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Decentralised Network Management using Web-based technologies

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Abstract

The emerging Web-based proposals for network management are a promising approach for managing distributed and heterogeneous computer networks. This paper discusses how these technologies can be used to implement the Management by Delegation decentralised paradigm (MbD, introduced by Yemini and Goldszmidt). Managers and agents can benefit from the ease of use and platform-independence of Web-based protocols and tools while supporting the essential feature of MbD: elasticity.

Keywords: Network Management, Web technologies, Internet protocols, Management Information Models.

1. Introduction

The Management by Delegation (MbD) decentralised paradigm (Goldszmidt & Yemini, 1995) was introduced as a solution to the network management problems caused by the rigid nature of Client/Server schemes. The complexity of today's heterogeneous networks requires dynamic systems that can readily adapt to ever changing circumstances. MbD aimed to fulfil that role by using delegation agent programs that supported a dynamic extensibility of distributed processes. This property was called "elasticity" (Goldszmidt, 1993). This paper discusses how the new web-based technologies provide suitable building blocks to implement a decentralised approach to network management that relies on the additional capability of both agents and managers.

The Client/Server interaction used by traditional platform-centred approaches lack flexibility. The managers and agents are assigned predefined (rigid) roles and several problems have been associated with this lack of 'elasticity' (Goldszmidt & Yemini, 1995), among them: network bottlenecks, inefficient utilisation of resources (computational cycles and communication bandwidth) and network delays.

The Management by Delegation paradigm addresses these limitations by using 'Elastic Servers' that have the ability to dynamically add and remove functionality during execution time. A delegation protocol provides service primitives to delegate, instantiate, suspend,

resume, abort and remove delegated programs. Elasticity enables applications to dynamically reduce their communication bandwidth demands, and advanced event correlation and aggregated reports are now possible. The MbD agents are programs coded in C or C++ with embedded SQL, and they can be delegated to an elastic process running on an elastic server. That elastic process supports interfaces to the device allowing delegated agents to access local data and functions.

The structure of the paper is as follows: section 2 discusses the main web-based network management models and techniques. Section 3 summarises the challenges in providing integrated network management. Section 4 sketches the model proposed as the basis of an integrated web-based network management environment. Finally, section 5 contains the conclusions and discusses related work.

2. Web-based Network Management Systems

The Internet is causing two dramatic shifts in network management. On one hand, it is spurring the need for new functionality to manage extra network resources. On the other hand, the Web is becoming a mechanism for network management delivery. Web technology is easy to use and is independent of the operating system.

Web-based network management systems need to go beyond browser interfaces. Simple HTML-based (HyperText Markup Language) clients can do little more than download and view pre-generated management reports as web pages. It is obvious that network managers want more realtime, two-way interaction with managed systems through the Intranet. Furthermore, the browser-enabled data needs to be integrated with information across network management environments. Thus, in order to collect, analyse and correlate information from different network domains, vendors need to agree on standardised ways to represent and exchange managed objects.

Various vendors and consortiums have proposed different architectures for Web-based network management (Terplan, 1999). The following is a summary of the main approaches:

1) Web front-end and SNMP-based back-end: These are mostly vendor-specific solutions that provide HTTP

(Hyper Text Transfer Protocol) access to the management system while preserving the use of SNMP (Simple Network Management Protocol) between the manager and agents. It uses SNMP to carry network management data and it uses the HTML and HTTP protocols to communicate with browsers. This helps to solve the problems of data collection and information display. However, this approach does not address critical areas, such as data repository and scalability. It is in a sense a "Web wrapper" technology.

2) Web-based device management: This architecture involves putting a Web server in each managed device or system for enabling HTTP access to management data. Web-based device management has a number of limitations. Web browsers are connection-oriented, they were not designed for machine-to-machine interaction. Since Web browsers are meant to handle only one connection at a time, they do not scale well to an enterprise-wide global view and are not efficient for fault management tasks. Nevertheless, web-based device management is well suited for some aspects of configuration management.

3) Web-based Enterprise Management (WBEM): The WBEM initiative was introduced in July 1996 by a vendor consortium that included Microsoft, Compaq, Cisco, and Intel. The group has developed three Web-based standards (Horwitt, 1999; Terplan, 1999): The HyperMedia Management Schema (HMMS) is an extensible data description for representing the managed environment. It is intended to address the need for a common way to describe and share management information across the enterprise. The Desktop Management Task Force (DMTF) has published a superset of the schema called the Common Information Model (CIM). CIM specifies mappings between HMMS and products conforming to the Common Object Request Architecture, SNMP and DMTF Desktop Management Interface (DMI) standards.

The HyperMedia Object Manager (HMOM) is a data model that consolidates management data from different sources. It is a C++ object broker that gathers management data from applications to be displayed on central management consoles. HMOM is based on Microsoft's OLE technology.

