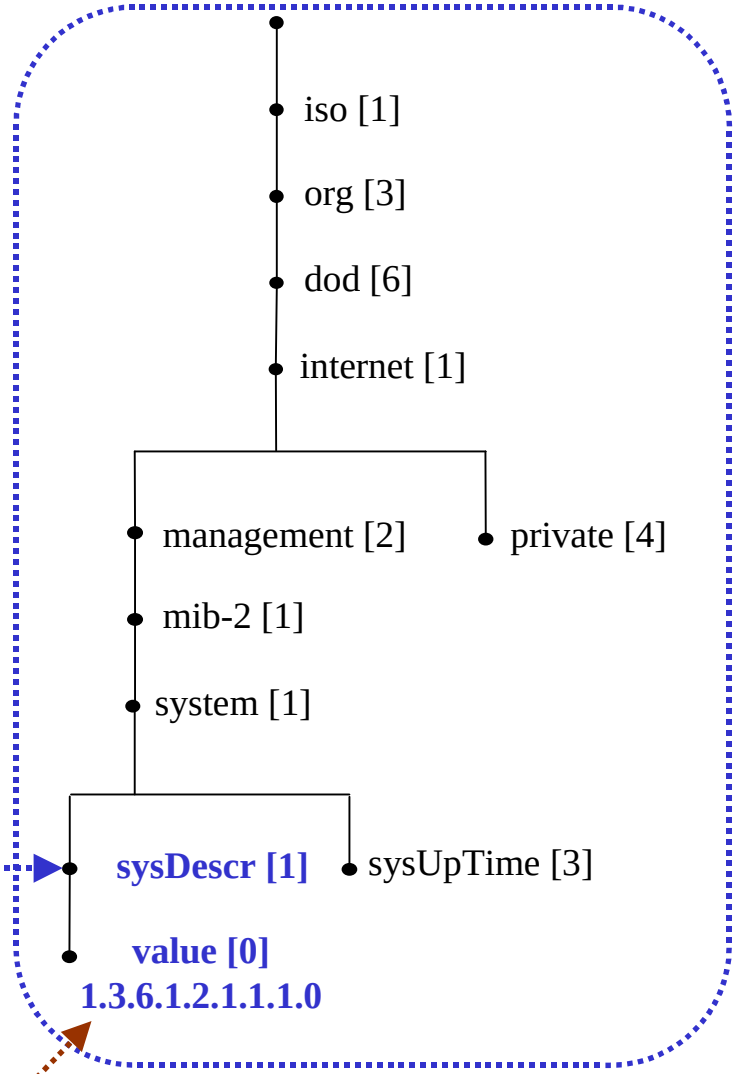
Management Information Base (MIB)

- Hierarchical Structure
- Values are represented as leaf nodes
- Objects are uniquely identified by OID

Sample MIB Segment

```
sysDescr OBJECT-TYPE
       SYNTAX DisplayString (SIZE (0..255))
       ACCESS read-only
       STATUS mandatory
       DESCRIPTION "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.“
        ::= { system 1 }
```

Sample SNMP Hierarchy



Object Identifier (OID)

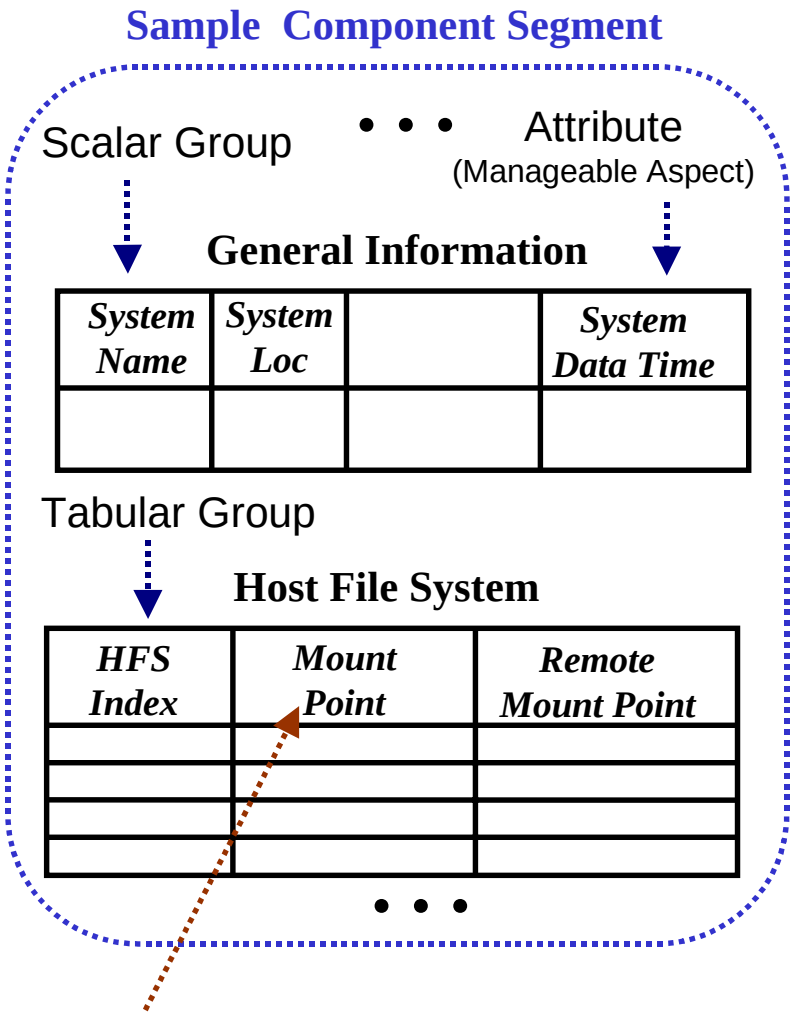
Data Model

DMI MIF

Management Interface Format (MIF)

- Relational Structure
- Values are represented as rows of the table

- 1 Component Per MIF
  - Corresponds to a “manageable product”
  - Contains one or more named groups
- Group
  - Collection of related manageable attributes (e.g., attributes that describe a file system)
  - Scalar Group
    - One instance per system (e.g., keyboard)
  - Tabular Group
    - Multiple instances per system (e.g., file systems or disk drives)
  - Collection of attributes (i.e. row) defines an instance of an object



Unique Attribute Identifier

defining body|specific name|version.attributeID

DMTF|Host File System|001.2

Data Model

DMI MIF

Group within DMTF "Master" Component

Unique Group Identifier
Defining Body|Group Class Name|Version

SNMP OID

Specifies mapping to SNMP OID

Attribute ID
Each attribute has a unique numeric identifier, starting with the number one (part of Unique Attribute Identifier)

Value is from a large set of possibilities v.s. small set of possibilities (common)

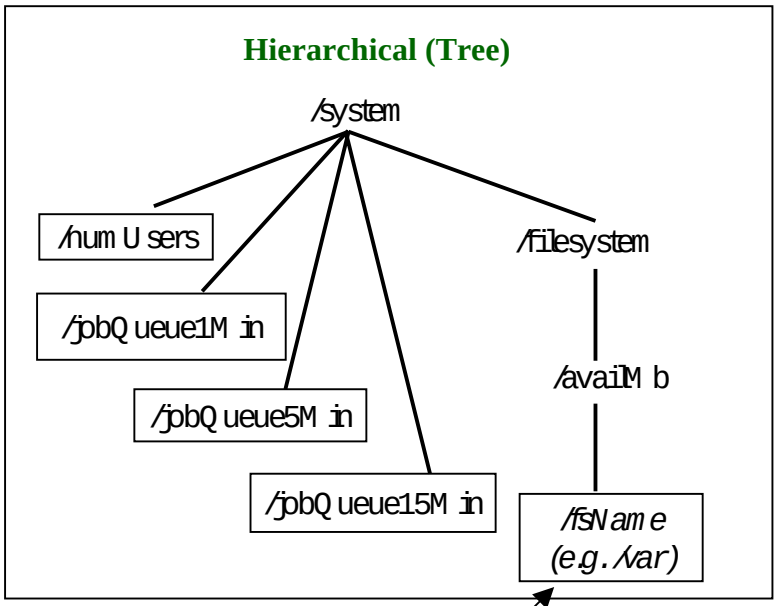
```
Start Group
        Name = "General Information"
        Class = "DMTF|General Information|001"
        ID = 61
        Description = "This group defines general information about this system."
        Pragma = "SNMP:1.3.6.1.4.1.412.2.4.1 ;"

        Start Attribute
                Name = "System Name"
                ID = 1
                Description = "A name to identify this system."
                Access = Read-Write
                Storage = Specific
                Type = DisplayString(64)
                Value = ""
        End Attribute
        . . .
        Start Attribute
                Name = "System Date Time"
                ID = 6
                Description = "The actual system date and time."
                Access = Read-Write
                Storage = Specific
                Type = Date
                Value = ""
        End Attribute
End Group
```

