Storage Management Tutorial
Part II

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Agenda

- Why is storage management important?
- Terminology & strategies.
- Standards based vs. proprietary management
- **The Storage Management Initiative**
  - Storage Management Initiative Specification (SMI-S)
  - SMI Interoperability Conformance Testing Program
  - CIM and WBEM Technical Overview

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Storage Management Initiative

- **What is it?**
  - Standard for storage devices & software used to manage devices
  - Owned & developed by Storage Networking Industry Association (SNIA)
  - Overall goal: to provide open & interoperable environment for storage management
    - Provides end users with multi-vendor management
    - Reduces cost barrier towards implementing new storage technologies
  - Storage Management Initiative Specification (SMI-S) version 1.0 released July, 2003
    - Common services defined for user interface, recipes, profiles
  - Goal of SNIA: all storage managed with SMI-S by 2005

Overview - History

- **DMTF**
  - started work on CIM in ~1996
- **SNIA**
  - started to look at WBEM as a potential storage interface in 1998
  - Proof of concept in Oct 1998
  - Focused on storage configuration model since Fall '00.
  - Pushed development with demos/plugfests.
- **PDP**
  - Private 'Partner Development Process' started in 2000
  - Leveraged SNIA work … and wrote 'Bluefin' draft
- **SMI (Storage Management Initiative)**
  - Bluefin contributed to SNIA in Summer '02
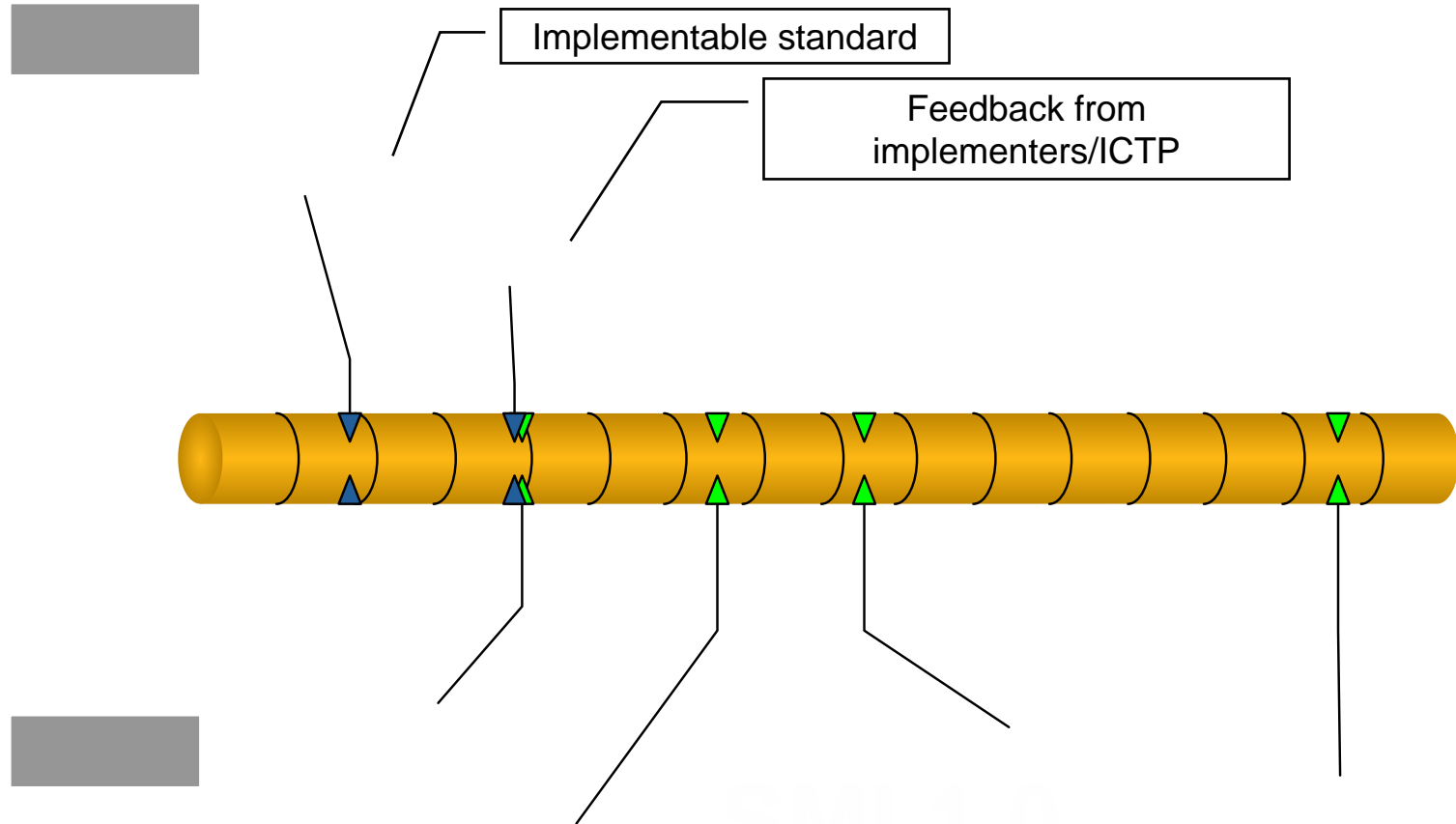
SMI vs Bluefin vs CIM vs ….