The HyperMedia Management Protocol (HMMP) is a communications protocol that embodies HMMS and runs over HTTP and with planned interfaces to SNMP and DMI. It allows browsers access and receive systems and network-management data, such as alerts and event reports, from devices and applications.

The WBEM initiative has little to do with Web usage or browser management. It focuses on specifying a

standard data structure that will allow management information collected by SNMP, Desktop management Interface, Common Management Interface Protocol, and other management protocols to be stored and accessed from a common repository.

4) Java Management API (JMAPI): The JMAPI initiative (Sun, 2000) is a programming environment for developing Web-based network and systems management software. JMAPI aims to instrument devices to deliver network management information and to provide a common look-and-feel for browser-based consoles. JMAPI is intended to be a standard set of class libraries, Java widgets and user interface specifications that Sun is hoping to promote with its partners' support. The initiative relies on the extensibility and popularity of Java's "write once, run anywhere" model. Java shows promise for reducing the portability problem while providing unprecedented information display capabilities.

3. Barriers to Integrated Network Management

The lack of standards for Network Management Systems (NMS) creates a barrier to effective integrated network management. The inability of different NM Systems to communicate requires an added level of processing needed to bridge the gap. This additional level is often found in applications, thus creating two main problems: first, the development and implementation of applications becomes more complex. Second, the flexibility of the NMS is compromised since every new managed object will cause modifications to all applications that need to interact with it (Neumair, 1993).

Network Management procedures are also affected by the lack of a common approach based on standards. Network administrators and operators need to adopt different methodologies and learn about new tools for each segment of their multi-vendor configuration. At the other end, users wish to have a top-down or general overview of a network that has essentially been built in a piecemeal, bottom-up fashion. This initial bottom-up approach to network management failed because of the problems related to lack of standards discussed above, and the cost incurred by each vendor trying to develop and maintain their own management systems. The other approach tried by the industry is a top-down centralised "Supersystem" which has as its main function to integrate the existing NM systems. Paradoxically this latter approach was doomed by the same reasons. The heterogeneous nature of existing NM systems proved a shaky foundation upon which to build a super system. It proved difficult to try to present a common front when the

building blocks were often distinct and sometimes contradictory.

Web-based network management has the potential to operate on heterogeneous networks using existing network management standards while providing an easy to use, platform-independent interface.

4. A Web-based Network Management Model

A model based on standard network management systems and using object oriented techniques addresses some of the problems mentioned in section 3 by providing a common communication protocol, shifting that responsibility away from the application programs, and by specifying a small, well-defined number of operations to be performed on all managed resources. Developers will be able to introduce new Managed Objects as long as the MOs can respond to that limited set of operations.

The "surviving" approach (after the failure of bottom-up and top-down systems) to integrated network management is the open system standards-based approach, providing a common, open management "platform" that could be used by vendors as a basis for their element management systems. This platform approach needs to be complemented by techniques that defeat the restricted role of traditional Client/Server configurations. Figure 1 illustrates a model for web-based network management suitable for the implementation of the MbD paradigm. WBEM and JMAPI should be used as complementary technologies with RMI (Remote Method Invocation) used as one of the possible "Proprietary protocols" illustrated in the bottom part of Figure 1.

The JMAPI techniques can provide the instrumentation needed at the device level and the specification for the agent-to-physical-device interface. Sun's tools can also be used to develop a common look and feel for browser-based consoles (Forbath, 1997). On the other hand the WBEM initiative provides a complete framework for data representation (HyperMedia Management Schema and HyperMedia Object Manager) and protocol communications (HyperMedia Management Protocol or HMMP).

The WBEM initiative allows Clients and Servers to switch functionality therefore relaxing the rigidity associated with the traditional C/S roles. A client or a server can become both a producer and a consumer of information with notifications "pushed" to them by providers ("Indications" in HMMP terminology). The facility to change roles plus the ability to configure stations from simple to complex, in terms of

responsibilities and capabilities, provides the basics needed to implement "elasticity" with web-based techniques.

The WBEM's meta-model describes what types of entities make up the schema and how they can be combined into objects which represent real-world devices, and the standard schema is a set of published classes which represent a wide range of hardware devices and other managed objects.

Java with its write once, run everywhere provides the platform independence advocated by the MbD paradigm and security is based on the fact that only trusted code runs on a client. The configuration requires an HTTP server to start Java operations. The Browser User Interface contains the Admin View Module (AVM) with the key client side classes for developers of JMAPI-based applets, and the Managed Object Interfaces use RMI to perform remote management methods. The RMI calls can be eventually encapsulated within HMMP (Sun, 2000).

