Distributed Management of Mobile Components

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Abstract

The development of network management applications is mainly lined with the Simple Network Management Protocol. This architecture, regardless of some shortcomings, has managed not only to survive but also to evolve, achieving a more complete set of features. This fact, combined with its inherent simplicity and coarse API availability, has pushed it to a dominant position in today's network management.

Other technologies are showing up as add-ons that can help reduce network overload, robustness and flexibility. Researchers currently consider that mobile agent technology can provide valuable contributes to these subjects. Mobile agents will help SNMP agents and managers to better perform in some situations.

I. INTRODUCTION

Current developing efforts are turning heterogeneous local area networks into more uniform environments. Also the construction of distributed applications is getting easier and faster. The Java language, for example, defines a common layer over heterogeneous physical platforms. The evolving of distributed programming environment (DPE) such as CORBA and well-known proprietary protocols, such as Sun's RMI (Remote Method Invocation) allows transparent distribution of objects. Moreover, mobile agent technology provides an abstraction over operating systems and services to easily migrate code and state thus taking advantage of local interaction.

Most of the research efforts on mobile agents have been developed under the context of the telecommunications market. Examples of such research have been: management distribution and delegation [1], network services deliver [2] network traffic optimisation and network's fault tolerance [3].

The diversity of scenarios and applications associated to the currently available variety of mobile agent platforms (from different vendors and supporting different languages) leads to the fact that mobile agents also need to be managed. The Mobile Agent System Interoperability Facilities (MASIF) specification, a CORBA based proposal from the OMG, is the first attempt to standardize actions aiming at the interoperability between different vendors agent systems. Moreover, it provides some management facilities over mobile agents [4].

Another approach is to provide a common management environment to both network components and mobile agents. For this, the SNMP model is very popular among data network administrators, gathering several years of experience and technical knowledge. It makes sense to use the same application to perform all the management tasks. Following the standards, a fundamental piece in this approach is a gateway SNMP to MASIF, driven by a MASIF-MIB, allowing SNMP management of MASIF compliant agent systems [5].

On the other hand, one of the problems associated with SNMP is its centralized architecture, not well suited for offline operation and not scalable on large networks. To cope with this situation, the IETF DISMAN charter aims at issuing a set of specifications to distribute management operations over a hierarchy of several distributed managers (DMs) [6].

In this paper, we describe an architecture that uses the DISMAN model to automate management tasks of MASIF compliant agent systems. This architecture allows, for example, periodically sending mobile agents with specific instructions without user intervention. It also allows, for example, dispatching code to perform some operation in case some condition occurs. Moreover, it provides a smooth integration between mobile agent technology and current network management standards, such as SNMP.

II. DISTRIBUTED MANAGEMENT

Management distribution allows reducing the processing load on traditional centralized management station (NMS) by delegation tasks upon several Distributed Managers (DM) or upon more powerful agents. A DM is an SNMP entity that receives requests from another manager and executes those requests by performing management operations on agents or other managers.

Since the management entities are split over the network and collaborate between themselves by assignment, a hierarchy of several "islands" is created increasing the robustness and fault tolerance of the overall management system. Although if the access to the central manager is not possible, each DM may handle locally critical situations.

The IETF DISMAN framework is based on distributed applications and services. This kind of application performs some management function, often by monitoring and controlling managed elements. The distributed management services can perform functions or store information once for all applications on the local system thus making a set of

applications more efficient. Each service is provided by specific MIB interfaces.

Currently there are being proposed several MIB to address different but complementary issues of management operations distribution [6].

The Event MIB is the successor of the SNMPv2 Manager-to-Manager MIB. It provides the ability to monitor MIB objects either locally or remotely and takes an action when a trigger condition occurs [7].

The Notification Log MIB is intended mainly for notifications providers but may be also used by consumers. It defines a mechanism to cope with notifications lost by recording each notification data [8].

The Remote Operations MIBs group (`ping`, `traceroute`, `lookup`) enables the correspondent network-checking operation to be performed at a remote location. It provides a standard way to perform remote tests, to issue periodical sets of operations, and to generate notifications with test results [9].

