Methodology for Specifying and Implementing a Management Solution

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Abstract:

This paper proposes a methodology for specifying and implementing a management solution on corporate networks. The proposed methodology is based on a set of steps which may be associated to one or more activities and which are divided in four different phases. The first phase determines the management requirements that need to be solved. The second phase specifies the management policy to be adopted, and which determines the relationship between the products and the personnel involved in the management process. The third phase cares for the selection of the management products, of interest. Finally, the fourth phase implements the solution resulting from the management policy and selected products. Based on the proposed methodology, it is possible to implement an effective resources management for corporate networks. The methodical determination of requirements for management permits that the corporation may visualize its current and future needs. The adoption of a policy, as presented, guarantees the quality of management. The wise selection of management products is a significant contribution toward a good compromise solution for matching predefined management requirements.

1. Introduction

The evolution in information technology during the last decades has caused the corporate network environment to change, transforming them from centralized networks to distributed networks. This fact has contributed to raise the degree of complexity of the systems needed to manage such networks, since, besides the increase in the number of computes to be managed, the diversity of existing platforms has increased as well (Unix, Windows NT, etc.). In addition to this, new devices for network interconnection have appeared (routers, *switches*, etc.), as well as the consequent need to manage them.

Considering the characteristics of this new environment, the lack of definition of management standards regarding certain areas to be managed, and the need for managing, from a computer network connection to the application that runs in this computer, it became increasingly difficult to find, in the market, management products meeting the management requirements of a full range of existing equipment, platforms and network devices.

Since a single product cannot, thus, meet all the management requirements of the computing environment of a given company, a management solution for a corporate network consists usually of more than a management product. There is, then, the need for determining the best management product mix to make up such management solution.

On the other hand, once the management solution is determined, it is necessary to implement it to take the maximum advantage of the investment made in management products. In other words, it is necessary to set up procedures, both technical and administrative, regarding how to properly address the issues related to the corporate network management among the people involved in solving such issues.

Taking into consideration what was said above, this paper aims to describe a methodology for specifying and implementing a management solution, which includes its component management products, as well as the management policy to be adopted in the management process, involving its execution personnel and the products themselves.

2. Management Standards

The OSI (*Open Systems Interconnection*) management architecture is described through a set of standards set as a result of joint work of ISO (*International Organization for Standardization*) and ITU SG 7 (*International Telecommunications Union Study Group 7)*. The OSI management architecture specification documents divide the management task into five functional areas [2] [9] [10], namely: Fault, Performance, Configuration, Accounting and Security.

Such areas became the basis for the process of evaluating management products made available by vendors, as well as for describing the requirements of whatever management system.

In addition to the specification of these functional areas, it is fundamental to set forth communication standards between management systems and managed resources, as well as standards for the information models employed in such systems. The management standards existing today include:

➢ **TCP/IP Management:** TCP/IP management [10] [11] uses the SNMP (*Simple Network Management Protocol*) management protocol to access management information in the MIB (*Management Information Base*) of the managed resource. There are three SNMP versions: SNMPv1, SNMPv2 and SNMPv3. SNMPv1 supports the operations *getrequest*, *getnextrequest*, *setrequest*, *getresponse* and *trap* for gathering/updating of data and notification of events of managed resources, respectively. SNMPv2, on its turn, offers support to the operations *getbulkrequest* and *informrequest*, for efficient transfer of large information blocks and distributed management, respectively, in addition to those operations already covered by SNMPv1. SNMPv3 covers, additionally to the previous systems, SNMPv1 and SNMPv2, safety and access control mechanisms associated to the management operations. Besides, RMON (*Remote Network Monitoring*) versions 1 and 2 have been defined to make feasible to monitor the managed resources of remote network segments, reducing, thus, the management traffic when such networks and the management system are interconnected through long-distance networks.

