Overview of the Pegasus CIM/WBEM Implementation

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Agenda

- CIM/WBEM Overview
- Overview - What (and why) is Pegasus?
- The Pegasus Environment
- The Pegasus Software Architecture
- Pegasus Status Today
- The Pegasus Project
1 CIM and WBEM
The Management Standards Groups

- DMTF
  - DMI
  - CIM / WBEM
- The Open Group
  - Unix Management Standards
  - Application Management Standards
  - CIM / WBEM
- IETF
  - SNMP
- TMF
  - CMIP
  - OSS/NG
Management Environment Today

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**Management application**
- Fault Config Perf ...
- MIB
- SNMP
- Network devices

**Managed Resource Definition**
- Fault Config Perf ...
- MIF
- DMI
- Desktop systems

**Service Layer & Infrastructure**
- Fault Config Perf ...
- CDMI
- CMIP
- Telecom devices

**Physical managed objects**
- Fault Config Perf ...
- Private
- Application systems
A “Management” Problem

Example: Managing a Fibre Channel SAN
- Computer system and its devices
- Storage enclosures
- Hubs and switches

Manageability difficult, not unique to Fibre Channel
- Different data standards (SNMP, DMI, SES, …)
- Different terminology
- Proprietary MIBs
- Missing data (topologies and dependencies)
WBEM Architectures

Data Description

CIM

Discovery

<xml/CIM>

Transport Encoding

HTTP

Access

WBEM

[Image: Diagram showing WBEM, CIM, DMI, Discovery, HTTP, Transport Encoding]
Why CIM?

- Enterprise-wide management
  - Wide breadth of objects + name scoping
  - Repository independent
  - Unifies and extends existing standards (SNMP, X.500, ...)

- OO design
  - Abstraction, inheritance, ability to “classify”
  - Reduces complexity, provides predictability
  - Well-defined “locations” and usage semantics for classes and associations
  - Extensibility via subclassing

- Associations depict relationships
  - Dependencies, topologies, aggregations, scoping, ...

- “Standard”, inheritable methods
What Is CIM?

- Object-oriented data model
- 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
  - Vendor extensions allowed
What Is WBEM?

- “Web-Based Enterprise Management”
- Model to present and organize data
- Use of XML and HTTP
DMTF WBEM Components

CIM Specification V2

Interoperability Specifications

- CIM Operations over HTTP
- CIM XML

CIM Schema v2.7
(900+ classes)

Extension
Schema

Core
Users

Network

Device

Apps

System

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The Major Schemas Today

- Core
- System
- Devices
- Networks
- Applications (today lifecycle)
- Metrics (originally for ARM support)
- User
- Policy (was originated as service)

- Databases – Dormant
- Unix System Extensions
- Support
WBEM Architecture (Client-Server)
What does CIM/WBEM Provide?

- Abstractions of Managed objects
- A common semantic for objects
- Rich set of defined objects
- Relationships between objects
- Interoperability between management components.
WBEM Architecture Components

- **Information Model**
  - CIM Schema (Core, System, …)

- **Communication Model**
  - CIM Operations over HTTP

- **Transport Encoding**
  - Cim-xml – CIM/XML mapping

- **Event Model**
  - CIM indications (new in CIM 2.5)

- **CIM Object Manager (CIMOM)**
  - Operation Routing
  - Result Aggregation

- **Repository**
  - Class and Instance Persistence

- **Resource Providers**
  - Instrumentation subagents
Interoperability Characteristics

- XML encoding
  - Definition for each operation
- HTTP Transport
  - HTTP 1.0 and 1.1
- Common Operations Semantics
  - Data
  - Meta data
  - Queries?
  - Methods
How Is CIM Schema Defined?