- SMI-S = Bluefin
  - Bluefin = SMI-S 0.1 ☺

- SMI CIM Model = CIM Schema 2.8
  - No unique 'SNIA' CIM Model

- SMI Transport = standard WBEM
  - All needed enhancements (SLP …) adopted by DMTF

- SMI added value
  - Single place for documents
  - Close definition of methods, property formats and contents
  - Storage specific profiles
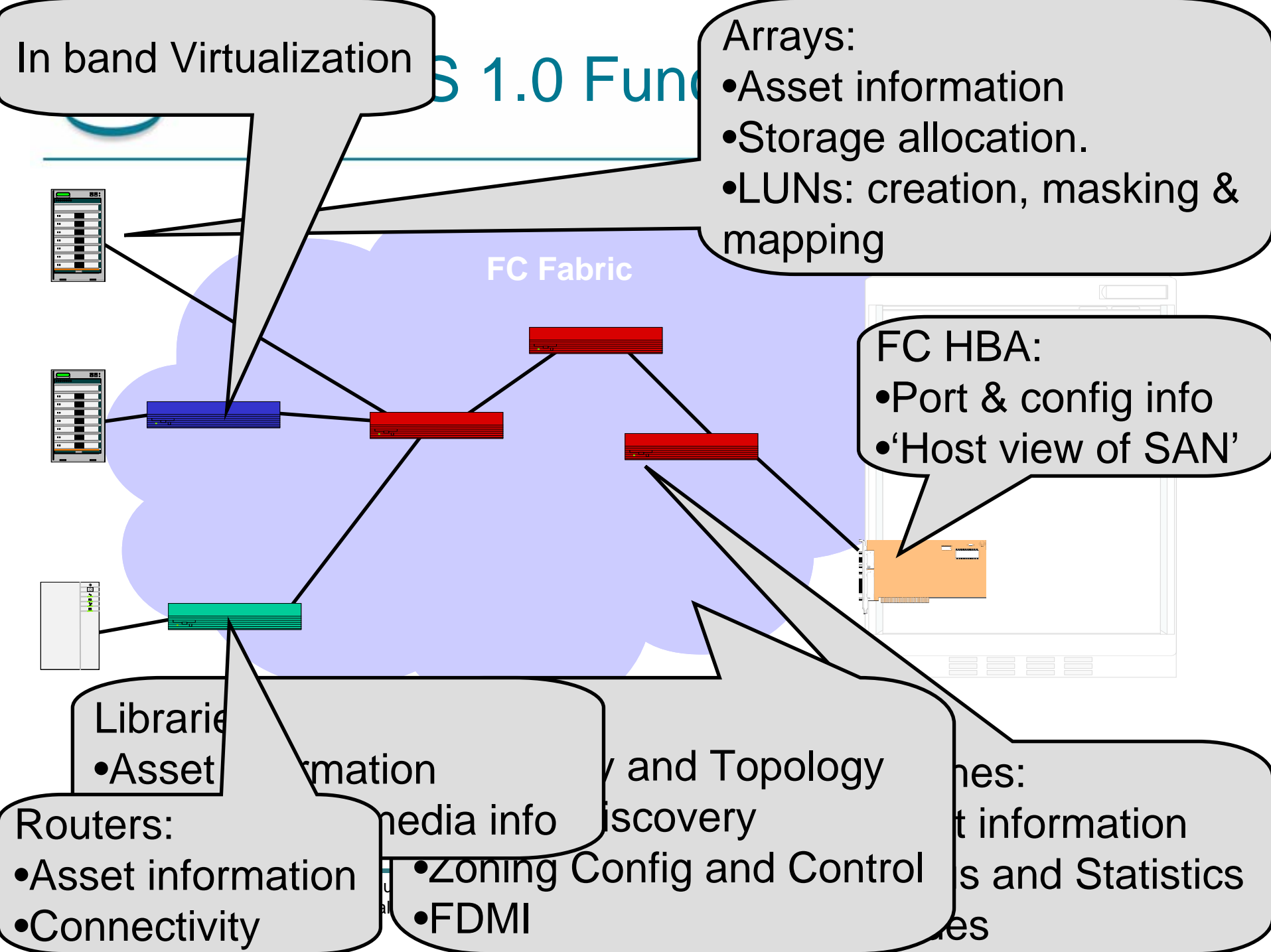 - Interoperability tests

Storage Management Initiative Specification

- Transport Protocol:
  - WBEM
  - Discovery via SLP (IETF standard)
  - Proposed locking mechanism
  - Security
- CIM Model Profiles (taken from CIM 2.8 Schema):
  - **Fabric:** Switches, Zoning, Router, Extender
  - **Host:** HBA, Management Appliance, Host Discovered Resources
  - **Storage Systems:** Array, JBOD, Virtualization (block server), Tape Library

SMI Specification Schedule

Implementable standard

Feedback from implementers/ICTP

In band Virtualization

S 1.0 Func

Arrays:
- Asset information
- Storage allocation.
- LUNs: creation, masking & mapping