The "Management Applications" (MA) component interacts with higher and lower levels in the model. Figure 2 shows the internal structure of this component. The management supervision element monitors the operation of the MA component and receives the requests for service. The management activation element identifies the management task and activates the corresponding management application service using the underlying connection service (lower level). The management activation element is the interface that allows the use of SNMP, DMI or proprietary requests.

The management application specifies (via a management Applications Programming Interface) the objects it wants to manage in its request, and the Management Activation component determines which agent holds the requested object. The following step consists of establishing an association to the agent or using a pre-established (i.e. active) association if one already exists.

The proposed framework offers many advantages over standard management protocols:

1. **Independence:** Operating systems-, hardware-, and protocol-independence can be achieved by using Java applets and RMI calls.
2. **Simple and easy access to network information:** Web browsers allow switching between management applications and remote monitoring of networks.
3. **Interoperability:** Adopting open standards and technologies, such as CIM, HMMP and Java result in interoperable systems.

4. **Cost-effectiveness:** Less time is needed on application development, user training and technical support by using web browsers and Java applets.
5. **Elimination of versioning and distribution problems:** The correct version of classes and libraries can be securely downloaded on demand. Clients downloading the software from a central location can avoid the agent distribution problems.
6. **Completeness:** Different formats of HMMQL allow access to different types of information.
7. **Seamless integration with on-line documentation:** Context-sensitive Help and documentation may be accessed through hyperlinks embedded directly into the agent's management pages.
8. **Modularity:** Reusable, mix-and-match Java applets and CIM promote modularity.
9. **Persistence:** The browser can go to another page, while the application stays and monitors a troubling piece of networking gear (Boardman, 1997).
10. **Scalability:** Multiple and concurrent browser access to the management system and the deployment of Managers and Providers allow future scale-up.
11. **Security:** Secure data access and transmission by using firewalls, RMI, HMMQL, SSL, and user passwords.
12. **Feasibility:** Large portion of this framework is built on existing technologies.
13. **Migration:** Smooth migration from standard protocols is possible.
14. **Efficiency:** Larger amounts of data can be transferred in a single transaction using TCP and IPv6.
15. **Support for management functionalities:** More complex tasks for the management functionalities can be supported by writing Java code.

However, there are a few possible disadvantages and concerns when using this framework:

- The latency of HTTP when used for small transactions.
- The burden of display is placed on the server.
- The adverse effect on performance by transmitting RMI calls as HTTP requests.
- The framework relies on the acceptance, by vendors and users, of the Common Information Model.

6. Conclusions and related work

Web-based technologies provide powerful mechanisms for implementing the MbD paradigm. Several advantages are derived from its use: agents operate closer to where they are needed; improved security can be achieved by using technologies such as Secure Sockets Layer (SSL), Secure HTTP (S-HTTP), and trusted Java code; web push technology (example: Java applets “pushing” information to managers) can be used to

increase “role flexibility”; use of platform-independent technology (anywhere/anytime accessibility); ease of use; scalability; support for SNMP agents and support for mapping data to commercially available relational databases.

Details of the “Management Applications” and “Connection Service” components can be found in (Gutiérrez, 1998). As part of the project a SDL (Specification and Description Language) specification of the “Management Applications” component and a library of managed objects classes have been created.

The combination of JMAPI and WBEM can add value to the well-established SNMP management protocol. JMAPI is more advanced in instrumenting devices to deliver information, and in developing a user interface. WBEM is further along in developing a common data schema (Forbath, 1997). SNMP should continue to be used for performance and fault monitoring, while leaving JMAPI and WBEM to address the areas that are not covered adequately by SNMP, such as manager-to-manager communications, remote troubleshooting, and security, accounting and configuration management.

REFERENCES

- Boardman, B., “*The Dawning of the Java Management Age*”, <http://www.iweek.co.uk/LABS/008/ab08.stm>, 1997.
- Forbath T., “Web-based management- a recipe for success”, *New Zealand Network World*, Issue No. 21, 1997, pp. 16-20
- Goldszmidt G., “Distributed System Management via Elastic Servers”, *Proceedings of the IEEE First International Workshop on Systems Management*, 1993.
- Goldszmidt G. & Yemini Y., “Distributed Management by Delegation”, *Proceedings of the 4th International Symposium on Integrated Network Management*, Eds.: Sethi A. S., Raynaud Y., Faure-Vincent F., Chapman & Hall, 1995, pp. 4-15.
- Gutiérrez J., “A Connectionless Approach to Integrated Network Management”, *International Journal of Network Management*, Wiley Publishers, Vol. 8, No. 4, 1998, pp. 219-26.
- Horwitt E., “WBEM Just might make systems management real”, *Computerworld*, Vol. 3, No. 5, February 1, 1999
- Neumair, B., “Modelling Resources for Integrated Performance Management”, *Integrated Network Management, III (C-12)*, H.-G. Hegering and Y. Yemini (Editors), Elsevier Science Publishers B. V. (North-Holland), 1993, pp. 109-121
- Sun (2000), Java Management API, <http://java.sun.com/products/JavaManagement/index.html>
- Terplan K., *Web-based systems and network management*, CRC Press, 1999