Data Model

HP-UX EMS

Event Monitoring Service

- Hierarchical Structure
- Resources that can be monitored are represented as leaf nodes
- Resources are uniquely identified by their path name (e.g., /system/filesystem/availMb/var)



Sample EMS Dictionary File

```
#  EMS Disk Monitor Dictionary File
#
RESOURCE_NAME: /vg
DESCRIPTION:  “Volume Groups Subclass”
MONITOR: /etc/resmon/lbin/diskmond
STATE_TYPE: S
```

EMS Configuration Example

Resource: /system/filesystem/availMb/var
Notify: When value is less than 5 MB
Polling Interval: 5 minutes
Notify via: SNMP

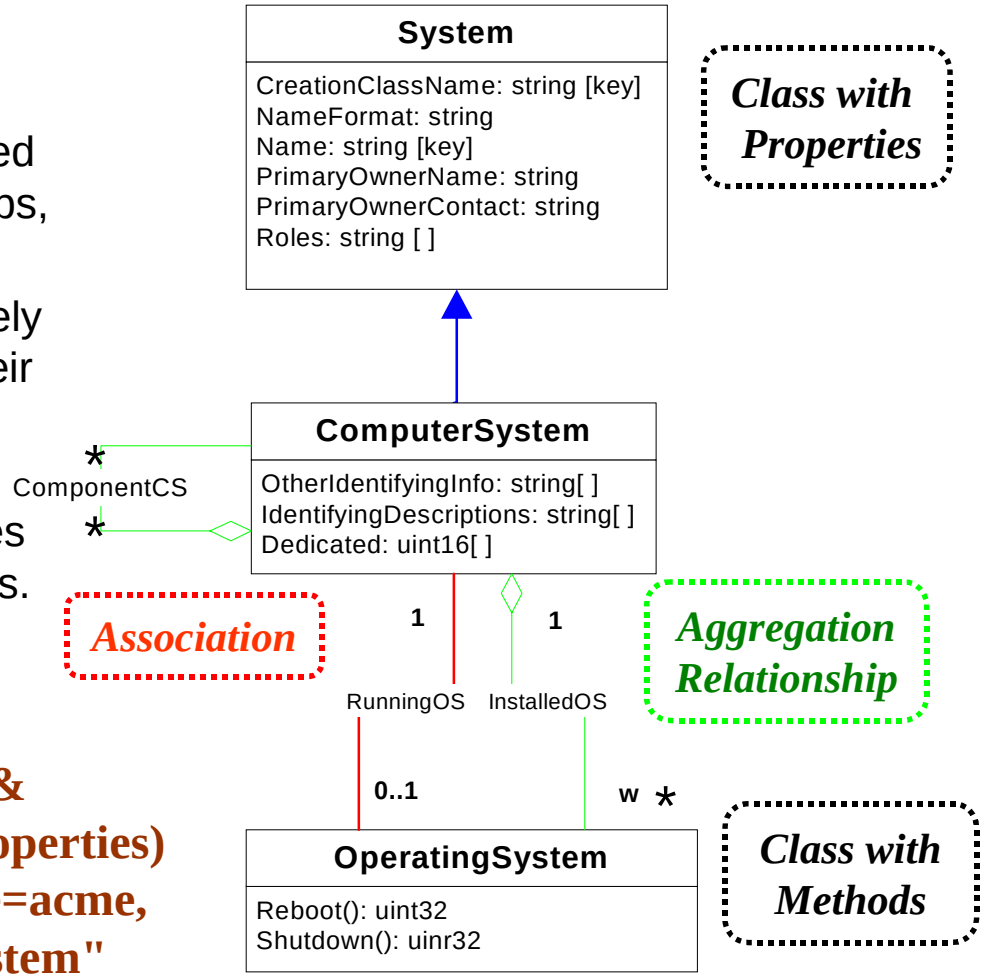
Data Model

DMTF Common Information Model (CIM)

Managed Object Format (MOF)

- Object-oriented Model
- Management information represented as instances, properties, relationships, classes, and subclasses.
- Instances of CIM classes are uniquely identified by their key properties, their class name, and a namespace identifier.
- Vendors extend the standard classes to represent unique feature/functions.

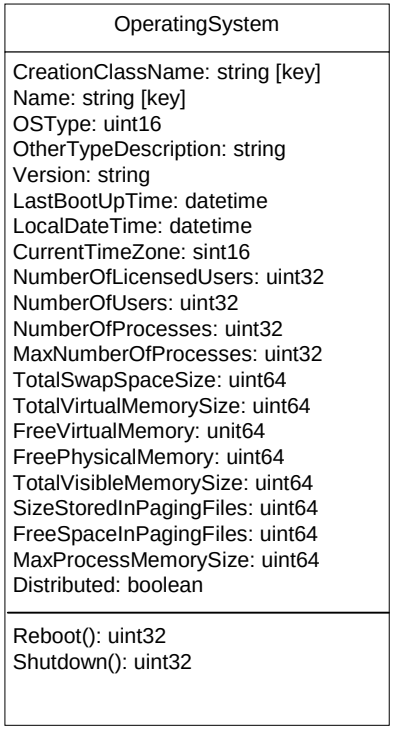
Sample CIM Schema (System Model)



Object Name = Namespace Path & Model Path (Class Name & Key Properties)
"//./root/cimv2:ComputerSystem:Name=acme, CreateClassName=ComputerSystem"

Data Model

DMTF Common Information Model (CIM)



Sample MOF Segment

```
// ==================================================
// OperatingSystem
// ==================================================
[Description ( "An OperatingSystem is software/firmware that
makes a ComputerSystem's hardware usable, and implements
and/or manages the resources, file systems, processes, user
interfaces, services, ... available on the ComputerSystem.")
]
class CIM_OperatingSystem : CIM_LogicalElement {
…
[Description ( "OperatingSystem's notion of the local date
and time of day."),
MappingStrings {"MIB.IETF|HOST-RESOURCES-MIB.hrSystemDate",
"MIF.DMTF|General Information|001.6"} ]
datetime LocalDateTime;
…
[Description ( "Number of user sessions for which the
OperatingSystem is currently storing state information."),
Gauge,
MappingStrings {"MIF.DMTF|Host System|001.4", "MIB.IETF|HOST-
RESOURCES-MIB.hrSystemNumUsers"} ]
uint32 NumberOfUsers;
…
};
```

Specifies mapping to DMI MIF

Specifies mapping to SNMP MIB

“Core” Data Definitions

IETF SNMP

MIB-II

Simple Network Management Protocol (SNMP)

www.ietf.org

SNMP MIB–II Management Interface Variables (System, Interfaces, Address Translation, IP, ICMP, TCP, UDP, EGP, Transmission, SNMP)

MIB for Network Management of TCP/IP-based internets: MIB-II , RFC 1213, STD 17, 1991.

Desktop Management Interface (DMI)

www.dmtf.org

Master MIF - manageable attributes that are expected to be supported by DMI-enabled computer systems

Master MIF, Version 001219, Dec. 19, 2000.

DMTF DMI

Master MIF

HP-UX EMS

HP-Provided Monitors

HP-UX Event Monitoring Service (EMS)

http://docs.hp.com/hpux/ha/

HW (e.g, I/O devices, interface cards, and memory) and SW Monitors (e.g., disk, cluster, network, and system) available from HP.

EMS HW Monitors User’s Guide;, 2000; Using High Availability Monitors, 1999.

Web-Based Enterprise Management (WBEM)

www.dmtf.org/spec/cim_schema_v25.html

CIM Schema (Core, Events, User-Security, Policy, Application, System, Device, Physical, Network, Metrics, Support).