FC Fabric

FC HBA:
- Port & config info
- 'Host view of SAN'

Libraries
- Asset information
- media info

y and Topology
iscovery
- Zoning Config and Control
- FDMI

Routers:
- Asset information
- Connectivity

hes:
t information
s and Statistics
es

- Automated discovery
  - SLP & profile advertisement
- Security
  - SSL
- Events (like SNMP traps)

Switches:
- Config
- Physical/Sensors

Arrays:
- Remote replication
- iSCSI/SATA..
- Fault management
- Performance man...
- Improved RAID mapping

- NAS Services:
FS creation/export
Remote copy

Out of Band Virtualization

Extenders

In Band Virtualization

IP

FCP

- iSCSI

Routers
- Masking and Mapping

Fabric:
- Trunking
- Config

Libraries:
- Media management
- Library virtualization

- Volume Management

IP

Data

Data

Host attachment:
- iSCSI/SATA ..
- Mount/dismount volumes
- Multi-pathing

Arrays:
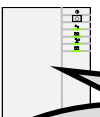- •Remote replication
- •iSCSI/SATA..

...ters
...ing and Mapping

Host attachment:
- •iSCSI/SATA ..
- •Mount/dismount volumes
- •Multi-pathing

NAS Services
- •File system creation/export
- •Remote copy

...ormation
...status & controls

Libraries:
- •Media management
- •Library virtualization?

- Policy

- Locking and Ownership

- Cascading

- Enhanced error reporting

SNIA
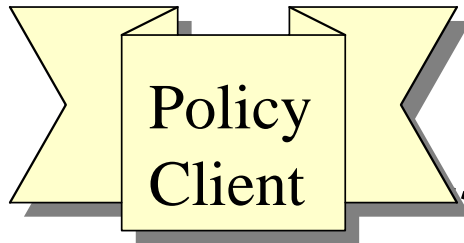
Administrator creates Policy model
Instance(s) using tool that acts as a
Policy Client

Policy Client

Object Manager

Provider
(Policy Implementation)
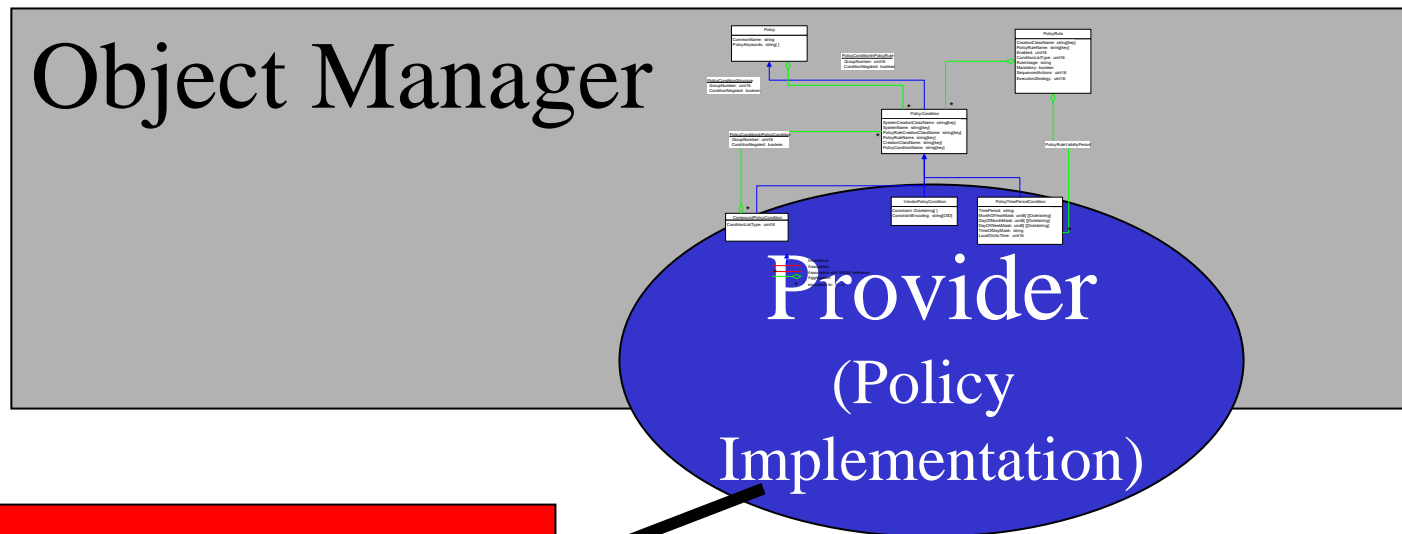
Device

Provider enforces policy directly
For the device

Cascaded Policy

SNIA

Policy Client

Rule, Condition, Action Instance(s) created in Object Manager(s)

Providers for those classes are all from the same vendors (or cooperating set of vendors) since there is no standard (yet) for context and result propagation.

Object Manager 1

Policy Implementation

Policy Implementation interprets policy on behalf of the device

Policy implementation creates subscriptions, evaluates rules and calls methods on basic model to enforce policy

Object Manager 2

Provider

Device

Provider only cognizant of basic CIM model

Locking, Ownership

- Locking allows for short term isolation between Clients trying to operate in the same part of the model
  - Simple model that is backward compatible with 1.0 systems
- Ownership allows for long term allocation of cascaded resources to parent devices that are managing them
 - NAS Heads, In-Band Virtualizers, etc.