The Schedule MIB provides the definitions to perform the scheduling of actions periodically or at specific times and dates. The actions are modeled by SNMP set operations on local MIB variables (restricted to `INTEGER` type). More complex actions can be realized by triggering a management script, which is responsible for performing complex state transitions [10].

The Script MIB module allows the delegation of management functions over distributed managers. Management functions are defined as management scripts written in a language supported by the managers. It may be a scripting language (such as TCL) or native code, if the remote site is able to execute this code. The module does not make any further assumptions on the language. The distributed manager may be decomposed in two blocks: the SNMP entity, which implements this MIB, and the runtime system, capable of executing the scripts. The Script MIB sees the runtime system as the managed resource, which is controlled by the MIB. The runtime system can be defined as an SNMP application, according to the SNMPv3 architecture [11].

The Expression MIB was planned to move to the agent side part of the management information processing typically performed by managers. In other words, it supports externally defined computation expressions over existing MIB objects. The Expression MIB allows providing the Event MIB with custom-defined objects. The result of an expression can trigger an event, resulting in an SNMP notification. Without the Expression MIB such monitoring is limited to the objects in predefined MIBs [12].

III. MOBILE AGENTS

Several approaches consider mobile agents for managing networks and services due to the distributed nature, efficiency savings, traffic reduction and robustness [13][14][15].

To ensure interoperability between mobile agent platforms, the OMG (Object Management Group) promoted a specification, MASIF [4], that we hope will gain a significant adherence. MASIF is based on CORBA standards and define methods to be implemented by different mobile agent platforms. These methods are then used to modify the mobile agent life cycle by creating, suspending, resuming or destroying them. Moreover, it is also possible to use MASIF interfaces to perform search operations on agents, places and agent systems. By being MASIF compliant it is ensured that, at least, the mobile agent platform is as interoperable as the standards allow.

Existing applications for network management are not CORBA compliant, meaning that they cannot easily call such methods. To cope with this, it is necessary a gateway between SNMP and MASIF which, on one side deals with management commands and, on the other side, calls methods using CORBA on MASIF interfaces [16].

These two bases, the SNMP framework on one hand and the mobile agent platform on the other, provide the main foundation for the following approach.

IV. ARCHITECTURE

The Distributed Manager can act as an SNMP agent for management stations or other higher-level Distributed Managers and as a management application for conventional agents. It has modules, which allows starting and stopping actions without user intervention, performing basic processing on management information and providing minimum sensing on the management environment.

In other words, it provides minimum autonomy functionality and can be thought of as a network management robot Fig. 1.

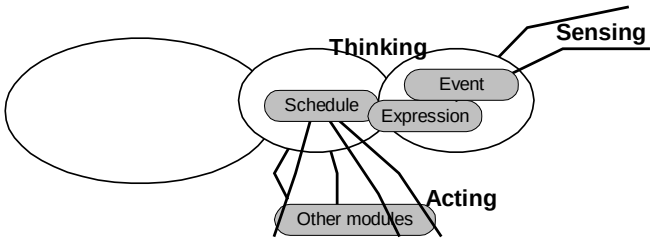

Fig. 1 Network management *robot*.

The Event MIB provides the sensing mechanism by listening for changes, checking existences and comparing SNMP values. If some condition is met, it may take an action.

The Expression MIB contributes with a way to create new, customized MIB objects for monitoring. One of the goals of this module is to save network traffic and overhead on management systems so it is not able to use remote objects as expression input values. If it did could use remote values for expression evaluation this goal would not be achieved.

The Schedule MIB allows launching actions periodically or at specific times. This allows performing repetitive, often boring tasks, without user intervention. It also provides a

suitable way to interact with the management system from temporary connections, such as a dial-in links.

In a physical robot, the cognitive system is attached to a system capable of realizing actions. Usually, the latter is mechanical and represents how the robot interacts with the surrounding world. In the network management robot, the actions are performed on other MIB modules by SNMP communication mechanisms or with more intimate, local interfaces that may, for example, bypass SNMP encoding but otherwise with identical functionally.

A. Management of Mobile Components

The action modules determine much of the robot behaviour. For example, the sensing mechanism (Event MIB) detects that some remote object exceeds some threshold for utilization or error rates. It is good to know this, but it is useless unless some action can be taken.