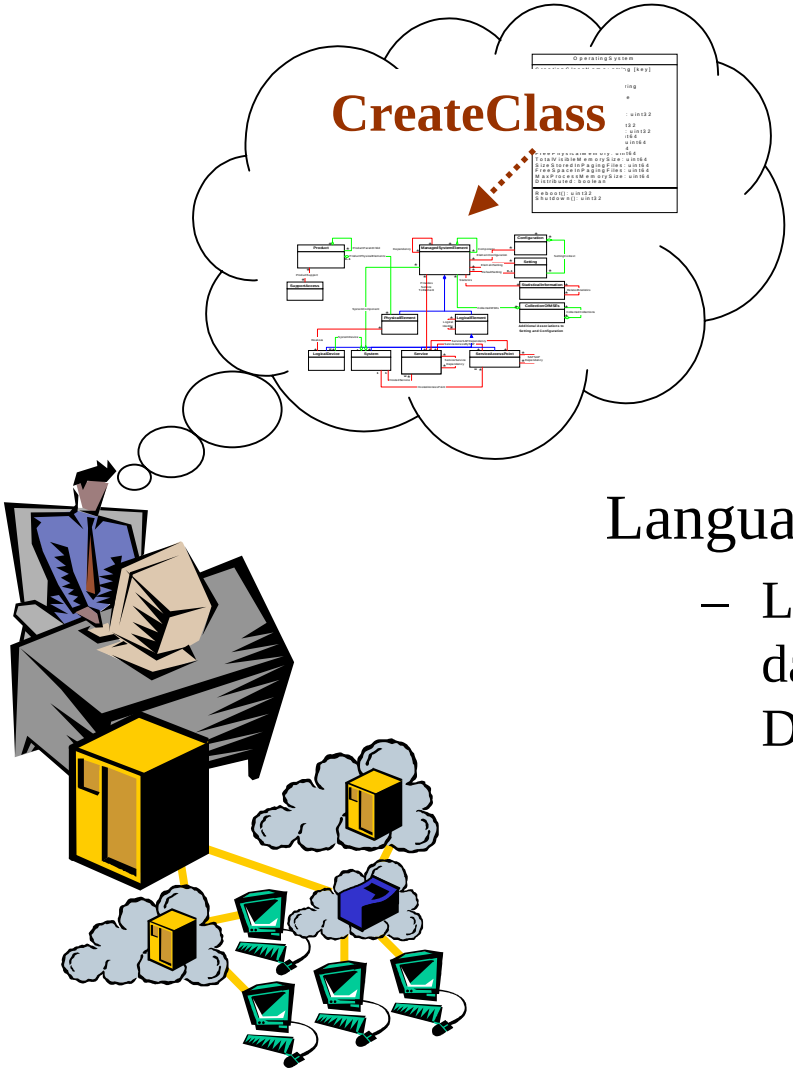
CIM Schema, V2.5, February, 2001.

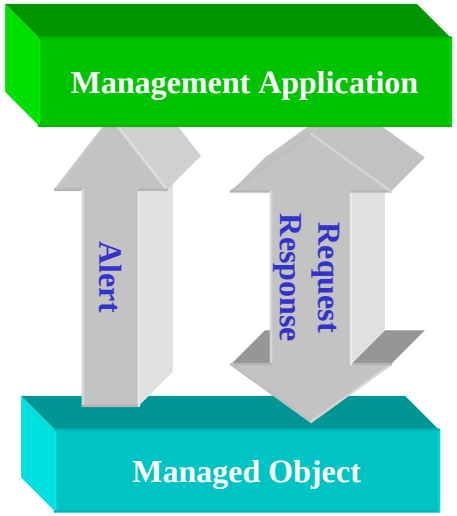
DMTF WBEM

Management Unification

Management Infrastructure

Data Language





Language

- Language syntax is influenced by choice of data model (e.g., EnumerateClass, DeleteRow)

Management Infrastructure

Data Language

IETF SNMP

SNMP Protocol

SNMPv1
get-request
get-next-request
get-response
set-request
trap
SNMPv2 Extensions
get-bulk
inform

Management Interface (MI)

Initialization Functions
•DmiRegister()
•DmiUnregister()
•DmiGetVersion()
•DmiGetConfig()
•DmiSetConfig()

Listing Functions
•DmiListComponents()
•DmiListComponentsByClass()
•DmiListLanguages
•DmiListClassNames
•DmiListGroups
•DmiListAttributes()

Operation Functions
•DmiGetAttribute()
•DmiSetAttribute()
•DmiAddRow()
•DmiDeleteRow()
•DmiGetMultiple()
•DmiSetMultiple()

DBA Functions
•DmiAddComponent()
•DmiDeleteComponent()
•DmiAddLanguage()
•DmiDeleteLanguage()
•DmiAddGroup
•DmiDeleteGroup

DMTF DMI

HP-UX EMS

EMS Event Configuration

Resource: /system/filesystem/availMb/var
Notify: When value is less than 5 Mb
Polling Interval: 5 minutes
Notify via: SNMP

CIM Functional Groups

Functional Group	Dependency	Methods
Basic Read	none	GetClass, EnumerateClasses, EnumerateClassNames, GetInstance, EnumerateInstances, EnumerateInstanceNames, GetProperty
Basic Write	Basic Read	SetProperty
Schema Manipulation	Instance Manipulation	CreateClass, ModifyClass, DeleteClass
Instance Manipulation	Basic Write	CreateInstance, ModifyInstance, DeleteInstance
Association Traversal	Basic Read	Associators, AssociateNames, References, ReferenceNames
Query Execution	Basic Read	ExecQuery
Qualifier Declaration	Schema Manipulation	GetQualifier, SetQualifer, DeleteQualifier, EnumerateQualifier

DMTF WBEM

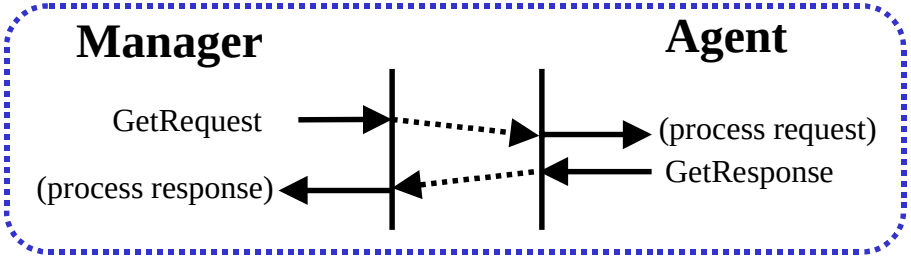
Data Language

SNMP Commands

SNMP enables

- A manager to retrieve (i.e., get) management information from an agent
- A manager to alter (i.e., set) management information by an agent
- An agent to send information (i.e., trap) to a manager without an explicit request from the manager.

Command	Description
get	Get a value
get-next	Get the next value
get-bulk	Get many values
get-response	Return a value
set-request	Set a value
trap	Event notification (Agent to NMS)
inform	Event notification (NMS to NMS)

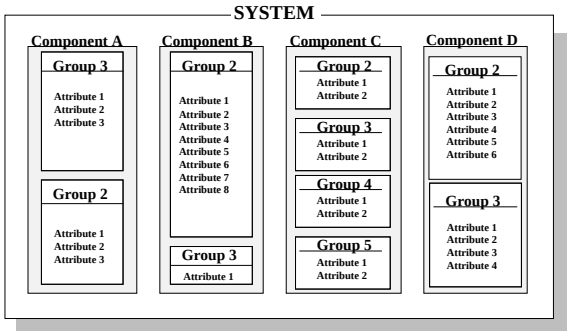


Request: **snmpget testnode public system.sysDescr.0**

Response: **OCTET STRING- (ascii): HP-UX hpcndk 7.0 B 9000/370**

Data Language

DMI Management Interface (MI)