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  - **SMI Interoperability Conformance Testing Program**
  - CIM and WBEM Technical Overview

Interoperability Conformance Test Program (ICTP)

- SNIA owned/developed conformance test for SMI-S

  - Interoperability Conformance Test Program (ICTP) provides "validation" of storage vendors implementation

  - Responsible for testing all specifications from SNIA not just SMI-S

- Customers can specify SNIA SMI-S Conformance Logo in their RFPs and require it of their vendors
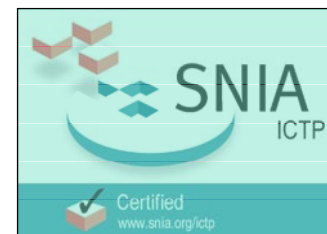
Interoperability Conformance Test Program (ICTP)

- Upon executing SNIA contract, vendors may:
- Have access to test suites for development in house
  - Participate in "plug fests" (Colorado Springs)
    - Provide vendors with "pre-test" solution before entering formal ICTP test
  - Solutions passing ICTP receive logo for use on packaging & marketing, name on SNIA web site along
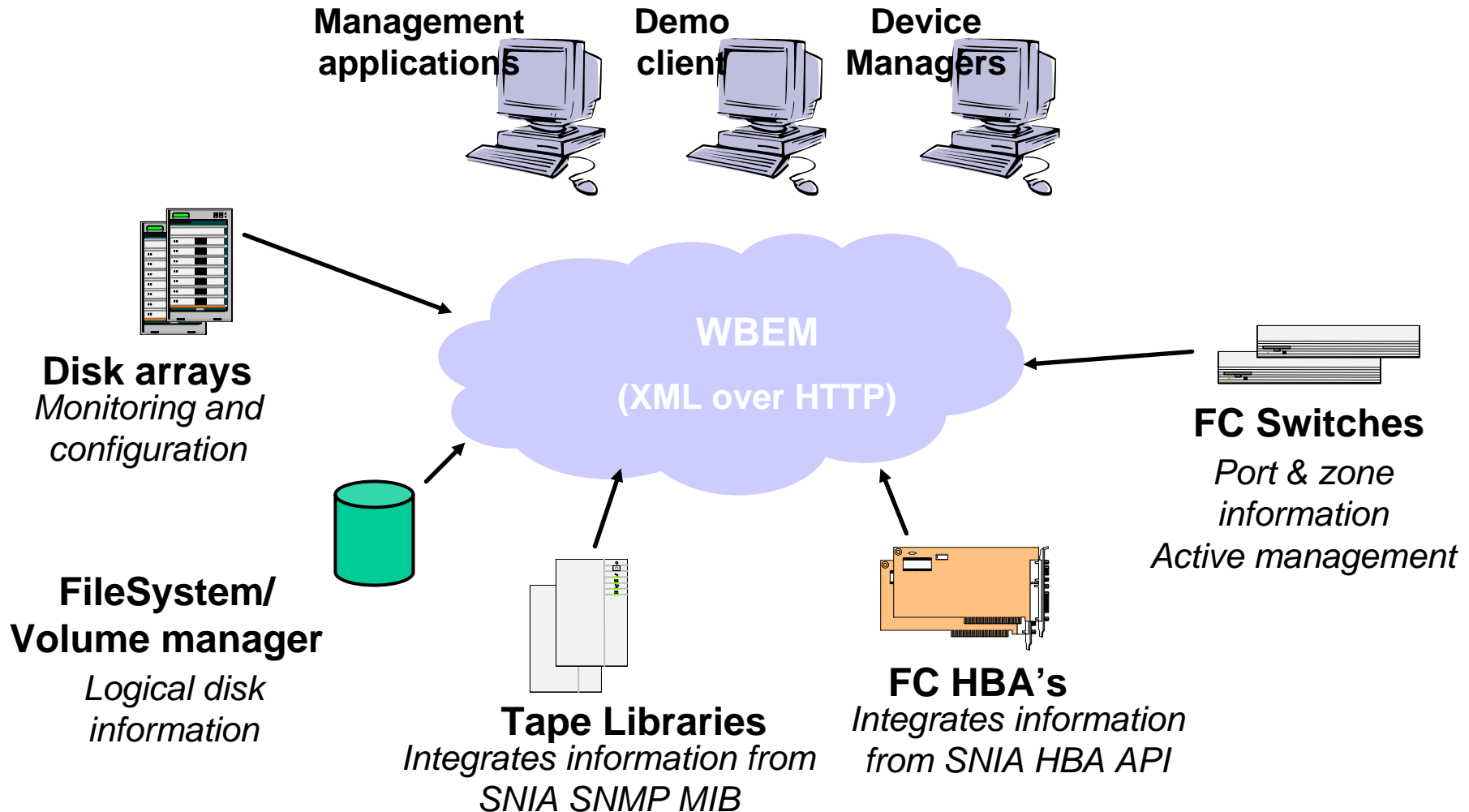   with configuration