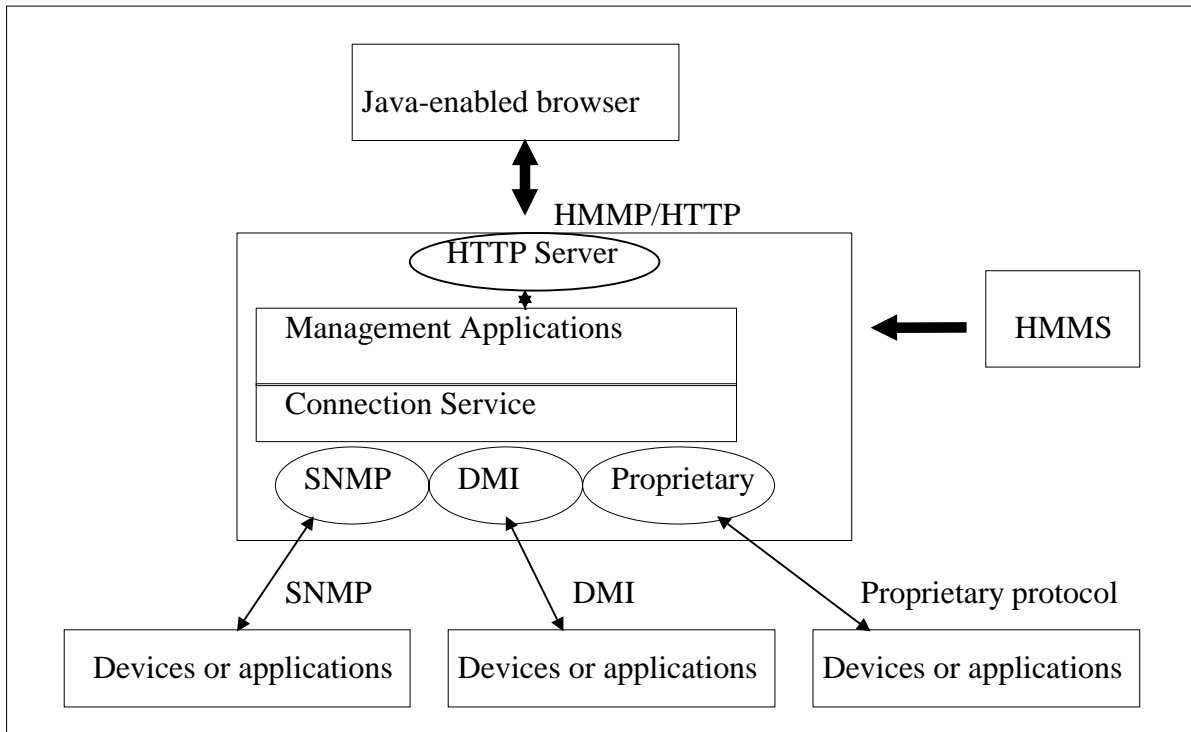
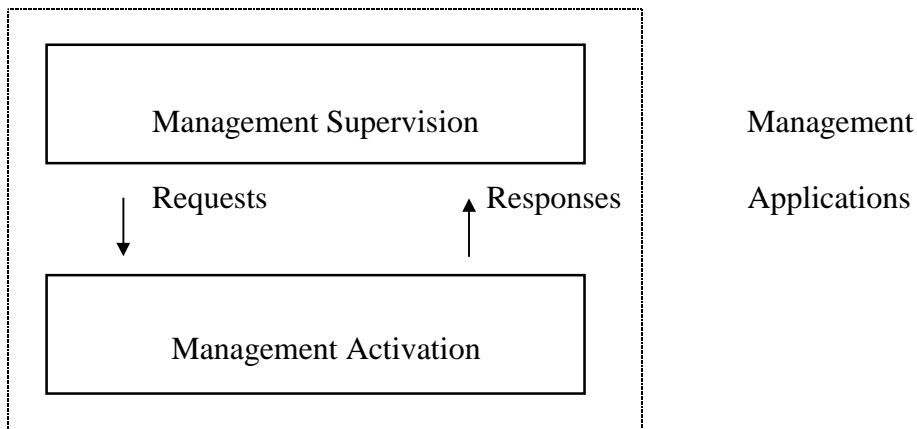


Figure 1 - A Web-based Network Management Model

Higher Levels



Lower Levels

Figure 2 - Management Applications component