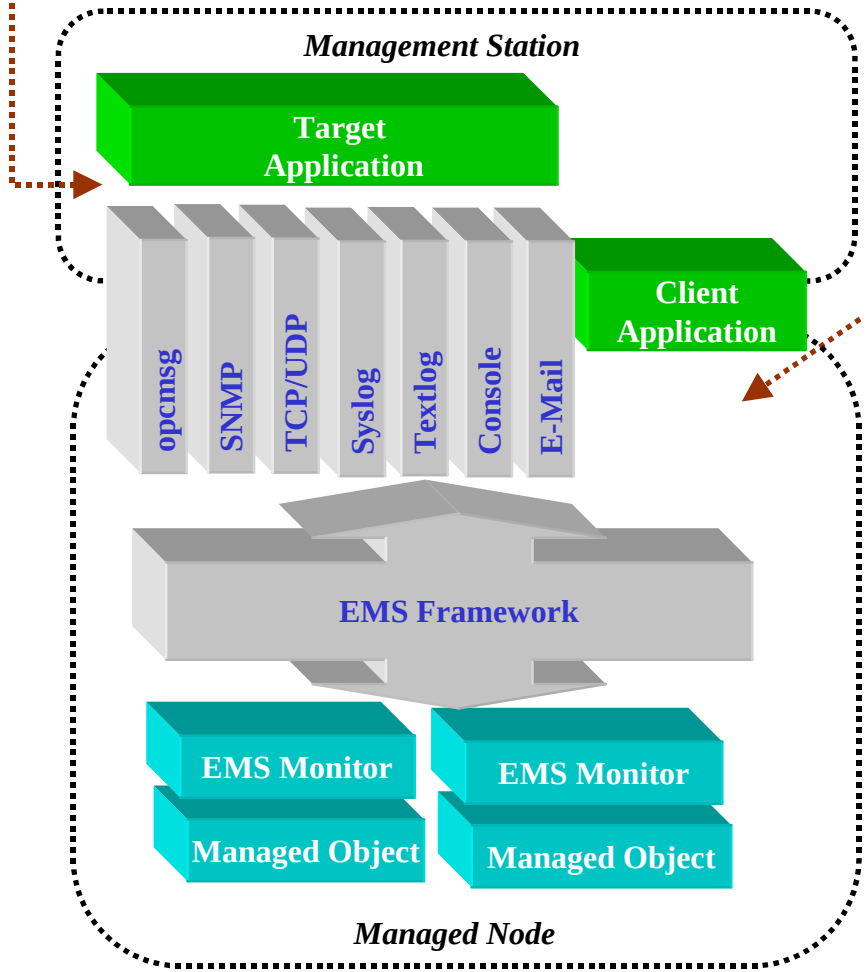


- Initialization Functions
  - DmiRegister()
  - DmiUnregister()
  - DmiGetVersion()
  - DmiGetConfig()
  - DmiSetConfig()
- Listing Functions
  - DmiListComponents()
  - DmiListComponentsByClass()
  - DmiListLanguages
  - DmiListClassNames
  - DmiListGroups
  - DmiListAttributes()
- Operation Functions
  - DmiGetAttribute()
  - DmiSetAttribute()
  - DmiAddRow()
  - DmiDeleteRow()
  - DmiGetMultiple()
  - DmiSetMultiple()
- Database Administration Functions
  - DmiAddComponent()
  - DmiDeleteComponent()
  - DmiAddLanguage()
  - DmiDeleteLanguage()
  - DmiAddGroup
  - DmiDeleteGroup

Data Language

HP-UX EMS

“Notify method”-specific

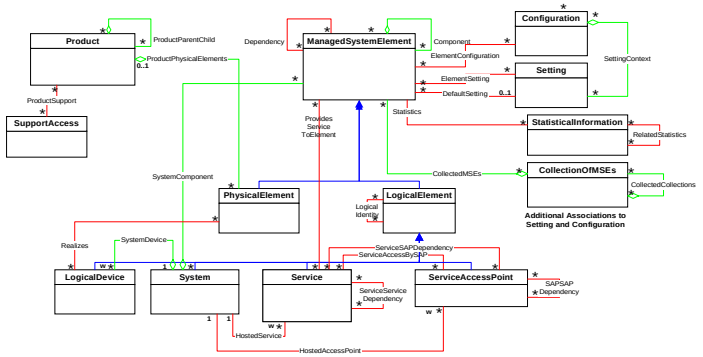


EMS Event Configuration

Resource: /system/filesystem/availMb/var
Notify: When value is less than 5 Mb
Polling Interval: 5 minutes
Notify via: SNMP

Data Language

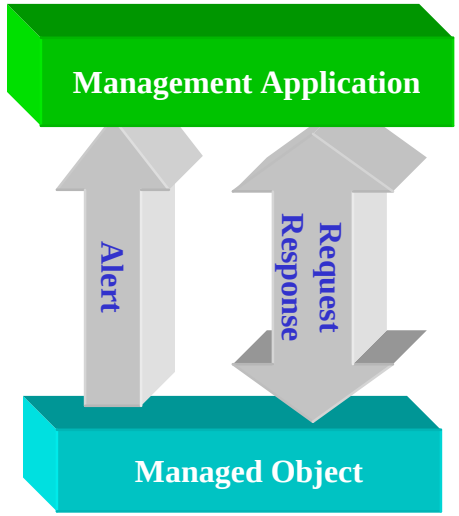
CIM Operations

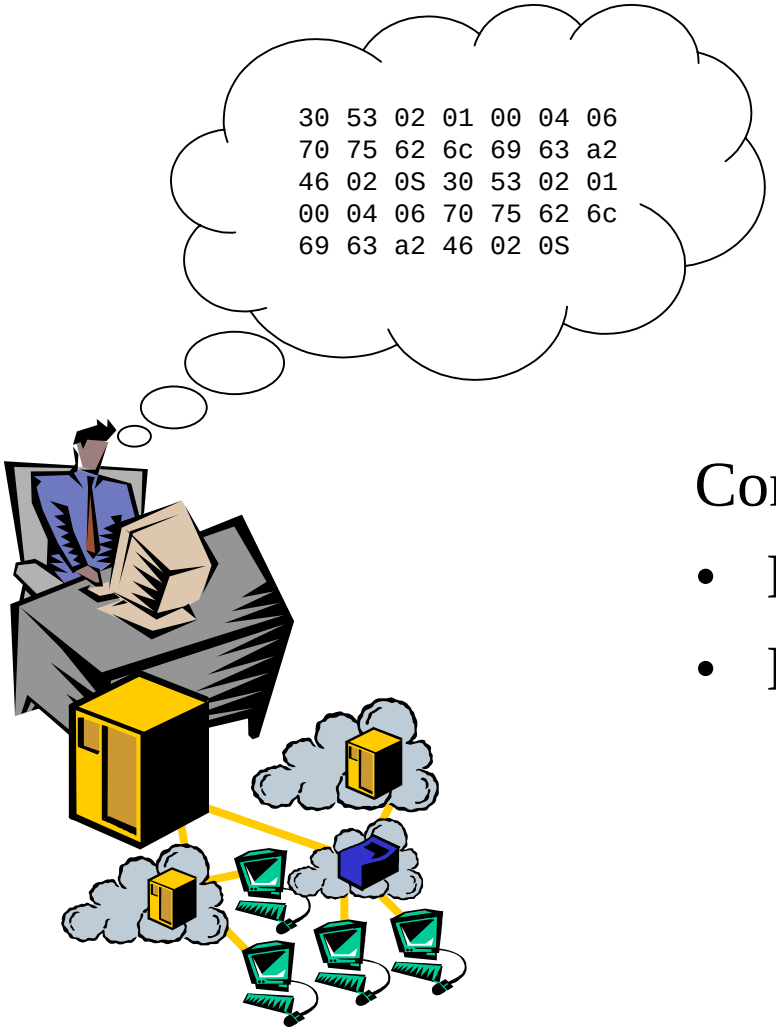


Functional Group	Dependency	Methods
Basic Read	none	GetClass, EnumerateClasses, EnumerateClassNames, GetInstance, EnumerateInstances, EnumerateInstanceNames, GetProperty
Basic Write	Basic Read	SetProperty
Schema Manipulation	Instance Manipulation	CreateClass, ModifyClass, DeleteClass
Instance Manipulation	Basic Write	CreateInstance, ModifyInstance, DeleteInstance
Association Traversal	Basic Read	Associators, AssociateNames, References, ReferenceNames
Query Execution	Basic Read	ExecQuery
Qualifier Declaration	Schema Manipulation	GetQualifier, SetQualifer, DeleteQualifier, EnumerateQualifier