- MOF - Managed Object Format (ASCII or Unicode)
- VISIO for UML (Unified Modeling Language)
- Whitepapers
- XML - eXtensible Markup Language
  - XML grammar can be used to describe CIM metaschema, Detailed in DTD (Document Type Defn)
    - DTD defines tags such as CLASS, INSTANCE and QUALIFIER
  - Associations are described via an ASSOCIATION.CLASS tag (Distinguished because they include references as properties)
Managed Object Format (MOF)

Class Name and Inheritance

```
[Abstract, Description ("An abstraction or emulation of a hardware entity, that may "
"or may not be Realized in physical hardware. ... ") ]
class CIM_LogicalDevice : CIM_LogicalElement
{
  ...
  [Key, MaxLen (64), Description ("An address or other identifying information to uniquely "
  "name the LogicalDevice.") ]
  string DeviceID;
  [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);
  ...
};
```

Qualifiers (Meta data)

Properties

Methods
UML/Visio Example

ASSOCIATIONS

AGGREGATION
(A kind of association)

INHERITANCE

METHODS

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XML Example

<?XML Version="1.0"?>
<!DOCTYPE CIM SYSTEM
 "http://www.dmtf.org/cim-v2.dtd/”>
<CIM VERSION="2.0”>
<Class
 NAME="ManagedSystemElement">
 <Qualifier NAME="abstract">
 </Qualifier>
 <Property NAME="Caption"
 TYPE="string">
 <Qualifier NAME="MaxLen"
 TYPE="sint32">
 <VALUE>64</VALUE>
 </Qualifier>
 </Property>
 <Property NAME="InstallDate"
 TYPE="datetime">
 <Qualifier NAME="MappingStrings"
 TYPE="string">
 <VALUE>MIF.DMTF|ComponentID|001.5</VALUE>
 </Qualifier>
 </Property>
 <Property NAME="Status"
 TYPE="string">
 <Qualifier NAME="Values"
 TYPE="string" ARRAY="TRUE">
 <VALUE>OK</VALUE>
 <VALUE>Error</VALUE>
 <VALUE>Degraded</VALUE>
 <VALUE>Unknown</VALUE>
 </Qualifier>
 </Property>
 </Class>
</CIM>
CIM Operations

- Intrinsic Operations
  - Create, Modify, Delete
    - Qualifiers
    - Classes
    - Instances
    - Properties
  - Invoke Query
- Extrinsic Operations
  - Execute Methods

```cim
<instance> GetInstance (  
  [IN] <instanceName> InstanceName,  
  [IN,OPTIONAL] boolean LocalOnly = true,  
  [IN,OPTIONAL] boolean IncludeQualifiers = false,  
  [IN,OPTIONAL] boolean IncludeClassOrigin = false,  
  [IN,OPTIONAL,NULL] string PropertyList [] = NULL  
)
```
CIM Indications (Events)

Indication Types
- Process Indications
  - External Events
- Lifecycle indications
  - Changes to CIM Objects

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CIM Client

CIM Listener

SNMP

CIM Server

1. Subscription
2. Filter
3. Indication Provider
4. Export Indications

Produce Indications Based on Filter

Export Indications
Query Language - WQL

- SQL based Query Language
- Used in:
  - CIM Indication Filters
  - CIM Queries (CIM Operation)
- 4 levels of Language
  - 1 – Simple queries from single tables
  - 2 – Adds DELETE INSERT UPDATE
  - 3 – Add complex expressions and specific data constructs
  - 4 Add Joins, etc.

Subset of SQL supports queries in the form
SELECT <row set>
FROM <table list>
WHERE <selection expression>
Industry Work

- Microsoft’s WMI (Windows Mgmt Instrumentation)
- Sun’s WBEM Services
- Cisco’s CiscoWorks2000 and LDAP mapping
- Coordinated development with IETF
  - Policy Framework
  - IPsec Policy
- The Open Group
  - Unix and software modeling
  - Pegasus (Manageability Services Broker) open source
Industry Work

- SNIA (Storage Networking Industry Association)
  - Fibre Channel and Tape / Storage Library modeling and media management
  - Disk Resource Management - CIM prototype
  - CIM Object Manager open source (Now Open Group)
- WBEMSource (open source) initiative
- Applications and instrumentation for the various “object managers”
2. Pegasus Overview
What is Pegasus?