➢ **Client Stations Management:** due to the widespread use of client stations (PCs - *Personal Computers*) in a corporate network, other important aspect regards the management of this kind of resource, including functions such as inventory control software deployment. The main goal of such management is to reduce the TCO (*Total Cost of Ownership*) of client stations. To do so, there is some standardization and initiatives, namely:

- **DMI (*Desktop Management Interface*):** DMI acts as an abstraction layer between the management applications and the system components that need management [5]. It has been developed by DMTF (*Desktop Management Task Force*) to be: easily adopted by vendors; computer-, operating system- or management-protocol-independent; locally (without connection to the network) and remotely (through RPC - *Remote Procedure Call*) useable, and mapped by existing management protocols (SNMP and CMIP - *Common Management Information Protocol*).
- **Net PC (*Network Personal Computer*):** the Net PC project [6] sets forth the requirements for the development of a manageable PC, either using Intel architecture or not, that runs Microsoft Windows or Windows NT Workstation operating systems. Net PC specifies a highly manageable platform with instrumentation, remote boot feature, managed upgrade capability and sealed cabinets to prevent the user access for possible changes to hardware or software setup.
- **WFM (*Wired for Management*):** the WFM initiative, led by Intel, aims to make Intel-based systems universally manageable, without sacrificing their efficiency and performance. The version WFM 1.1a [7] features guidelines addressing the centralized management of a new generation of platforms. Such management provides advantages in four critical areas: inventory management, remote boot service, maintenance off working hours, and reduced power consumption.
- **ZAW (*Zero Administration Initiative for Windows*):** ZAW, an initiative by Microsoft, defines a set of technologies that allow managing environments with Windows-based operating systems [8]. The main functions made available by ZAW are the following: automatic applications installation and operating system updates; lasting data and setup information caching; centralized management and system protection, and flexibility for application development.

➢ **Web-based Management:** aiming to apply the web technology to corporate networks management, new management standards have appeared, namely:

- **WBEM (*Web-Based Enterprise Management*):** the WBEM initiative has initially resulted from joint efforts of Microsoft, Intel, BMC Software, Compaq and Cisco Systems, currently supported by DMTF, including over 75 other companies [14]. WBEMs management standards and technologies complement the existing management standards (SNMP, DMI and other). Its HMMA architecture (*HyperMedia Management Architecture*) allows using direct access and *proxy* architecture for monitoring and control of the managed resources, by using the HMMP (*HyperMedia Management Protocol*).

- **JMAPI (*Java Management Application Programming Interface*):** JMAPI is a set of extensions to Java basic classes and methods, set forth by Sun, to address management issues. JMAPI allows the developers to build applications to provide solutions for integrated management of services, system and network, taking advantage of the Java computing environment [12]. The JMAPI management architecture [13] allows the user to use the BUI (*Browser User Interface*) to access the managed resources (*appliance*) through ARM (*Admin Runtime Module*), using RMI (*Remote Method Invocation*). ARM, run in a specific server, also allows the access to managed resources through SNMP.

The OSI management architecture, based upon CMIP (*Common Management Information Protocol*), has not been dealt with in this paper because it currently does not play a significant role in corporate networks management.

3. Terminology and Methodological Concepts

The proposed methodology [3] uses mostly terms and concepts found in the literature on management and set forth by the vendors of management products themselves [4]. In certain situations, even due to the way the methodology has been built, it was necessary to construct some additional terms and concepts. These shall be presented in this section. Part of these terms and concepts are not, thus, of common usage among the community, since this methodology does not appear in bibliographical references, having been constructed from experience.

Figure 3.1 represents the management model used by this methodology. It shows that the management process involves equipment and people interacting to manage properly the corporate network resources. This management process is fed by a set of management requirements and by a management policy, which shall determine its behavior.
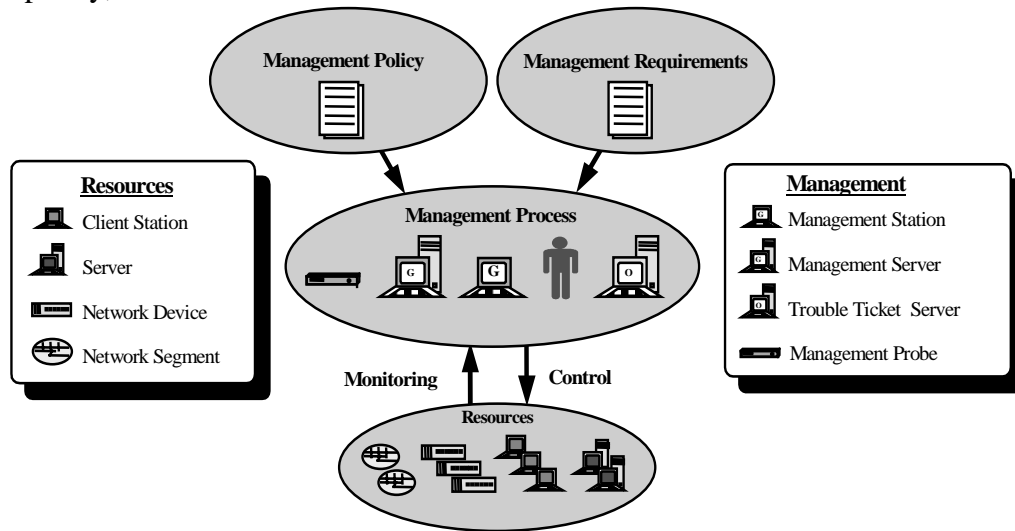