Management Infrastructure

Communication Protocol





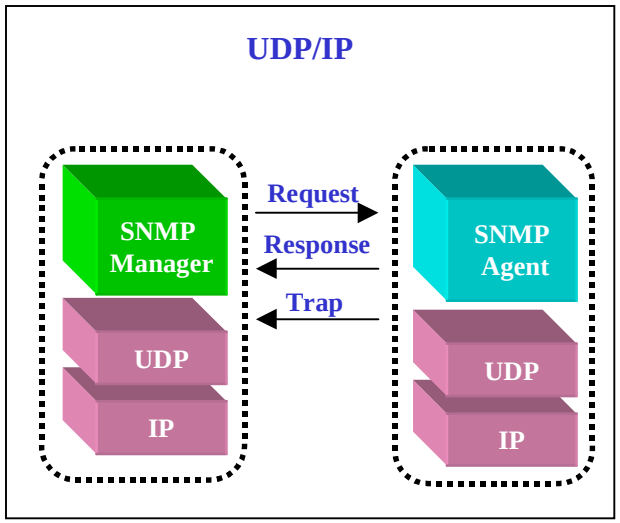
Communication Protocol

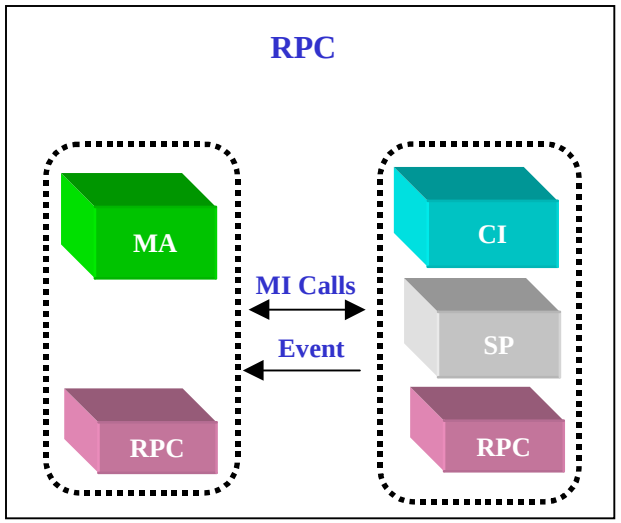
- Encoding
- Network Protocol

Management Framework

Communication Protocol

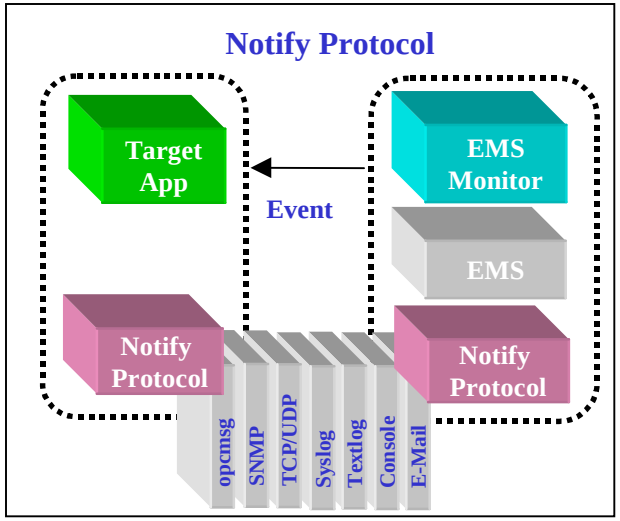
IETF SNMP

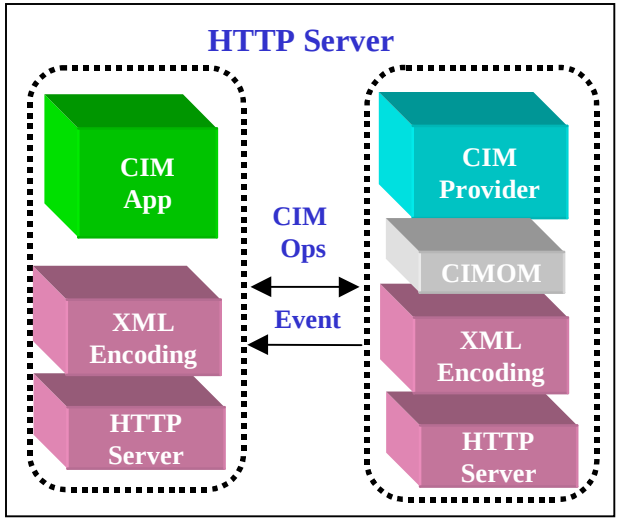




DMTF DMI

HP-UX EMS

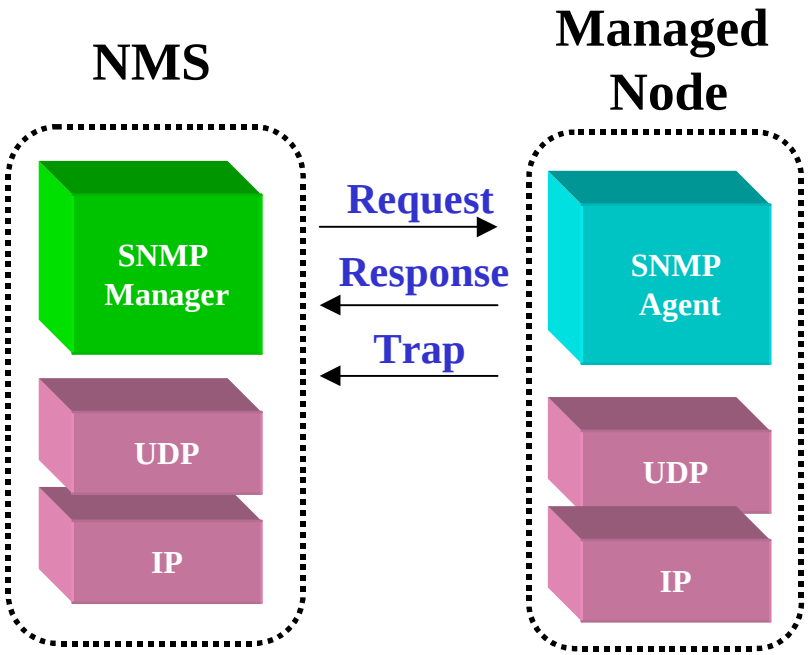




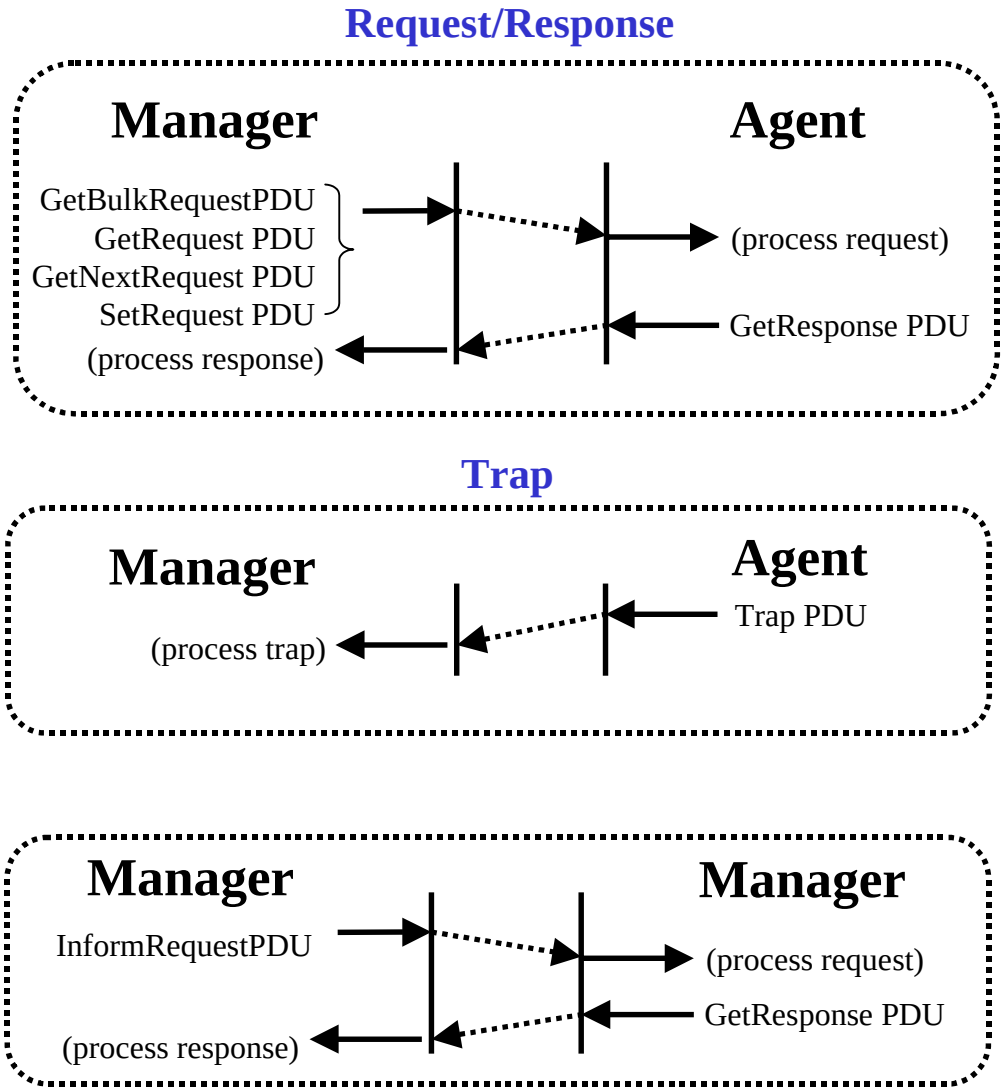
DMTF WBEM

Communication Protocol

SNMP



SNMP requests are typically sent to UDP port 161. SNMP responses are typically sent from UDP port 161. SNMP traps are typically sent to UDP port 162.