- Open-source implementation of the DMTF WBEM specifications
- Work project of the Open Group Enterprise Management Forum
  - Pegasus is primarily volunteer labor but through company commitments, not just individuals
- Platform for building application management
- Pegasus is a function-rich, production-quality open-source implementation designed to be used in high volume server implementations.
Why Produce Pegasus?

- Demonstrate manageability concepts.
- Provide additional standards for WBEM
- Provide a working implementation of WBEM technologies
- Provide an effective modular implementation
- Support other Open Group manageability standards
- Base Platform for Open Group Application management Projects
- Help make WBEM real

Pegasus was Initiated in 2000 by the Open Group in collaboration with:

- BMC Software
- IBM
- Tivoli Systems

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Key Pegasus Objectives

- Open Source
- Portable
- Efficient and Lightweight
- Standards Based
- Continuity
- Modular and Extensible
- Production Quality

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Pegasus Working Group Philosophy

- **Manageability not management**
  - The Pegasus working group’s objective is not to manage systems but to make them *manageable* by promoting a standard instrumentation environment.
  - The actual *management* of systems is left to systems management vendors.

- **No standards without implementation**
  - The process of implementation provides a rigorous process for testing the validity of standards.
  - Therefore all standards must be validated by implementation.
Open Source

- Code and documentation freely available
  - Open Group and Source Forge
- MIT source license
  - Minimal Demands on licensee
    - No GPL demands
  - License used for X-Windows
- Open to contributions
  - But process controlled to keep strategy
- No commitment to Open Group to
  - Use code
  - Contribute code
- Royalty Free

But in a controlled environment
Portable

- Designed for multi-platform, multi-OS, multi-compiler implementation
- Platforms ported today
  - UNIX (AIX, HPUX, Solaris, Tru-Unix)
  - Linux
  - Windows Platforms (NT, 2000, 9x)
  - Compaq Himalaya (Tandem)
  - OS 400*
  - Z/OS*
- MultiPlatform Build
  - Only Make and compiler required to build
- Multiple Compilers on most platforms
  - GNU compilers preferred
Efficient and Lightweight

- Core written in C++
- Designed for execution efficiency
  - Custom xml parser
  - No STL
  - Minimal Templates, etc.
- Designed to be production-quality solution
- Message/Queue based multithreaded Architecture
Standards Based

- Based on DMTF CIM and CIM-XML specifications
- Open Group is active partner in DMTF
- Growth through participation in specification growth
- Commitment to continue DMTF compliance
Modular, Extensible, Flexible

- Minimize core object broker.
- Maximize extensibility through plug-in components
- Component types
  - Providers
  - Standard Provider interfaces
  - Clients – Connection local and cim-xml
  - Repositories (additional repository handlers)
  - Manageability service extensions
  - Protocol Adapters
  - Modules (extend and modify core functions)

Modularity is key to doing parallel development and to extensibility
Project for Continued Development

- WBEM will continue to develop functionality and standards
- Open Group will develop application management partly around Pegasus
- Pegasus is a project, not just a technology
- Pegasus Development will continue beyond current versions
  - Integrate contributions
  - Add basic new functionality
  - Grow with DMTF/Open Group standards
- Light Weight Versions are part of our vision
The Open Group

- Enterprise Management Forum
  - Projects include:
    - Pegasus
    - Ex-SNIA Java Based open-source Implementation
    - Application Management APIs
      - ARM
      - AIC
    - Software Licensing Standards

- QoS Task Force
  - User/Supplier interaction forum to advance QoS and Service Level Standards
  - Working with DMTF, IETF, TMN
3. The Pegasus Environment
Key Interoperability Interfaces

Manageability to Manager
- Multiple management systems
- Common open manageability