Figure 3.1 – Management Model

This methodology regards the corporate network as a set of **resources** employed in providing **services** to its users. Therefore, to a given **service** are associated the **resources** needed for providing this service, as the Figure 3.2 shows. A given **resource** may be use by one (resource 1 in Figure 3.2) or more **services** (resources 2, 3 and N in Figure 3.2).

A **resource** is divided into **components.** A **component** is associated to a single **resource**. A resource may contain a variable number of **components.** In Figure 3.2, resource 1 has two components and resource 2 has just one.

Each component has a set of **management requirements**, set forth by the company according to the desired management level, that is to say**, management requirement** is the assignment of each one of the items the company wants to manage in a component. It is noteworthy that the **management requirement** may be associated to one or more objects of previously standardized MIBs, or may not have any equivalence whatsoever with objects of MIBs, because it is still not standardized. Likewise, there may be objects of MIBs with no equivalence with **management requirements** of a given company's corporate network (see Figure 3.2).

The hierarchy and the relationships presented in Figure 3.2 are generic ones, and they can be applied beyond the scope of the proposed methodology. However, aiming to a better approach to the issues addressed by this methodology, some particularization and subdivisions are made regarding **resources** and **components**. It was applied to such particularization and subdivisions the concept of **domain** [1] [9], which is the name given to **resources** clusters made following a certain criterion.
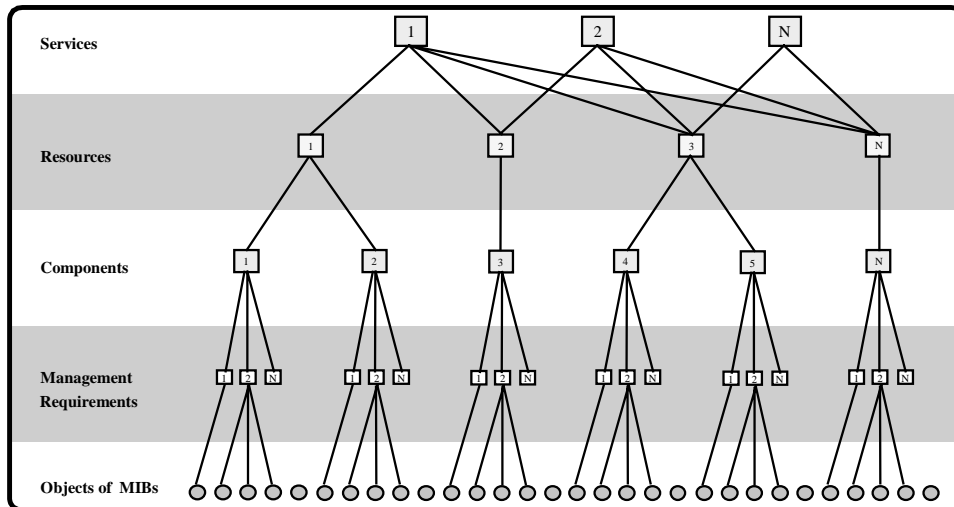
Figure 3.2 - Hierarchy and Relationship of Terms Associated to the Corporate Network

In this methodology, using as criterion the general functionality of the resources making up a corporate network, four domain categories have been set forth, namely:

➢ **Client station:** the equipment (computer or terminal) serving as the corporate network access point to the user. The term refers mostly to the users' PCs (Personal Computers).