PDU = Protocol Data Unit

Communication Protocol

SNMP

```
 0: 30 27 02 01 00 04 06 70 75 62 6c 69 63 a0 1a 02 0'.....public...
16: 02 46 5a 02 01 00 02 01 00 30 0e 30 0c 06 08 2b .FZ......0.0...+
32: 06 01 02 01 01 01 00 05 00 -- -- -- -- -- -- -- .................
 0: SEQUENCE (0x30): 39 bytes
 2: INTEGER VERSION (0x2) 1 bytes: 0
 5: OCTET STRING COMMUNITY (0x4) 6 bytes: "public"
13: GETREQUEST-PDU (0xa0): 26 bytes
15: INTEGER REQUEST-ID (0x2) 2 bytes: 18010
19: INTEGER ERROR-STATUS (0x2) 1 bytes: noError(0)
22: INTEGER ERROR-INDEX (0x2) 1 bytes: 0
25: SEQUENCE (0x30): 14 bytes
27: SEQUENCE (0x30): 12 bytes
29: OBJECT ID (0x6) 8 bytes: .1.3.6.1.2.1.1.1.0
39: NULL (0x5) 0 bytes
```

GET request for system.sysDescr.0

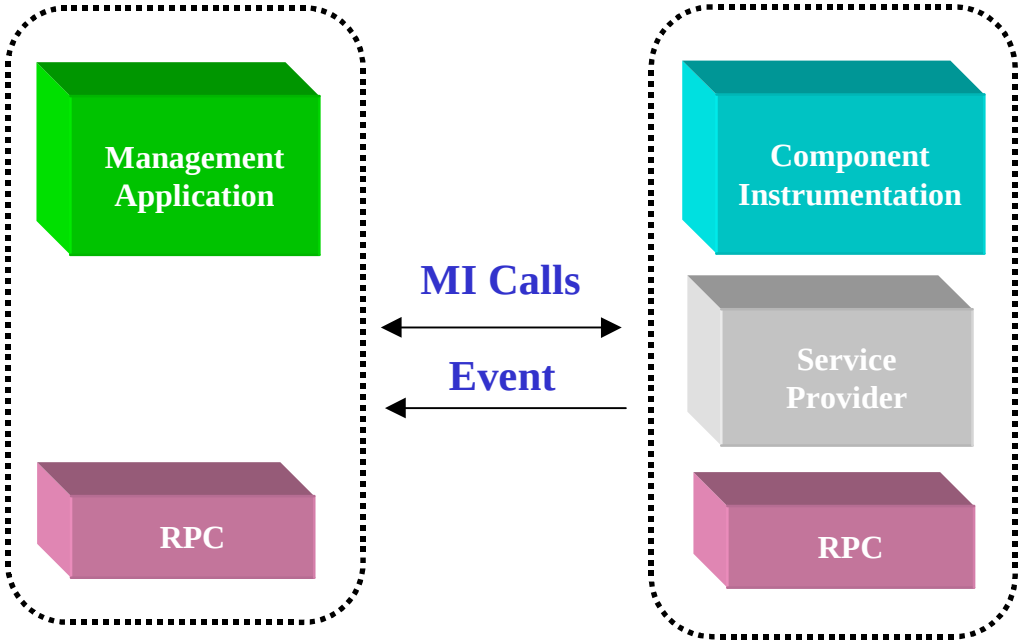
And the response is …

```
 0: 30 53 02 01 00 04 06 70 75 62 6c 69 63 a2 46 02 0S.....public.F.
16: 02 46 5a 02 01 00 02 01 00 30 3a 30 38 06 08 2b .FZ......0:08..+
32: 06 01 02 01 01 01 00 04 2c 48 50 2d 55 58 20 68 ........,HP-UX h
48: 70 77 69 6e 64 38 31 20 41 2e 30 39 2e 30 35 20 pwind81 A.09.05
64: 43 20 39 30 30 30 2f 37 31 35 20 32 30 30 36 37 C 9000/715 20067
80: 32 32 36 38 30 -- -- -- -- -- -- -- -- -- -- -- 22680...........
 0: SEQUENCE (0x30): 83 bytes 2: INTEGER VERSION (0x2) 1 bytes: 0
 5: OCTET STRING COMMUNITY (0x4) 6 bytes: "public"
13: GETRESPONSE-PDU (0xa2): 70 bytes
15: INTEGER REQUEST-ID (0x2) 2 bytes: 18010
19: INTEGER ERROR-STATUS (0x2) 1 bytes: noError(0)
22: INTEGER ERROR-INDEX (0x2) 1 bytes: 0
25: SEQUENCE (0x30): 58 bytes
27: SEQUENCE (0x30): 56 bytes
29: OBJECT ID (0x6) 8 bytes: .1.3.6.1.2.1.1.1.0
39: OCTET STRING (0x4) 44 bytes: "HP-UX hpwind81 A.09.05 C 9000/715 2006722680"
```

Communication Protocol

DMI

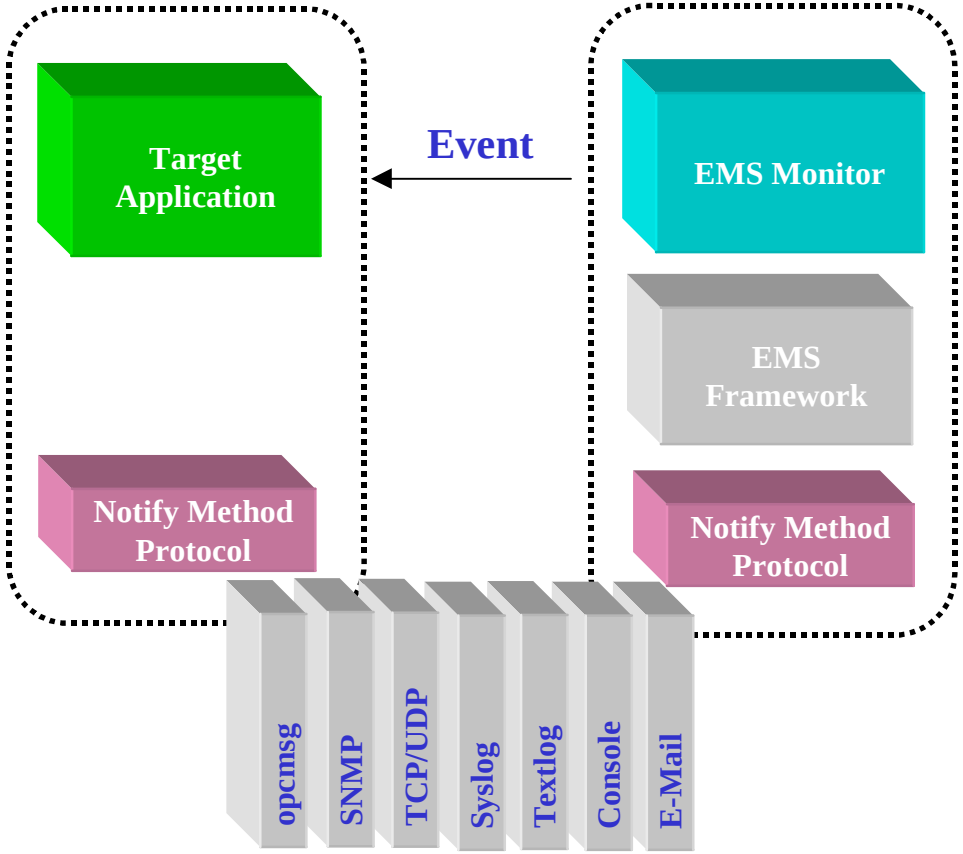
- DMI procedural interfaces are designed to be remotely accessible through the use of Remote Procedure Calls (RPC). The RPCs supported by DMI are: **DCE/RPC (HP-UX Mechanism),** ONC/RPC, and TI/RPC.
- The RPC, with associated services, handles all inter-communication session management



Communication Protocol

HP-UX EMS

- ***opcmsg (ITO) option*** – sends messages to ITO applications
- ***SNMP Trap option*** – sends event notifications to SNMP-aware management application
- ***TPC/UDP option*** – sends encoded events to the target host name and port indicated in the request
- ***Syslog option*** – sends event notification to the system log
- ***Textlog option*** – sends event notification to user defined text log
- ***Console option*** – sends event notification to the system console
- ***E-Mail option*** – sends event notification to the e-mail address indicated in the request.