The action can be as simple as notifying the user, for example, that the link utilization between Bragança and Aveiro has raised above 80% or more complex, such as activating a backup dial-up connection to deal with the excessive traffic.

The modules responsible for taking actions would respond to SNMP `set` operations from the Event MIB by initiating the predefined deed.

We suggest that mobile agents be activated in this way to perform pre-programmed tasks thus achieving location transparency for some specific situations.

In this context, mobile agents are created, suspended or terminated by SNMP, controlled by a DM (Fig. 2).

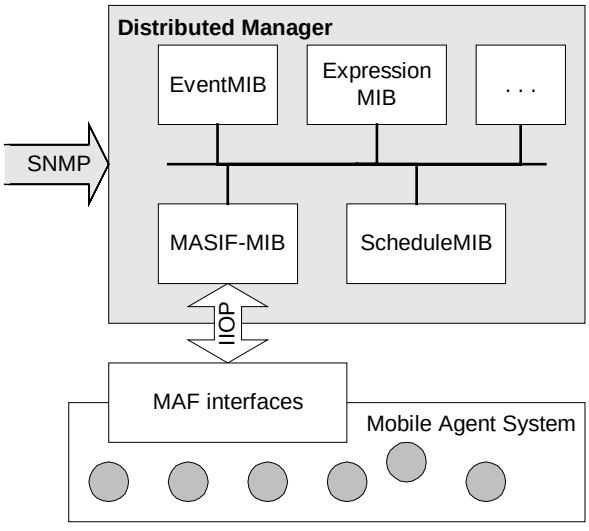

Fig. 2 Distributed management of mobile agent systems.

The MASIF-MIB module is responsible for converting SNMP commands to CORBA method calls on MAF interfaces. The reason for using MASIF is to maintain interoperability with different vendors mobile agent systems. This way, the system is not compromised by choices on platform specificities.

B. Implementation Experience

The system is being implemented in Java in association with several public domain tools. The Expression MIB module [17] uses the tools JavaCUP [18] and Jflex [19] for expression parsing and evaluation.

The MASIF-MIB module [16] invokes CORBA methods on Grasshopper, a MASIF compliant mobile agents platform [20].

The Schedule MIB uses a common clock engine for different threads, each one of them representing different scheduled actions.

The Event MIB implementation is currently ongoing work and, when complete, it will close the system development.

With the concentration of functionality on the agent side, the terminal can be simpler and, eventually, may be disconnected a large percentage of time.

To allow using the system from virtually any terminal, we are using an XML based tool for producing several output types, such as SNMP, WML and HTML. This allows the user to monitor and control the network management robot anywhere at anytime using either the network management station or the WAP compliant cellular phone.

V. USAGE SCENARIOS

There are several possible usage scenarios for a system of this kind. The concentration of features on the agent side will alleviate network management traffic and will make operation possible when the management station goes offline.

Moreover, the association of mobile agents with DISMAN allows having a library of mobile network management components that are activated by SNMP either by the user or autonomously by the Distributed Manager.

A possible scenario is to have a mobile agent that can carry the Expression MIB module around. This would allow using the Expression MIB on remote objects and also to use values from different agents on the same expression by maintaining full compatibility with DISMAN specifications. Moreover, it would allow dealing with platform load balancing, carrying the expression processing for more alleviated hosts.

Mobile agents also can extend the sensing mechanism by taking the “eyes” near the source of information. This would allow reducing traffic and increase the system robustness. It would then wait for the condition to happen before taking actions or communicating to the distributed manager (it is better to go several times to see if the coffee machine is operating or to leave someone there that can warn us when the machine is ready to produce a nice cup of coffee?).

The scheduling of actions, for example, would allow an anti-virus mobile agent to walk over all available hosts looking for specific viruses on all Thursdays the 12 before midnight.

VI. CONCLUSIONS

The association of DISMAN modules with mobile agents can provide a smooth integration environment of different technology for network management. Indeed, mobile agents can prove to be valuable in this field but they have to deal with existing SNMP network management systems and not the other way around.

The Distributed Manager capable of initiating mobile agents operation would thus provide an autonomous, intelligent tool for issuing mobile network management components with several goals. This would allow the user to be temporary absent without disrupting operation and provide an advanced set of fault, performance, configuration, accounting or security management tools.

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