➢ **Server:** all computers not fit in the "client station" category, and that make available to corporate network users some kind of service.

➢ **Network device:** any equipment used to provide networking infrastructure is assigned such name. This category includes equipment such as *hubs*, *switches*, modems, routers, and other.

➢ **Network segment:** the resources category representing each part of the network, separated by a network device segmenting it (router, *switch*, bridge). The network segments may use different networking technologies (FDDI - *Fiber Distributed Data Interchange*, Token Ring, Ethernet, ATM - *Asynchronous Transfer Mode*, etc).

The corporate network can, this way, be described by means of the scenario presented in the Figure 3.3, where it can be noted the existence of a corporate server with its proprietary network (for instance, a SNA - *Systems Network Architecture* network) and a *web* server for Internet access.
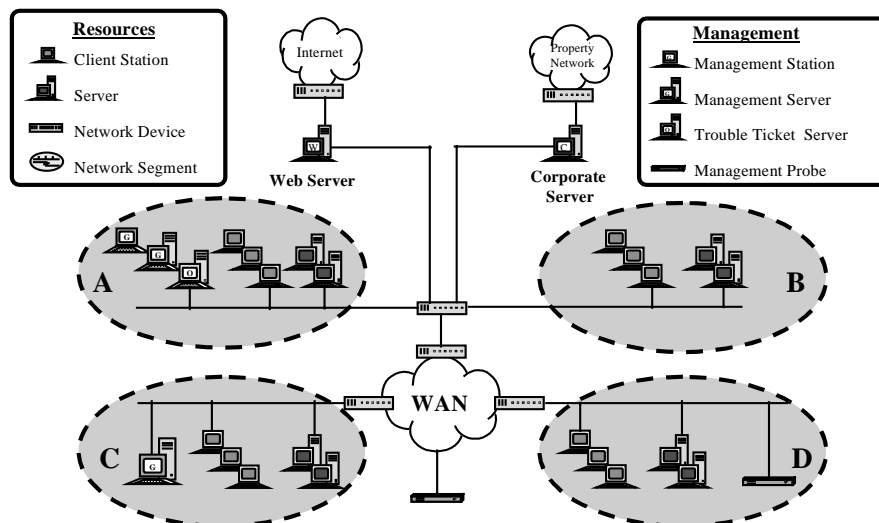

Figure 3.3 - Corporate Network Scenario

In the Figure 3.3 it can also be noted the presence of equipment aimed to the corporate network management. Such equipment has been defined according to the features found in the various management products currently available. The equipment is the following:

➢ **Trouble ticket server:** the server used to run the software responsible for logging the corporate network trouble ticket. **Trouble ticket** is an user request or automatic problem detection by a management product. The trouble ticket logging can be done by a person, or automatically, by the management product.

➢ **Management server:** the server used to run management products that shall act monitoring and controlling the corporate network resources.

➢ **Management station:** the equipment used to access the management server. Examples of this are: X-Terminal, PC.

➢ **Management probe:** the equipment used to gather management information from a given network segment, in order to, later, send it on demand to the management server.

Taking into consideration that management products are focussed on network management and systems management, it has been created the concept of **component,** which is the name assigned to the component (hardware) or executing (software) parts of a given resource. They have been classified as follows:

➢ **Network component:** the component containing the parts (hardware and software) involved in connecting the resource to the network (e.g., network card, software responsible for running protocols, etc).

➢ **System component:** the component containing the basic parts (hardware and software) of a server or client station resource (e.g., processor, memory, operating system, etc.).

➢ **Application component:** the component containing the set of programs developed by the company itself or by third parties, being part of a given system (e.g., checking accounts, stock control, billing, etc.).

➢ **Database component:** the component containing the software responsible for handling databases (e.g., Oracle, Sybase, etc.).