Object Manager / Providers
- Multiple Providers
- Encourage common providers

Provider / Resource Interface
- Protect Applications
- Make application management easy

Management System
Enterprise Management Console
CIM Object Manager
CIM Providers
Application
Pegasus Architecture

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Interoperable

MOF Compiler

CIM/HTTP

CIM Server

Clients

Providers

Interoperable*

CIM/HTTP

Services

Standard Interfaces
CIMOM Capabilities

- Respond to Operations defined in “CIM Operations” spec.
  - Create, Modify, Delete operations on
    - Class, Instance, Property, Qualifier

- Manage Providers
  - Install, register, load
  - Interface for Operations and Indications

- Forward Requests to Providers, repositories, etc.

- Read/Write access to Management Information
  - Maintain Class/Instance Information

- Traversal of Associations

- Use of WBEM Query Language

- Syntax/Semantic checking (with Qualifiers)
4. The Pegasus Software Architecture
Major CIM/WBEM Components

CIM Clients

CIM Server / CIM Object Manager

Repository

CIM Providers

Cim-xml Protocol (standard)

Provider Interface (Language APIs)
CIM Object Manager Capabilities

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Network

CIM Objects Implementation
- Objects
- Accessors

Protocols
- Encoding
- Messages

Security plugins
- Authentication
- Access Control
- Traffic

Providers
- Management
- Interfaces

Core Server Capabilities
- TCP Communications
- System Interfaces (Files, etc.)
- Containers
- Thread/Process Management
- Message/Queuing
- Option Configuration
- Logging
- Signal Handling
- Service Configuration
- Authentication
- Access Control
- Module Control

WBEM Processing
- Operations
- Indications

Repositories
- Classes
- Instances

Indication Handlers
- Management

Operating System

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Building A Modular Manageability Environment

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XML-CIM

Undefined

Resources

Resources

Resources
5. The Pegasus Project
Today
And
Tomorrow
Pegasus Project In Context

Core System Development

Incremental Function growth

V1 Core Development

V2 Multi Thread Server Development

V 2.1 SDK, Clean Up

V 2.2 Multiple Functions

Compaq, IBM, HP Join

V2 Release July 2002

2000  2001  2002
The Pegasus Functions Today

- CIMOM Functions
  - Class and Instance
  - Security
  - Threading
  - Queued execution model
  - Async CIM Operations APIs
  - Modular Services
  - C++ Provider Manager
  - Provider Control

- WBEM Functions
  - Provider Registration
  - CIM Operations
  - Indications (Process)

- Clients
  - Test Clients

- Providers
  - In-Process
  - Test
  - Sample Implementations
    - OS
    - ComputerSystem

- Platforms
  - Unix (AIX, HP-UX, Tru-UNIX)
  - Compaq Himyla
  - Linux
  - Windows

Current with CIM 2.6

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Planned Extensions

- CIMOM Functions
  - Lifecycle Indications
  - Increased Modularity
  - Enhance Service Configuration
  - Additional Provider Managers
    - C Provider Interface
    - Java Provider Interface
  - Out-of-Process Providers
  - External Providers
- WBEM Functions
  - Discovery
  - CIMOM Object Manager Mgmt. (Interop Schema)
  - Chunking
- Specifications
  - C Provider Interface Standard (Sept 02)
  - C++ Provider Interface standard (Oct 02)
- Security (pluggable and extra security)
- WMI Mapping

- Clients
  - Object Browser
  - Test Clients
  - Real SDK
- Protocol Adapters
  - Add protocol Adapters
- Providers
  - Test Providers
  - Extend Generic Providers
  - Create real SDK
- Platforms
  - Easier portability
  - More platforms
- Testing
  - Extend Unit and System tests
A Pegasus Lite Project

- Two Solutions
  - Lighten existing Pegasus (6 mm ext) – 1 – 2 MB
  - Lightweight core/model (15 mm est) – 300-500 KB
- Today requirements vary widely
  - Footprint
  - System resources
  - Functionality
- Either or both doable but requires commitment
  - Membership in Pegasus community
  - Better definition of requirements
  - Possibly specific extension projects
- This will be incremental
  - Both solutions will probably exist with later merge.
Portability of Pegasus

