TITLE: Proposal for a real distributed network management architecture

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Abstract

Having an efficient and easy to use telecommunications network management system is of great advantage for the network operator that intends to be in the market lead. On the other side, integrated services and technologies are, today, replacing distinct networks that, in the past, were used to support different types of services. Broadband networks, with special relevance to ATM and IP based networks, are gathering more and more clients and are becoming the common factor for service integration and for globalization of communications. The explosive growth of the Internet, the World-Wide-Web and the common acceptance of the Java language as the programming language to provide the development of portable applications make possible new approaches to the design and implementation of network management systems, and applications.

Research and Development in the network management area is very active. Distinct proposals from different research groups exist, each reflecting the different views and main concerns they have. CORBA is one of those which are collecting more supporters, even if its complexity and performance could limit its applicability to this particular area. Solutions based on mobile code principles are also being considered. It is the basis for Active and Intelligent Networks and for Management Mobile Agents. In the first, the code to collect and process the data at each node travels with that data, and the second consists in autonomous entities that travel the network performing management actions for which they were mandated, acting on behalf of some managing entity. Other solutions, like WBEM and JMAPI, address Web technologies to provide for a management platform. Management by Delegation (MdD), a concept first introduced by Goldszmidt and Yemini in 1995, is taking repercussion in important organisms like ITU and IETF. Together, with Mobile Agent technologies and WBEM, all have proposals for standardization

This paper describes the proposal for a new network management system that is a result from the previous considerations, from the analysis of existing solutions and from the identification of some requirements that existing solutions do not fulfil. From all the identified requirements, the most important ones are:
- Present **low latency** to the user inputs and to react to the network events,
- Need to have a **clear separation between user interface tasks and processes performing the core network management**,
- Provide **geographic and time independence** to perform management operations,
- Develop a **portable system**, capable to run in several distinct platforms,
- **Real distribution of management tasks** on the network,

- Capable to easily **adapt to managed environments of all dimensions** and accompanying its growth without service disruption,
- **Secure**, with different levels of security,
- **Efficient, consistent, simple and reliable**.
- Based in **autonomous entities** capable to work under network failure and **reducing network management traffic**.

As a result of the identified requirements, a four-layer management architecture is proposed. Making an analogy with a "three-tier", multi-client/multi-server model, it can be considered as its natural evolution, splitting the middle layer in two. The first one, the Management Servers layer, establishes the contacts with system users, while the second, the Managers layer, keeps in close contact with all the managed entities. Users located in any place in the network, connect their terminals to the closest Management Server, while Managers are responsible for a number of managed entities or resources. Communications between Management Servers and Managers make use of the communications network facilities and are based in object serialisation and remote invocation of object's methods.

Management Servers must provide a set of special services in order to guarantee geographic and time independence to users. In conjunction with the need to isolate the users interface processes from the network management tasks, it is concluded that Servers must hold all the users information and configuration. This is the only way to guarantee operation under users disconnection and to resume operations at reconnection time, without forcing users to use always the same terminal. This way, user's terminals are needed only to display data and not to hold any particular information, what gives the possibility to use Web technologies for that purpose. Web browsers, Java enabled, will run appropriate Java applets to interface with the users.

Managers receive management operations, defined by users using a suitable user interface, and execute them following their instructions. Managers have a modular configuration where management functionalities can be added, removed or changed according to the management needs in each moment, by the usage of Functional Management Modules (FMM). These update operations are performed offline during low network traffic. Management operations instruct Managers on the procedures to relate management operations, available from FMM, and when to execute them, all in an autonomous way. Arithmetic and logical relationships, as well as activation and deactivation conditions, are some of the possibilities.

Managers are organised in a logical structure, called the Management Tree. All or part of the Managers existing in the network, participate in that Tree by the establishment of a single logical connection, at set-up time, to an already existing node on the Tree. This way, no loops will exist in the Tree and all the nodes have the same importance. The existence of this Tree provides an higher level of flexibility and capacity to adapt to different network dimensions. Besides other operations, it provides the means for Managers update and for the distribution of management operations that apply to a large number of managed devices. An additional application of the Management Tree consists in the processing of the generated management information by the Tree nodes, while it travels towards the node taken as root node. Filtering and processing functions are used for that purpose.

This paper will give an overview of existing management standards and current research initiatives in the area. The proposal for a new architecture, which will fulfil the limitations identified in available solutions, is described, addressing Web integration, real distribution of the execution of management tasks, and time and space independence to execute them. Results from its implementation and practical use in a distributed broadband network will be given.