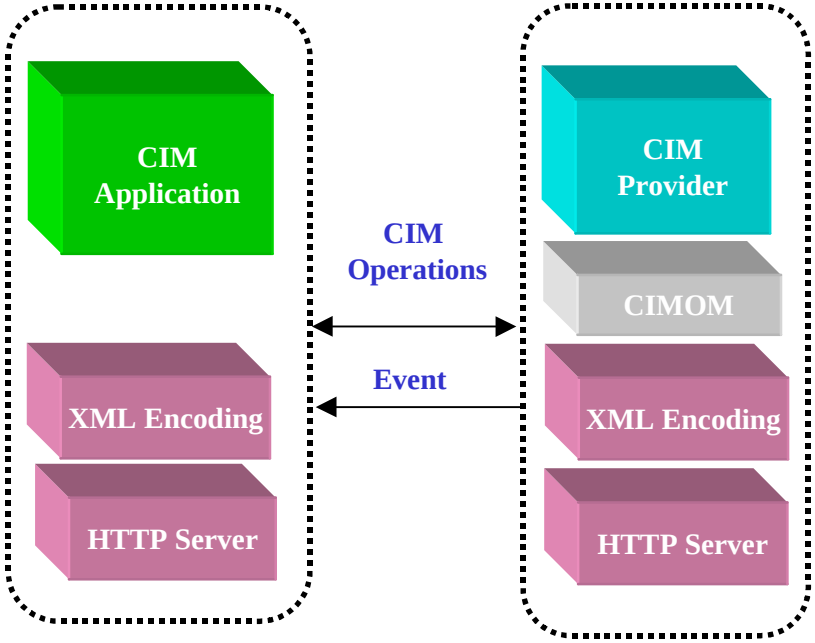


Communication Protocol

DMTF WBEM

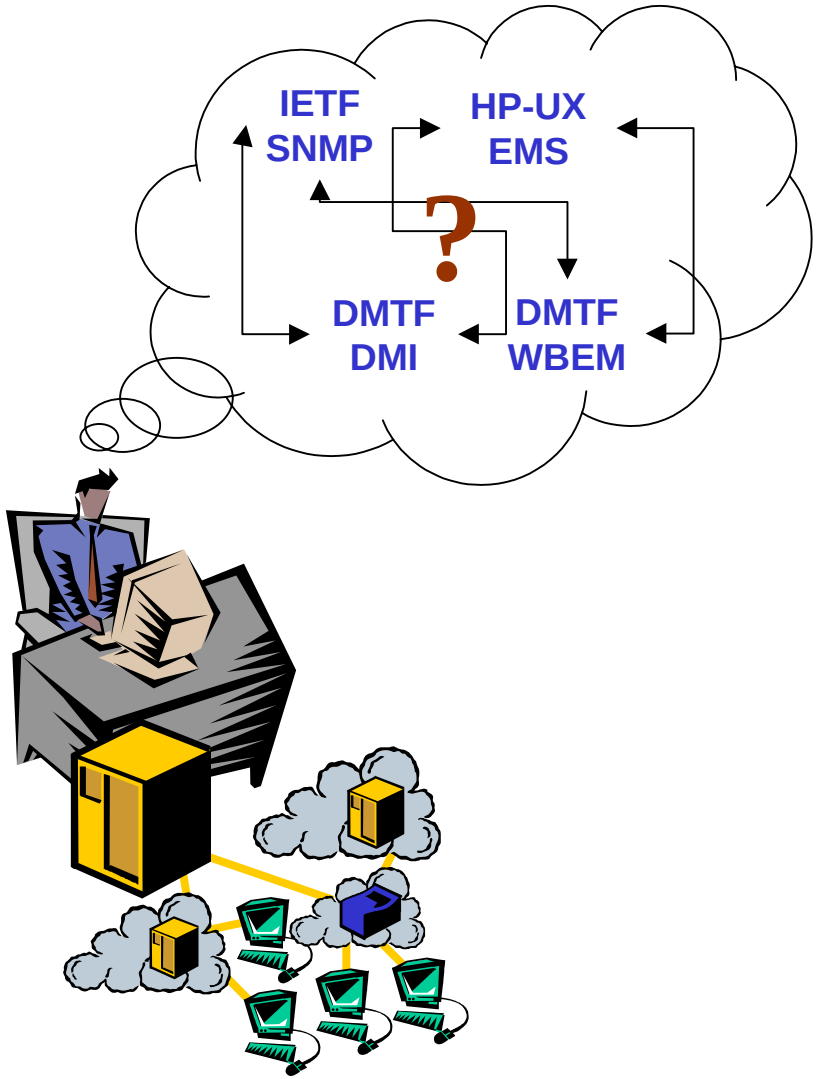
HTTP Request
CIM Operation – XML Encoding

```
M-POST /cimom HTTP/1.1
HOST: www.hpserver1.com
Content-Type: application/xml; charset="utf-8"
Content-Length: xxxx
Man: http://www.dmtf.org/cim/mapping/http/v1.0; ns=73
73-CIMOperation: MethodCall
73-CIMMethod: GetProperty
73-CIMObject: root/cimv2

<?xml version="1.0" encoding="utf-8" ?>
<CIM CIMVERSION="2.0" DTDVERSION="2.0">
 <MESSAGE ID="87872" PROTOCOLVERSION="1.0">
  <SIMPLEREQ>
   <IMETHODCALL NAME="GetProperty">
    <LOCALNAMESPACEPATH>
     <NAMESPACE NAME="root"/>
     <NAMESPACE NAME="myNamespace"/>
    </LOCALNAMESPACEPATH>
    <IPARAMVALUE NAME="InstanceName">
     <INSTANCENAME CLASSNAME="MyDisk">
      <KEYBINDING NAME="DeviceID"><KEYVALUE>C:</KEYVALUE></KEYBINDING>
     </INSTANCENAME>
    </IPARAMVALUE>
    <IPARAMVALUE NAME="PropertyName"><VALUE>FreeSpace</VALUE></IPARAMVALUE>
   </IMETHODCALL>
  </SIMPLEREQ>
 </MESSAGE>
</CIM>
```