Therefore, a **component** represents the parts of a resource, being whichever part (hardware or software) of a resource represented in one of its components, that is to say, the set of components of a given resource correspond to the sum of the component parts (hardware or software) of this resource. Figure 3.4 represents the components of each of the defined resources categories, situating them in relation to the approach presented by the management products.
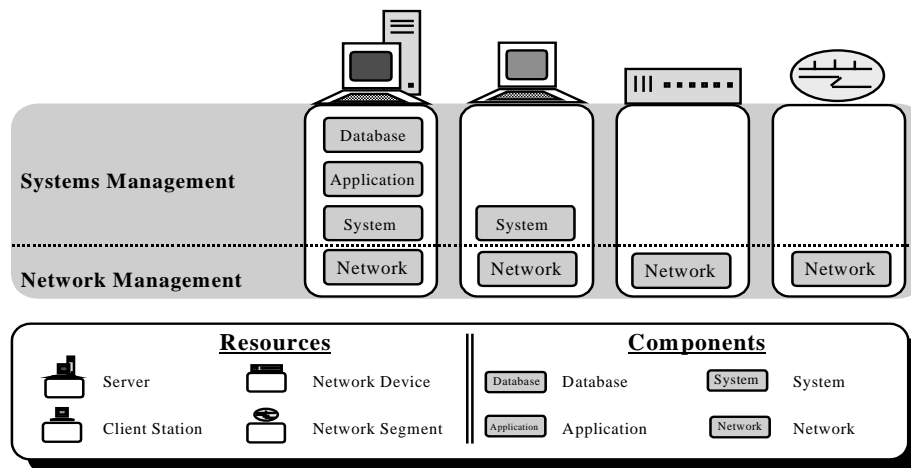

Figure 3.4 - Components Associated to Resources

The methodology is made up of **activities**, name given to the smallest pieces of action (effort necessary to performing a task) in the methodology. The **activities** are grouped together, making up the methodology **steps**, which may contain one or more activities. For organization purposes, the methodology **steps** have been grouped together according to their affinity with the execution of a larger task, making up, thus, what is known as "methodology **phase**".

A phase has a set of **inputs** and **outputs**, which is a subset of the sum of inputs and outputs of their steps. The activities of a step process the step's **inputs** in order to generate their **outputs**.

The methodology assumes that the management process happens through the concurrence of equipment and people (see Figure 3.1) and, in this context, the concept of **management policy** arises**.** This is the name given to the set of rules established for obtaining a quality management, involving management equipment (stations, servers and probes) and personnel.

The **management policy**, together with the set of management products having their respective customizations and complementary developments which shall satisfy the management requirements set forth, make up a **management solution**.

When selecting management products, besides the management requirements the **management product requirements** are also taken into consideration. This is the name given to the management products features that are regarded as mandatory or optional for the specified management solution.

The methodology assumes that the management implementation in a corporate network is a cyclical and continuous process, that is to say, the execution of the methodology phases is part of a cycle that shall satisfy a range of management requirements. In order to satisfy management requirements sets, new methodology cycles should be executed. As a corporate network undergoes continuous technological updates, not being always possible to satisfy to the management requirements all at once (typically due to cost reasons), the management implementation process is cyclical as well as continuous. Then the concept of **management stage** arises**,** which is the name given to the completion of one methodology cycle, encompassing one execution of each of its phases (see Figure 4.1).

The function of each one of the people who are part of the management process is described below:

➢ **User:** people using the corporate network resources to perform their activities within the company. Should this user perform their functions in the DPC (Data Processing Center), s/he is called a **DPC user**. Otherwise, s/he is called **end user**.

➢ **Provider:** people (or companies) that provide some kind of resource (hardware or software) making up the corporate network.

➢ **Performer:** people who perform some function in the corporate network management process. Performers may be:

▪ **Help Desk Operator:** people who work in the help desk, being responsible for recording events notified by corporate network users, and for routing these events to the operators and analysts. They may be responsible for solving simpler events.

▪ **Management Operator:** people responsible for the day-to-day activities of the management process, such as: work at management stations, observing the alarms issued by management products, take corrective actions regarding detected problems or route to the analysts the events they could not solve.

▪ **Analyst:** people with specialized knowledge at certain areas, and able to provide solutions for more complex events.

▪ **Manager:** people fully responsible for all issues related to the corporate network management, such as: follow-up of service level indices and implementation of management stages.