- **Storage Vendors/Integrators**
  - Standard eliminates the need for custom integration (proprietary APIs)
  - Faster time to market of new solutions – focus on higher value functionality
  - Streamlines testing matrix

- **End-Users**
  - Reduces complexity of storage management
  - First steps towards real interoperability rather than power point interoperability
  - Conformance testing provides additional assurance that reduces finger pointing between vendors *(for services covered by specification)*
  - Enables leverage across business solutions
  - Allows implementation of larger storage infrastructures without increasing personnel costs

Management applications

Demo client

Device Managers

WBEM

(XML over HTTP)

Disk arrays
Monitoring and configuration

FileSystem/ Volume manager
Logical disk information

Tape Libraries
Integrates information from SNIA SNMP MIB

FC HBA's
Integrates information from SNIA HBA API

FC Switches
Port & zone information
Active management

CIMSAN2 (now called SMI-Lab) Matrix

SNIA

	AppIQ Solution Suite	Brocade WebTools	CA BrightStor SAN Manager	CA BrightStor Portal	Commvault QiNetix	CreekPath Suite	EMC Control Center	EMC Visual SAN	Fujitsu Softek SANView	HP OpenView Storage Area Manager	Hitachi HiCommand	IBM Tivoli Storage Resource Manager	Inrange	McData SANavigator	Veritas SANPoint Control
EMC Clariion	x x	x! x	x	x x	x x x	x! x! x!	x!	x!	x!	x! x x	x! x x				x! x
EMC SYM	x x	x! x x	x	x x	x x x	x! x! x!	x!	x!	x!	x! x x	x! x x				x! x
HP VA 7400	x x	x! x	x	x x	x x x	x! x x	x!	x	x!	x x x	x x x				x!
HP EVA	x x	x! x x	x	x x	x x x	x! x x	x!	x	x!	x x x	x x x				x!
HDS 9970V	x! x	x! x x	x!	x x	x x x	x! x x	x!	x!	x!	x! x x!	x! x x				x! x!
HDS 9200	x! x	x! x	x!	x x	x x x	x! x x	x!	x!	x!	x! x x!	x! x x				x! x!
IBM SHARK	x! x	x! x x	x!	x x	x x x	x! x x!	x!		x	x! x x	x! x! x!				x! x
LSI E5600	x! x	x! x x	x!	x x	x! x x	x! x x	x!	x!	x	x! x x	x! x x				x!
Net APP	x! x	x!	x	x x		x x x	x!	x!	x	x! x x	x x x				x
STK Array	x! x	x	x	x x x		x! x x	x!		x	x x x	x! x x				x
SUN T3	x! x	x	x!	x x		x! x x	x!	x!	x	x! x x	x! x x				x! x
VRTS VxVM				x		x									x!
Brocade SilkWorm 3800	x! x! x! x!	x! x!	x! x x	x!	x x x	x! x! x!	x! x! x			x! x!				x x x	x! x
Brocade SilkWorm 2800	x! x! x! x!	x! x!	x! x x	x!	x x x	x! x! x!	x! x! x			x! x!				x x x	x! x
Cisco	x x x		x		x	x x x	x x x	x! x x	x!					x x x	x!
Inrange FC 9000	x! x! x	x! x x	x!		x x x	x x x	x! x! x		x! x!			x!		x x x	x! x!
McData	x! x! x	x! x x	x		x x x	x x x	x! x! x		x! x!			x!		x x x	x! x
QLogic SANbox2	x x x	x! x x	x!		x x x	x x x	x! x x		x! x!			x!		x x x	x!
HP Ultrium		x	x				x								
STK L180		x	x				x								

Function Points Planned:	399	# Clients:	17	
Function Points Tested:	152	# Providers:	20	.

Legend:
x Switch
x Fabric
x Zoning
x Zoning Config
x Array
x LUN Config
x LUN Mask
x SNAP/Mirror
x LVM

