INTELLIGENT AGENTS IN AN ENTERPRISE MANAGEMENT ARCHITECTURE

Tony Parsons
Digital Equipment Corporation (Australia) Pty Ltd

This paper describes a viable Enterprise Management Architecture for network, system and application management using Management by Delegation (MbD) and managed objects. The Overall Manager distributes policies and even programs using the Electronic Software Distribution (ESD) component of the network and system management facility.

The design is scalable, reliable and extensible. The architecture has proven workable in an environment containing 1000 machines.

1. INTRODUCTION
This paper describes a viable Enterprise Management architecture for network, system and application management using Management by Delegation (MbD) and managed objects [GOLD95]. The design is scalable, reliable and extensible design of enterprise management architecture.

The architecture is a three tier client-server solution utilising a hierarchical management model, shown in Figure 1. The Overall Manager is crucial to the functioning of the Enterprise Management System.

It provides for the definition of multiple management domains whether based on geography, administration or function. The clients are the systems used by the enterprise management staff, irrelevant of their proximity to the Overall Manager. The Overall Manager is a monitoring management station where policies are designed and specified but are not implemented. Instead, the policies are enacted by the intelligent agents using Management by Delegation (MbD) [GOLD93].

All of the Intelligent Agents have their own relational databases. The Overall Manager’s database is the sum of these Intelligent Agent’s databases. This overcomes a lot of the monitoring and polling problems encountered in system and network management today.

The Overall Manager can use fault tolerant techniques to reduce the risk of single points of failure.

2. MANAGEMENT BY DELEGATION
Management by Delegation (MbD) assumes that agents have intelligence. Hence, applications to analyse MIB data may be delegated to the devices, relieving polling and processing from the platform. MbD assumes the resources that can (and should) be allocated to management exceed those assumed by the minimalist approach of SNMP [GOLD95].

MbD addresses the limitations of platform-centred management, and is independent of the choice of methods to collect, organise and access managed data. Management processes can delegate to MbD agents the execution of management programs that can monitor and control local managed objects effectively without unnecessarily involving the remote managers. An MbD agent is implemented as an intelligent agent whose role is a hybrid combination of proxy agent and a hierarchical manager. It supports interfaces to the device operations, permitting access by delegated agents to local data and functions [GOLD95] [YEMI93].

MbD simplifies the handling of semantic heterogeneity across devices. Delegated management programs may be designed to handle the specific operational environment and distinct features of specified resources [BENA90].

3. COMMUNICATIONS IN MBD
For MbD to operate successfully the MbD “Manager” must communicate with the MbD “Agent” to let the agent know what has been “delegated”. This is accomplished using the Electronic Software Distribution (ESD)
component of the network and system management facility [LEIN96]. Policies and even programs and other code are automatically distributed to the intelligent agents. Because communication from the agent to the manager is typically more “urgent”, SNMP traps are used. In the event of a serious network breakdown where new policies need to be communicated and Electronic Software Distribution (ESD) is not functioning, “emergency” out-of-band management network communication can be used [CCIT92].

All intelligent agents perform health monitoring functions, that is they monitor themselves, taking corrective action where possible. When irrecoverable conditions are encountered they ask for “help” via a notification message (normally an SNMP trap) to the Overall Manager [KOOI95] [MEYE95]. The technique of MbD is used, along with ESD, to reconfigure the intelligent agents dynamically. This means that a large amount of manual configuration work in intelligent systems is avoided.

4. IMPLEMENTATION

A practical implementation of the enterprise management architecture has been realised using the selection of commercially available products listed in Table 1.

The Overall Manager uses CA Unicenter TNG which provides the Graphical User Interface (GUI). CA Unicenter TNG has an object-oriented, multi-tiered architecture. It is based on a distributed object repository and a manager/agent infrastructure.

The Real World Interface provides a 3-D visualisation of the entire IT environment. This interface is highly customisable, allowing clients to specify maps, define buildings, and control layouts of network and computer systems. The object repository drives the Real World Interface, enabling it to display, navigate, and control objects from different management functions.

Any subsystem, including third-party extensions, can be defined as classes and objects in the repository. All objects created by any management function are supported by the Business Process Views, which are also managed through the object repository [WILS96].

CA Unicenter TNG is used as the overall SNMP TCP/IP based manager for network management. Other element managers, such as Cabletron SPECTRUM and Bay Networks Optivity are integrated at the object level. This ensures that the additional management functions provided by these element managers are available from a single GUI to the enterprise management staff.

For system management of UNIX systems, CA Unicenter is used. For OpenVMS systems a combination of POLYCENTER products are used, including POLYCENTER Console Manager and POLYCENTER System Watchdog. For system management of Windows NT systems, Microsoft Systems Management Server (SMS) and POLYCENTER AssetWORKS are used. Client based operating systems, such as Windows 95 and Apple Macintosh are also managed using Microsoft SMS and POLYCENTER AssetWORKS. All of the system management products are integrated with CA Unicenter TNG.

For application management BMC Patrol is used, and is integrated at the event exchange level with CA Unicenter TNG. BMC Patrol is used to monitor applications from the “inside”. That is the BMC Patrol Knowledge Module is used to identify potential application problems before they manifest themselves to the system management products like POLYCENTER System Watchdog, which are monitoring them from the “outside”.

5. RESULTS

The practical implementation was tested in a customer environment as part of a pilot evaluation. The Overall Manager, CA Unicenter TNG, was installed and configured on a dual 200 MHz Pentium-Pro system with 128 Mb of memory running Microsoft Windows NT Server V4.0 [PARS96].

A second, identical system, was configured and the database replication functions of Microsoft SQL Server V6.5 used to enable both Overall Managers to continue functioning even with the loss of the other Overall Manager. All of the other commercial products were installed, configured, and integrated and the pilot completed.

The pilot system showed that most systems were able to “self-manage” using intelligent agents. The traffic to the Overall Manager was reduced by 60%.

This meant that the Overall Manager should be able to administer an environment containing over 10000 machines [MCCO95] [PARS96].
6. REFERENCES


7. TABLES

<table>
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<tr>
<td>POLYCENTER AssetWORKS</td>
<td>Computer Associates (originally Digital Equipment Corporation)</td>
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<tr>
<td>POLYCENTER System Watchdog</td>
<td>Computer Associates (originally Digital Equipment Corporation)</td>
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<td>POLYCENTER Console Manager</td>
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Table 1. Commercial products used in implementation.
8. FIGURES
Key

→ Normal communication  ←  Direct Enterprise Manager/Intelligent Agent Communication

 ←→ Out-of-band management  MO  Managed Object

Figure 1. The Enterprise Management Architecture.