4. Methodology Overview

In order to reach its two primary goals (specification of a management solution and implementation of this solution in a corporate network), the methodology is based upon the following principles [3]:

- ➢ The management implementation shall be performed in stages, given the complexity and the costs involved in its overall implementation all at once. Such principle describes a cyclical methodology for implementing the subsequent management stages (see Figure 4.1).
- ➢ The starting point for determining the management requirements that shall make up a given management implementation stage are the services provided by the corporate network.
- ➢ Management is a process made up of equipment and people. Therefore, the management policy set forth should take into account the relationship between them. In order to properly satisfy such principle, the methodology anticipates the existence of event-recording software to be used by the help desk operators.
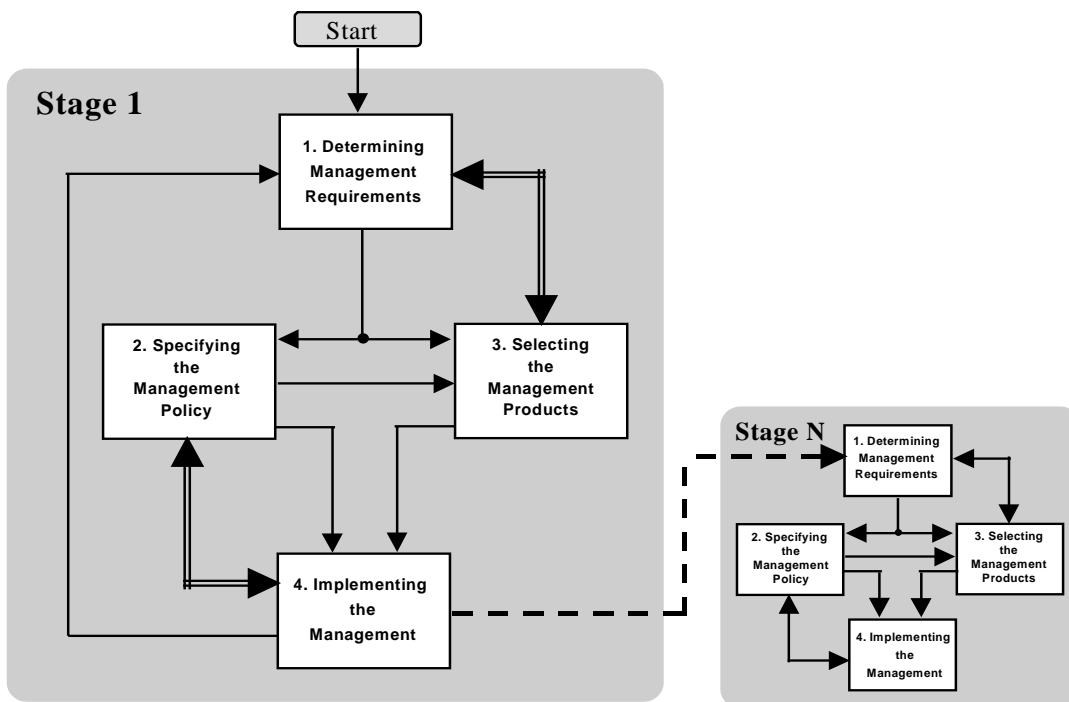

Figure 4.1 – Methodology Overall Diagram

Such methodology consists of the following phases:

- ➢ **Phase 1 – Determining Management Requirements** (see item 4.1)
- ➢ **Phase 2 – Specifying the Management Policy** (see item 4.2)
- ➢ **Phase 3 – Selecting the Management Products** (see item 4.3)
- ➢ **Phase 4 – Implementing the Management** (see item 4.4)

The description of the function of each phase, as well as their steps are to be found in the corresponding items. The relationship of these phases is shown in the general diagram of Figure 4.1. Note, in this diagram, arrows with double lines, pointing to both directions, indicating a reevaluation relationship between the phases, that is to say, reevaluation is a return to review and, possibly, change outputs generated by certain steps, due to new information produced after the execution of subsequent steps. The diagram shows a certain parallelism between the steps in phases 2 and 3, which have their execution started simultaneously from outputs generated by phase 1.

4.1 PHASE 1 – Determining Management Requirements

The main goal in this phase is to determine the requirements of the current management stage, by executing the following steps:

➢ **Step 1.1 - Preliminary study for starting a stage:** this step projects the development of a preliminary study for the start of a management stage, where a prioritized list of services to be managed is generated. Such preliminary study aims to estimate management stage implementation costs and to allocate budget to this implementation.