x Library

x Indications
! Tested

SNW Fall '03 SAN Management Tutorial.
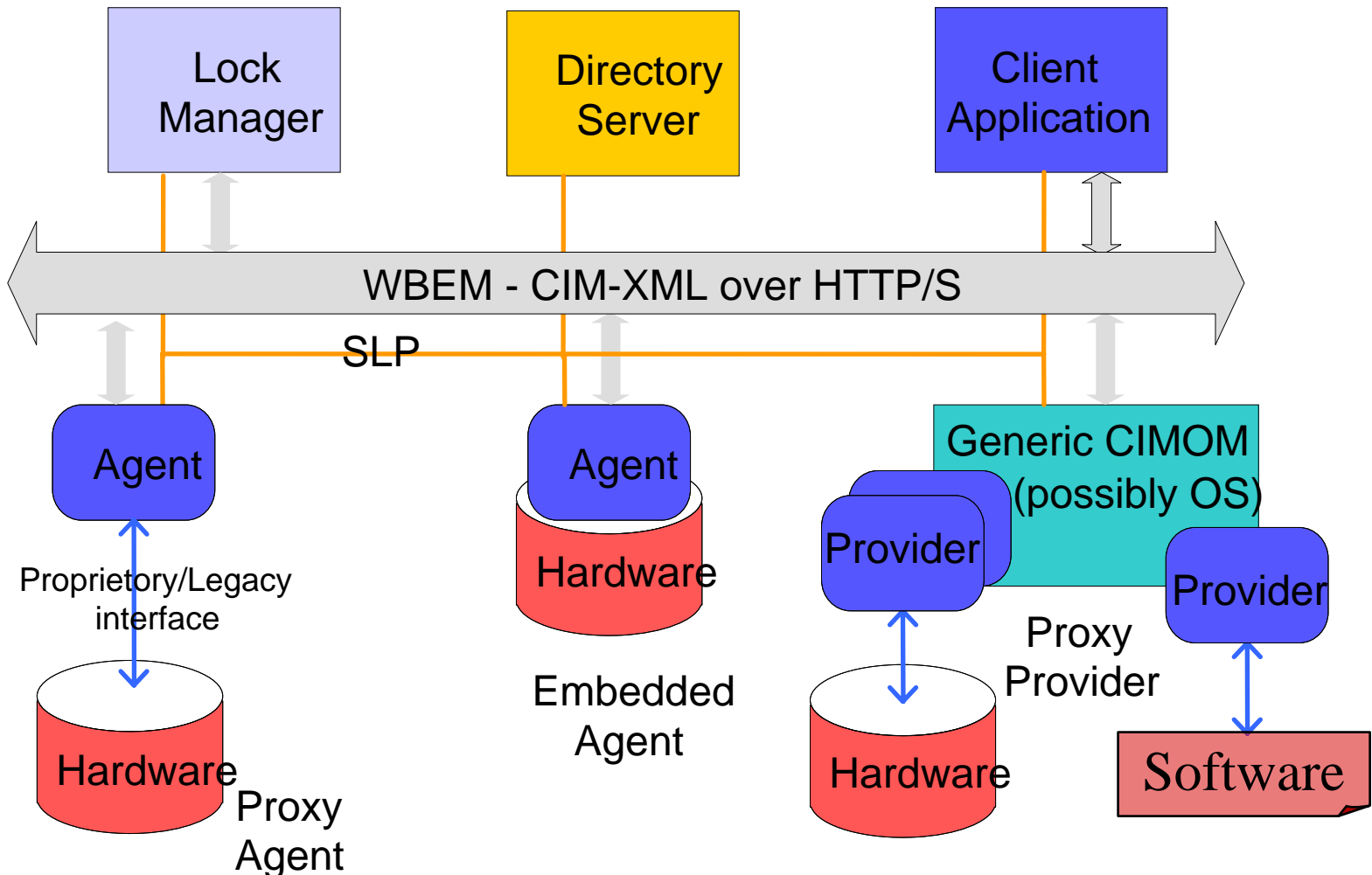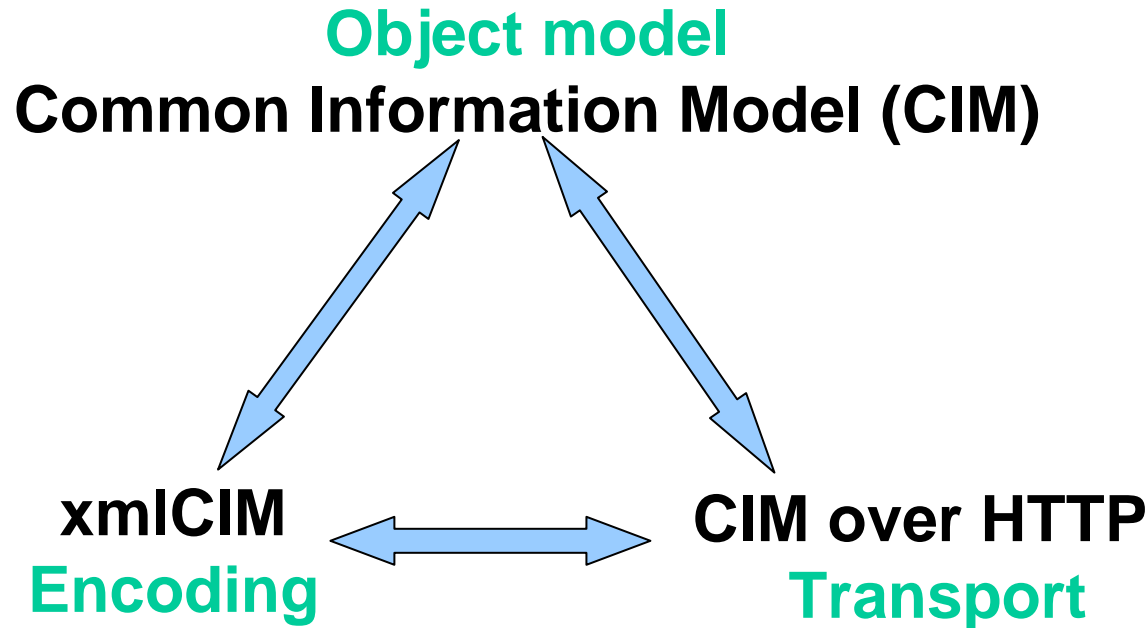
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Reference Model Overview

Lock Manager

Directory Server

Client Application

WBEM - CIM-XML over HTTP/S

SLP

Agent

Agent

Generic CIMOM (possibly OS)

Provider

Provider

Proprietory/Legacy interface

Hardware

Proxy Provider

Embedded Agent

Hardware

Software

Hardware
Proxy Agent

WBEM Technology

Object model
Common Information Model (CIM)

xmlCIM
Encoding

CIM over HTTP
Transport

Extensible (OO), platform independent, interoperable, distributed management environment for enterprise class systems.