- Any GNU based environment is easy
- Minimal tools required
  - C++ compiler
  - GNU Make
  - Project Provides one make portability tool
- Compiler issues
  - Minor compiler differences
  - Exceptions, templates
- Environment issues
  - Threads support
- Most ports – one week or less
Planned Standards

- C++ Provider API
  - Pegasus Internal Review of all APIs in process
  - Release SDK with Pegasus 2.1 Sept 2002
  - Review as Standard Q4 2002
- C Provider API
  - Draft available today for review
  - Formal review cycle (~September 2002)
- C++ Client API
  - In parallel with C++ Provider API
  - Need not clear today (Java, etc. for Clients)
  - Except for provider/clients.
Pegasus State Today

- 120,000 Lines of executable code
- Ported to at least 5 platforms
- 15 – 20 man years effort to date
- Components already used in multiple applications
- Major usage commitment from HP and IBM
- First “integrated” use this year
The Components Today

- Browsing Client
- Test Clients
- Compiler
- Instance Repository
- Class Repository
- Pegasus CIM Object Manager
- C++ Provider Manager
- C++ Providers
- C Interface Adapter
- Cim-XmIl Indication Handler
- SNMP Indication Handler
- Test Code
The Major Pegasus Contributors

- IBM
- Compaq
- HP
- BMC

The Pegasus Users Today

- IBM
- Compaq
- HP
- BMC
- ...

IBM Commitment

*IBM has chosen CIM/Wbem as the strategic technology for hardware platform instrumentation and manageability of all server platforms.*

Pegasus is the CIMOM that IBM has selected to include with eServer platforms in 2002 and beyond.

*During 2002 IBM is planning on maintaining and contributing to Pegasus for the Linux, Windows, AIX, OS/400 and System 390 operating environments.*
Managing The Pegasus Project

- Open Group
  - Sponsors the Project, Web sites, CVS, etc.
  - Creates standards for APIs
  - Environment for user understanding
- Steering Committee
  - Sets strategy, priorities, release commitments
- Contributors
  - Contribute via change requests, code, doc.
- Users
  - Take documentation, source, binary
- Project Manager
- DMTF / DMTF Work Groups
  - Standards, Interoperability

Management Tools
- Web Site
- Teleconferences
- Group Mail
- Change Requests
- CVS
Managing The Pegasus Project

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DMTF

DMTF Work Groups

Major Contributors (HP, IBM, ...)

Pegasus Steering Committee

Open Group

Bugzilla

CVS Repository

Change Requests

Other Contributors And Users

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Working With the Pegasus Project

- Using the Code
  - Free for use

- Contributing to the Project
  - Outside contributors
    - In Company
    - Specific financed projects
    - Contribute via patches or authorized developers
  - Join the Steering Committee
    - Influences priorities, commitments, releases.

We want and NEED participation from users and Potential users
Open Group

- The Enterprise Management Forum
  - http://www.opengroup.org/management

- The Pegasus Web Site and code
  - http://www.opengroup.org/pegasus

- The ex-SNIA web site and code
  - http://www.opengroup.org/snia
Other Manageability Projects

- AIC – Application and Control
  - AIC as a Pegasus Provider
- ARM – Applications Response Measurement
  - ARM and DMTF DAP Information as Pegasus Provider
- Other possible Providers
  - JMX (Java)
  - SNMP
  - DMI
  - WMI
WBEMSource Consortium

Create common interfaces and APIs

Create an environment of open-source WBEM implementations

Create commonality between implementations and integrate different implementations.

Create a library of providers and tools

Hosted by The Open Group

Members Include:
Sun, Compaq, HP, IBM, Tivoli, Open Group, SNIA, Caldera, Novell, Nokia, Intel
6. QUESTIONS?