➢ **Step 1.2 - Definition of the corporate network resource types:** the information survey concerning the corporate network (steps 1.2 and 1.3) allows to view the environment to be managed. In a corporate network may exist various resource types, classified according to their components' features. For example, it is possible that there is a resource type Windows NT server running the Oracle database, and another resource type Windows NT server running the Informix database. This step aims to determine the types and the current and future number of resources in the corporate network.

➢ **Step 1.3 - Development of a corporate network diagram:** this step aims to develop a corporate network diagram showing at least one usage case for each resource type in the network and, thus, providing a view of the geographical location of the resources which shall be the object of the management.

➢ **Step 1.4 - Definition of the management stages scope:** the management stages scope is defined by taking into consideration the services prioritized list and the OSI management model functional areas to be served.

➢ **Step 1.5 - Definition of the resources of the current stage:** from the results of previous step, we can define, for the current management stage, the involved resources/components.

➢ **Step 1.6 - Definition of the management requirements in the current stage:** for each resource/component, we can define, for the current management stage, the respective management requirements. For instance, the failure detection of the application running under Windows NT Server may be crucial to increase the availability of the service controlling the company's billing.

With the management requirements defined, it is possible to start the management policy specification (phase 2) and the selection of management products (phase 3).

4.2 PHASE 2 – Specifying the Management Policy

This phase aims to specify the management policy through the execution of the following steps:

➢ **Step 2.1 - Definition of service level indices:** establishing service level indices is crucial in order to follow up the quality and efficiency of the management process. For instance, the index regarding the limit of failures which make the service completely unavailable may have one failure per month as its goal, that is to say, should more than one monthly failure occur, its causes must be found and corrective actions must be taken.

➢ **Step 2.2 - Definition of the management policy:** by specifying the management policy it is possible to define the relationships between performers and management equipment, aiming to allow the efficient routing of the corporate network events. For instance, it may be defined that the help desk operator should provide first-level service at events concerning PCs, due to its high frequency, aiming to service more promptly the end user.

➢ **Step 2.3 - Definition of the performers' function and profile:** once the management policy is specified, it is possible to define functions/profile of the performers, who will be responsible for following the policy set forth in the management process. For instance, if the help desk operator's function is to provide first-level service at events concerning PCs, s/he must have at least an average knowledge level regarding the issue.

4.3 PHASE 3 – Selecting the Management Products

The main goal in this phase is to select the management products that satisfy the requirements of the current management stage, by executing the following steps:

- ➢ **Step 3.1 - Definition of the management product requirements:** this step defines the architecture and requirements of the management products, supported by the theory on management standards and products. For instance, it may be defined as a requirement that management products should use the management standard SNMPv1 and should have distributed management mechanisms.

- ➢ **Step 3.2 - Definition of the requirements of the management product supplier:** this step defines the management products supplier's requirements concerning its attributes (mission, etc.), services provided (installation, support) and costs (support, training, etc.).

- ➢ **Step 3.3 - Development of management products evaluation script:** the products and suppliers requirements, along with the management requirements of the current stage listed in phase 1, are used in developing an evaluation script for management products.

- ➢ **Step 3.4 - Selection of the management products to be evaluated:** by means of information on the management products, obtained from suppliers, companies using these products and specialized literature, the management products able to satisfy the management requirements set forth and to be evaluated are chosen.

- ➢ **Step 3.5 - Evaluation of management products:** the management products chosen at step 3.4 are evaluated by using the management products evaluation script, developed at step 3.3. At the end of this evaluation, it is possible to define the products that shall make up the management solution. The evaluation also allows defining the integration level of the management products making up the solution.

- ➢ **Step 3.6 - Reevaluation of the management stages scope:** having the selected proposals and scripts, it is likely that some factor related to cost or difficulty implementing some management requirement may define some scope change in management stages. In other words, the management stages scope reevaluation may define that some management requirements should be left to further stages.

- ➢ **Step 3.7 - Purchase of management products:** after the management stages scope reevaluation, the proposals of the products making up the management solution are accepted, as far as the requirements to be satisfied and the involved costs are concerned. Therefore, step 3.7 handles the contracting of management products, which shall involve analysis and signing a contract of hardware, software and services providing contract.