What Is CIM?

- Object-oriented data model not an implementation
- CIM facilitates the integration of management information from different sources (e.g. easy to map DMI, SNMP etc).
- Core Specification
  - "Meta"-model, high level concepts and language definitions
- "Core" and "Common" Models
  - Core Model contains info applicable to all management domains
  - Common Models address specific domains - Systems, Devices, Applications, Networks, Users, ...
    - Subclass from the Core Model
    - Models overlap and cross-reference
  - SNIA have been working to extend storage model.
- Expressed graphically (UML) or text ("Managed Object Format")

UML/Visio Example
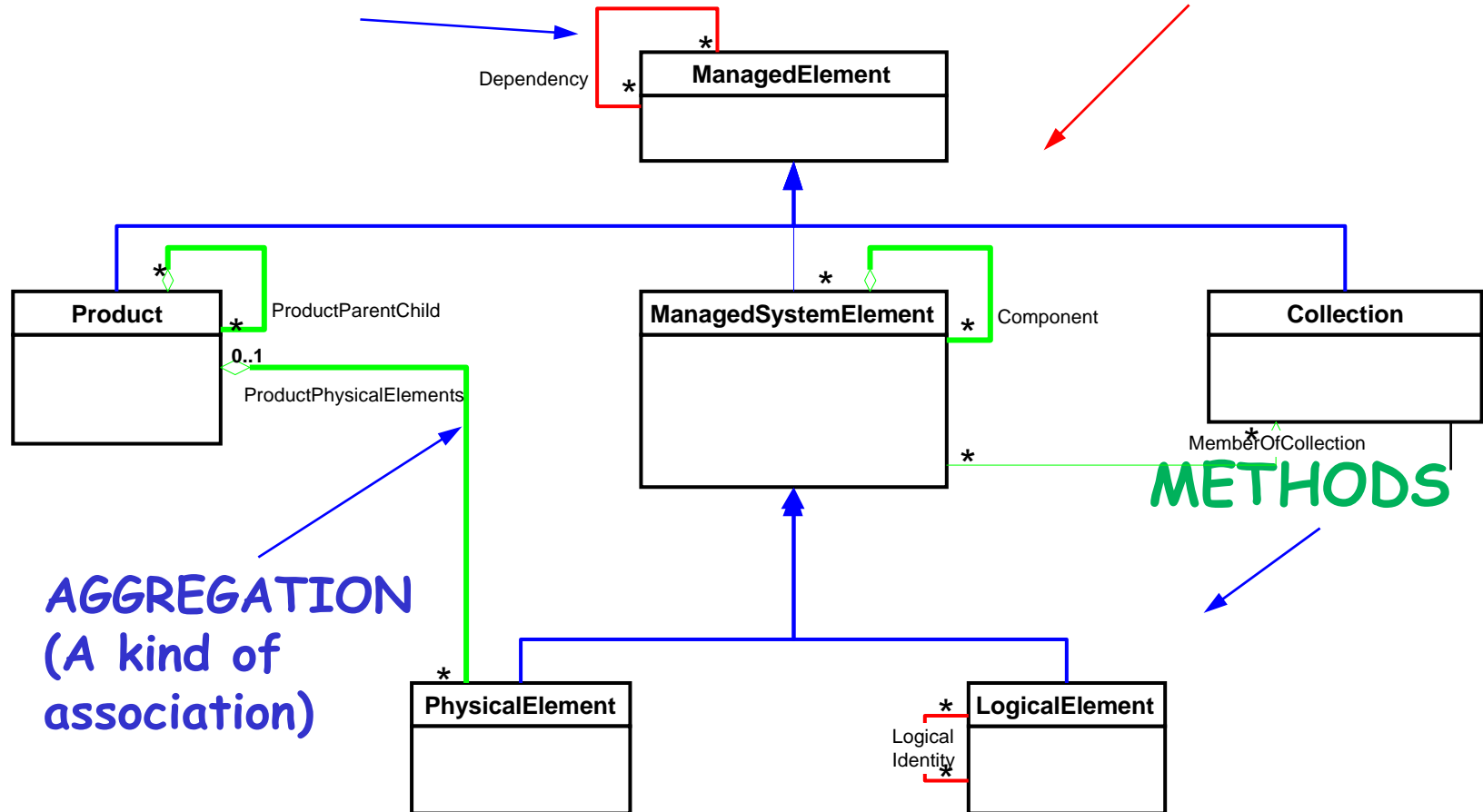
MOF Example

```
    [Abstract, Description (              Qualifiers
      "An abstraction or emulation of a hardware entity, that may "
      "or may not be Realized in physical hardware. ... ") ]
class CIM_LogicalDevice : CIM_LogicalElement
{                    Class Name and Inheritance
. . .
        [Key, MaxLen (64), Description (
          "An address or other identifying information to uniquely "
          "name the LogicalDevice.") ]
    string DeviceID;                      Properties
        [Description (
          "Boolean indicating that the Device can be power "
          "managed. ...") ]
    boolean PowerManagementSupported;
        [Description (
          "Requests that the LogicalDevice be enabled (\"Enabled\" "
          "input parameter = TRUE) or disabled (= FALSE). ...)" ]
    uint32 EnableDevice([IN] boolean Enabled);
. . .                                    Methods
};
```