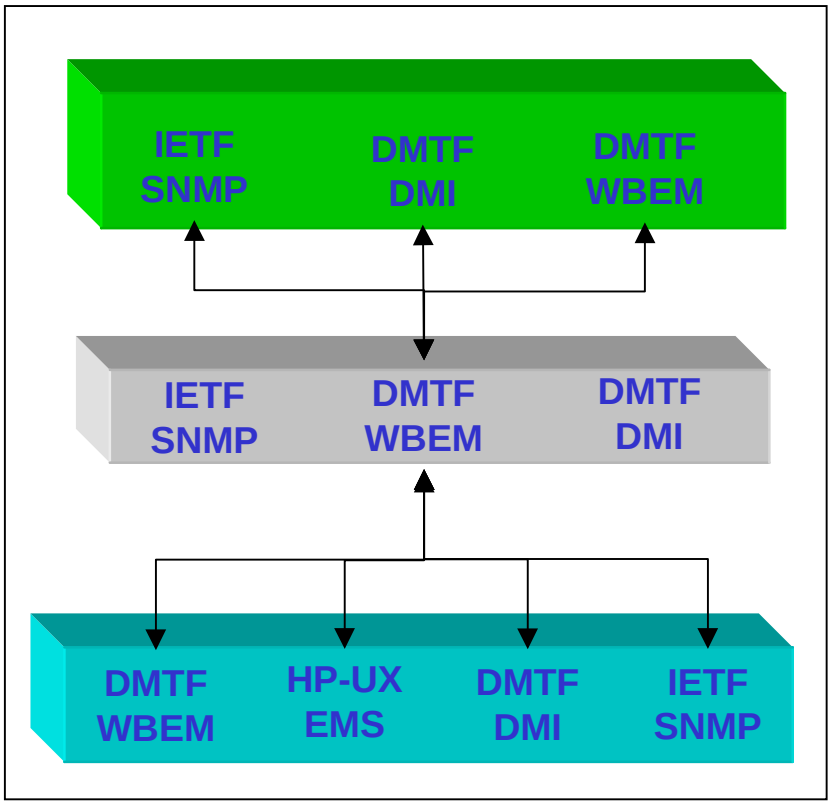


Management Infrastructure

Interoperability

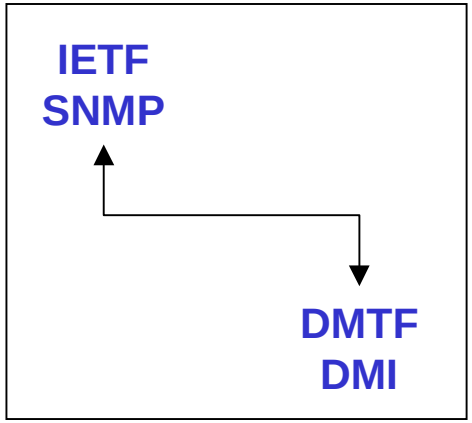


Possibilities



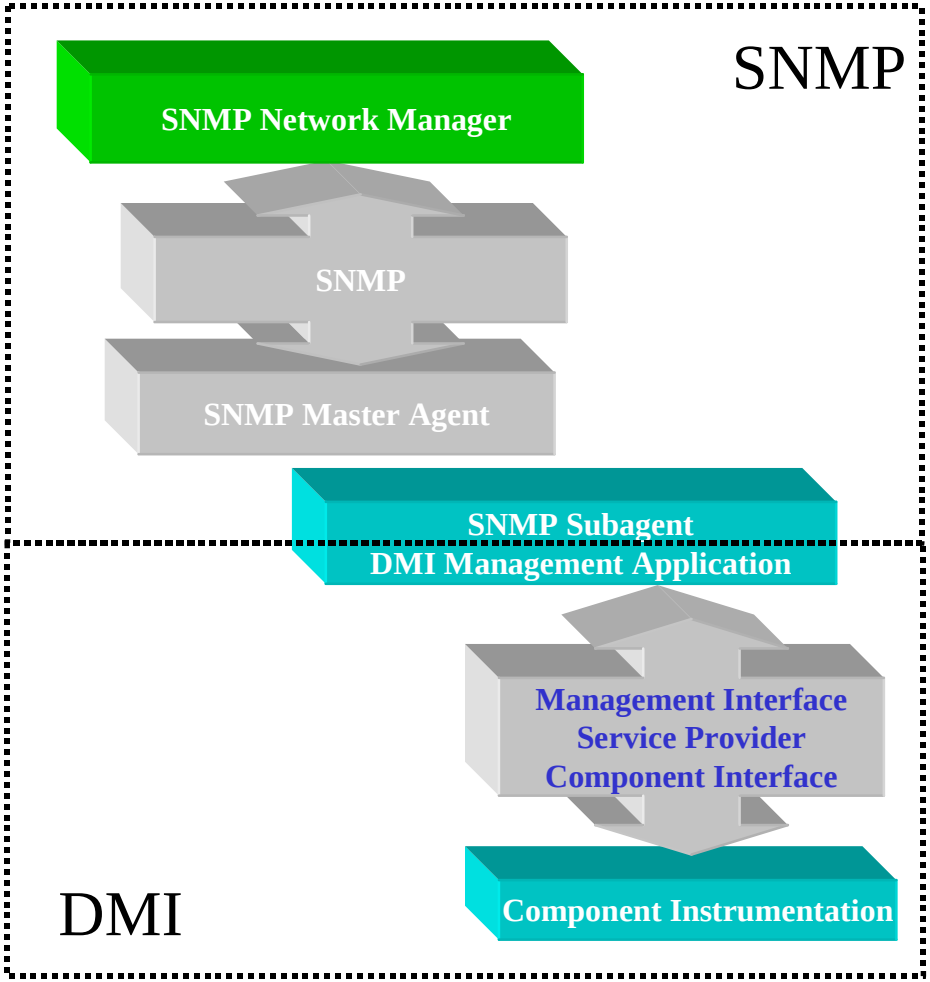
Management Framework Interoperability

DMI-to-SNMP Mapper Architecture



Desktop Management Task Force
DMI to SNMP Mapping Standard
Defines a set of mapping procedures to enable systems instrumented to DMI to be remotely, and uniformly, managed using the SNMP.

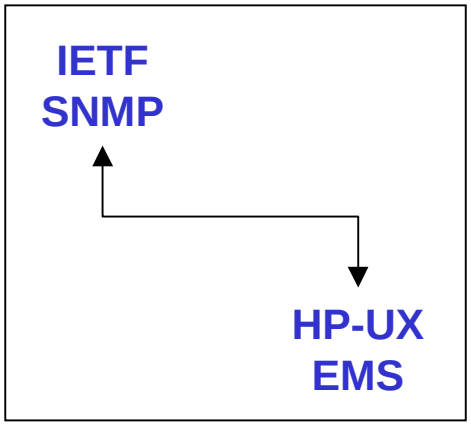
Objective: Expose DMI instrumentation to SNMP Applications

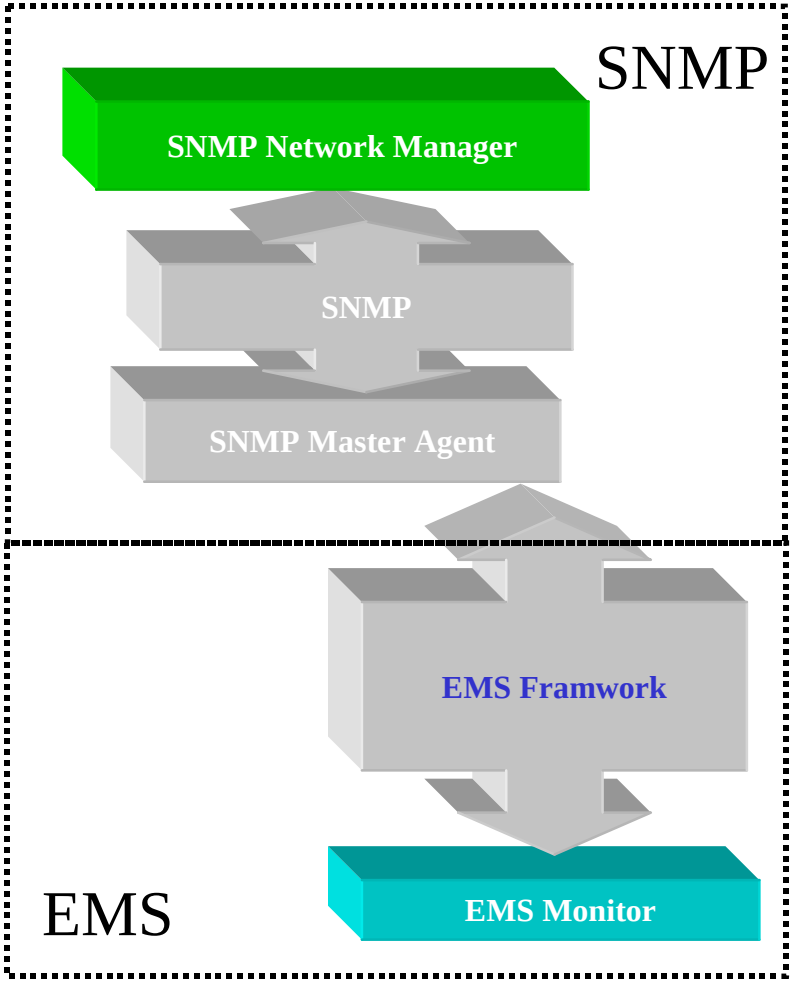


Management Framework Interoperability

EMS-to-SNMP Mapper Architecture

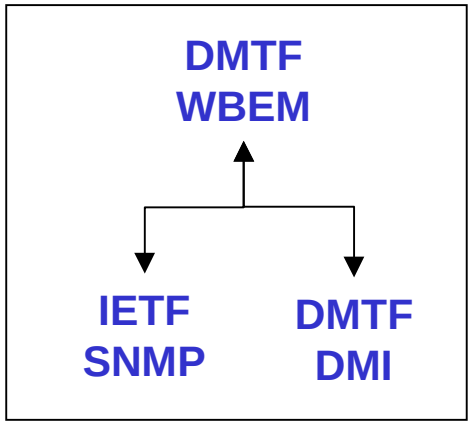
Objective: Expose EMS events to SNMP Applications





Management Framework Interoperability

WBEM Provider Architecture



Objective: Expose SNMP and DMI instrumentation to CIM Applications