4.4 PHASE 4 – Implementing the Management

After specifying the management policy and the management product selection, in order to implement the management policy and products, this phase aims to perform the following steps:

- ➢ **Step 4.1 - Infrastructure setup for management products:** the setup of the infrastructure for installing the equipment to be used by the management products may involve, for instance, cabling, outlets placement and displacement of cubicles.

- ➢ **Step 4.2 - Reevaluation of performers' profile and functions:** after the management solution is already defined, it is necessary a reevaluation of performers' profile and functions, defined at phase 2. This should allow the more accurate identification of the performers at step 4.3.

- ➢ **Step 4.3 - Performers pinpointing and/or hiring:** having the performers' profile and function reevaluated, it is possible to pinpoint people in the company and/or hire personnel to act as management functions performers.

- ➢ **Step 4.4 - Training of performers at management products:** step 4.4 aims to train the management performers, chosen at step 4.3, in using the contracted management products.

- ➢ **Step 4.5 - Management products installation and configuration:** this step intends to install and configure the management products. Ideally, such task should be undertaken by technical personnel from the management product supplier.
- ➢ **Step 4.6 - Reevaluation of management policy and service level indices:** after cultural maturity regarding the management, by performers trained at the management products, ideas may arise aiming to improve the management policy and the service level indices previously set forth. This step aims to reevaluate the management policy and the service level indices.
- ➢ **Step 4.7 - Training of performers at the management policy:** having the management policy and the service level indices reevaluated at step 4.6, the performers may be trained at the management policy, finishing thus the training needed for implementing the management.
- ➢ **Step 4.8 - Implementation of the current management stage:** with the products installed and the performers trained both at products and management policy, it is possible to consider the management stage implemented. It means that every performer shall, begin to perform their functions from this moment on.
- ➢ **Step 4.9 - Follow-up of the implemented management stages:** once the management stage is implemented, it is crucial to keep a follow-up in order to continuously reevaluate the service level indices and the management policy, as well as verify whether the performers are properly undertaking their functions. The manager, in charge of such follow-up, should issue periodical reports recording what has been observed as well as potential changes introduced. In this report, the manager may include remarks and advice regarding the need for implementation of new management stages, since this report shall be an input of step 1.1 (preliminary study for the beginning of a stage).

5. Conclusion

The proposed methodology has been employed at PSK (alias), having been reorganized and improved at several aspects. As an example of this we can mention the step 1.1, inserted aiming to avoid the surprise that happened at PSK, when the management implementing costs have been presented. The remaining steps have been systematized and the terminology has been well defined. Every step have been improved, especially highlighting step 1.4, which defines the management stages scopes by taking as a base the **services** that need to be managed and the budget and deadline curbs.

The use of this methodology at PSK has therefore proven that its steps can be executed within reasonable deadline and resources curbs. In spite of the insertion of step 1.1, it is important to highlight that the steps following step 1.1 have been successfully executed. So, we can conclude that this methodology can be successfully used.

Therefore, we can say that the proposed methodology sets forth the services that should be managed at each stage, as well as the current stage management requirements. Such procedure allows the company to view clearly its current and future management needs. Additionally, the management requirements mapping, done along with the people in charge who daily face the corporate network issues, provides the advantage of choosing a management solution that actually meets the needs and expectations around such solution.

The clear-sighted choice of management products, done by means of evaluation scripts, gives a significant contribution for the good specification of the management solution, and ensures the meeting of the management requirements set forth.

The specification and implementing of a management policy ensure good use of the investment in the management products. The lack of a management policy leads usually to a poor usage of the management products and to the impossibility of determining the advantages resulting from the management. Specifically, the follow-up by means of service level indices allows for a continuous

verification of the implemented management quality level and, consequently, for the advantages resulting from such management.

The staged approach of the management implementation is crucial and fit to the reality, mainly to the reality of the high cost of management solution that meets all requirements of a corporate network. Through this approach, the company can meet the main management requirements, according to the currently available budget. Independently of such aspect, the staged management implementation is important also due to the necessary management review when a technological update in the corporate network happens.

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