WBEM - HTTP Operations

- Works with existing Web servers
- No new HTTP extensions
- Compatible with existing Web programming
- Simple Concept and Implementation
- Works through firewalls
- Can be secured
- Extensions for Discovery, Locking

HTTP Operations

- Intrinsic Methods
  - Manipulate schema & instances
  - Retrieve classes, properties & instances
  - Navigate & query schema structure
- Extrinsic Methods
  - Execute method within classes
- Indication delivery
- Bulk & single operations

Intrinsic Methods

GetClass

DeleteClass

CreateClass

ModifyClass

EnumerateClasses

EnumerateClassNames

GetQualifier

SetQualifier

DeleteQualifier

EnumerateQualifiers

GetInstance

DeleteInstance

CreateInstance

ModifyInstance

EnumerateInstances

EnumerateInstanceNames

ExecQuery

Associators

AssociatorNames

References

ReferenceNames

GetProperty

SetProperty

```
[description ("Big hack .... but if it works"),
provider("MethodHack")]
class SNIA_StorageService
{
    [description ("instance key ... well we might want more than "
                    "one instance ..."), key]
    uint32 id;

    [description ("Scratch creation method"),provider("MethodHack")]
    uint32 createLun (
      [IN, description ("Size")]
      uint32 Size,
      [IN, description ("LUN Number")]
      uint32 Lun,
      [OUT] uint32 test
    );
};
```

```
//set up method input parameters
   Vector ins = new Vector();
   CIMProperty Lsize = new CIMProperty("Size");
   Lsize.setValue(new CIMValue ( new Integer(40)));
   CIMProperty Lun = new CIMProperty("Lun");
   Lun.setValue(new CIMValue (new Integer(20)));
   ins.addElement (Lsize);
   ins.addElement (Lun);

//set up method output parameters
   Vector outs = new Vector();

//call method
   CIMValue ret = cimClient.invokeMethod(storageService,
              "createLun", ins, outs);

//and print results
   System.out.println("Return="+ret.toString());
   System.out.println("Outs="+outs);
```

```xml
<?xml version="1.0" ?>
<CIM CIMVERSION="2.0" DTDVERSION="2.0">
    <MESSAGE ID="3" PROTOCOLVERSION="1.0">
        <SIMPLEREQ>
            <METHODCALL NAME="createLun">
                <LOCALINSTANCEPATH>
                    <LOCALNAMESPACEPATH>
                        <NAMESPACE NAME="root"> </NAMESPACE>
                    </LOCALNAMESPACEPATH>
                    <INSTANCENAME CLASSNAME="SNIA_StorageService">
                        <KEYBINDING NAME="id">
                            <KEYVALUE VALUETYPE="string"> 42 </KEYVALUE>
                        </KEYBINDING>
                    </INSTANCENAME>
                </LOCALINSTANCEPATH>
                <PARAMVALUE NAME="Size"><VALUE>40</VALUE></PARAMVALUE>
                <PARAMVALUE NAME="Lun"><VALUE>20</VALUE></PARAMVALUE>
                <PARAMVALUE NAME="test"><VALUE>1</VALUE></PARAMVALUE>
            </METHODCALL>
        </SIMPLEREQ>
    </MESSAGE>
</CIM>
```

Instance path

Parameters

XML 'Response' for Method Transaction

```xml
<?xml version="1.0" ?>
<CIM CIMVERSION="2.0" DTDVERSION="2.0">
    <MESSAGE ID="3" PROTOCOLVERSION="1.0">
        <SIMPLERSP>
            <METHODRESPONSE NAME="createLun">
                <RETURNVALUE>
                    <VALUE>24</VALUE>
                    <PARAMVALUE NAME="test">
                        <VALUE>21</VALUE>
                    </PARAMVALUE>
                </RETURNVALUE>
            </METHODRESPONSE>
        </SIMPLERSP>
    </MESSAGE>
</CIM>
```

SLP

- Mature IETF standard (V2 - RFC 2068)
  - Adopted for iSCSI
  - Only suitably mature standard available
  - Several open source implementations
- Consists of:
  - Directory Agent(s). Front end to directory (eg LDAP) ..
  - Service Agents: 'advertises service' (eg Bluefin agent)
  - User Agents: Uses directory to find suitable services (eg Management Client)
- Service Agent sends a 'service template' describing
- DMTF (with help ☺) have defined a standard service template for CIM
  - Will include the concept of 'profiles'

Kudos go to…

- Please send any questions or comments on this presentation to: tut-sanmanagement@snia.org
- Many thanks to the following SNIA members for their contributions to this tutorial:

  - Steve Jerman
  - John Crandall
  - Mark Carlson
  - Larry Krantz