# DESIGN AND IMPLEMENTATION PRINCIPLES FOR INTEGRATED NETWORK AND SYSTEM MANAGEMENT

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Abstract: Rising costs for the maintenance of increasingly heterogeneous IT infrastructures has been one of the main reasons why anticipated cost reductions with the evolving structures have not materialised. This paper provides an analysis of the requirements for Management Services. The paper presents an approach for the design and realisation of Integrated Management Services. Management Systems are divided into different functional areas and can be derived from a set of Building Blocks in order to accommodate the range of requirements and environments applicable to Integrated Service Management. The paper further presents ways to utilize SW implementations for the provision of integrated Management Services based on the proposed principles. The construction and maintenance of Management Systems is facilitated by the use of existing solutions.

## 1 INTRODUCTION

Rising costs in running and maintaining the IT (including the communication infrastructures) has been one of the main reasons why cost reductions anticipated with the evolving structures have not been realised. Another development has been an increased heterogeneity of IT environments. The problems encountered in the context of management provision are promoting a concentration of technologies and manufacturers. The addition of cost considerations and the technical aspects illustrate the problem space for the provision of Integrated Management Services.

The problem analysis identifies current approaches and requirements that must be addressed for the provisioning of Integrated Management Services. The paper then presents a planning and operation approach based on the INSMware framework. Management Systems are divided into different functional areas and can be derived from a set of Building Blocks in order to accommodate the range of requirements and environments applicable to INSM. The process to derive an implementation for the provision of integrated Management Services based on the proposed principles is illustrated and evaluated. The construction and maintenance of Management Systems is facilitated by the use of INSMware Software Components that can be reused and adapted for different management scenarios (Knahl, 2004).

## 2 PROBLEM ANALYSIS

The analysis of requirements for Integrated Management Services produced two categories, namely *Architectural* (e.g. System Distribution) and *Operational* (e.g. System Evolution) requirements (see Table 1). The Management Architecture has to enable the distribution of Management Services to reflect the requirements of a given infrastructure (Lewis, 2003). The extensive overhead resulting from this requirement results from the challenges associated with the distributed system technologies of the existing and future heterogeneous infrastructures and the wide variety of the mobile systems and services. Therefore the architecture must neither impose additional constraints on the underlying distributed systems technology nor rely on specific system environment (e.g. with respect to the location of certain services and resources). Operational requirements refer to an actual implementation and operation of the Management Architecture. These requirements facilitate the process of formulating, developing and refining the



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principles for a flexible, composite and comprehensive integrated Management System capable of meeting both the immediate requirements and accommodating those which will arise as technologies develop.

Table 1: Requirements for new Management Systems.

| Archtitectural | Operational |
|---|---|
| 1. System Distribution<br>2. System Extensibility<br>3. Compact Architecture<br>4. Modular Architecture<br>5. Based on open standards<br>6. Based on generic development methodology<br>7. Support of existing development languages and technologies<br>8. Integration with 3rd Party Building Blocks<br>9. Reuse of existing Building Blocks<br>10. Security support | 1. System Evolution<br>2. System use and development<br>3. Support of distributed environment<br>4. Efficient resource utilisation<br>5. System portability and generality<br>6. Support of Internet standards<br>7. Support of management standards<br>8. System scalability and performance<br>9. Support of specific platform features<br>10. System administration |

The delegation of routine management tasks to a management system enables a human administrator to concentrate on high level activities such as business process monitoring or strategic network planning and control. The Management Platform approach tends to be based on loosely integrated applications that are used alongside each other on a common user interface (Dornan, 2001; Mayerl, 2003). Furthermore, Management Platforms such as IBM Tivoli or HPOpenView typically require complex customization to reflect specific characteristics and integration of 3rd party applications through proprietary interfaces (Mayerl, 2003). System Management is mainly being resolved on an application specific basis. General methodologies and approaches for the management of distributed applications (e.g. license and performance monitoring) and services are still at the development stage (Cox, 2005; Foster, 2004; Naik, 2004). Service Management will gain in importance compared to the management of resources and network elements as the need to provide customised services for users with specific requirements (e.g. specified in a Service Level Agreement) will further increase. To cope with these challenges, Management Systems can be composed of a range of components that perform the required Management Services (Knahl, 2004; Lewis, 2003). Uniform concepts for solutions are not yet available and existing approaches only touch upon certain aspects (Cox, 2005; Lewis, 2003).

The IETF management related standards focus largely on TCP/IP related management provision, the TMN family of standards focusing largely on telecommunications network and network element problems (Patel, 2002). The TMForum has provided guidance on how Management Systems could be planned and developed within their architectural frameworks (TMF-OM, 2000). A novel management system should reflect this and combine it with an appropriate planning and operation strategy to integrate management into the business processes (Knahl, 2004). Management instrumentation of existing resources is complicated and expensive. Therefore management requirements of resources and services must be incorporated in the development process taking the management aspects into account at the stage of resource and service development. This has to apply particularly for application development. Developers have to become more sensitive toward these management related problems. The development of Management Services must focus on user requirements and the development technologies should facilitate rather than dominate the planning and implementation stages.

# 3 PLANNING AND OPERATION APPROACH

The planning, running, maintenance and configuration of an IT infrastructure and services are embedded in the Business Processes of an organisation. The better the management tools integrate with Business Processes the more useful they are from the viewpoint of the IT service provider and hence, the higher the acceptance. Hence the overall aim is the integration of the Management Services with the Business Processes through the Management Framework as illustrated in Figure 1. The co-ordination of these activities requires support for defining and implementing task dependencies, business rules and data across the various domains of a given organisation. The Management Services provide the fundamental mechanisms for the management of the integrated IT services. The Management Services provide the required management functions and support protocols such as SNMP or CMIP to access the elements of the IT infrastructure. The User Services support the interaction with Management Actors. These services provide a role oriented view on the operational process and support the Management Actor to perform the required Management Tasks. The Cooperation Services provide the cooperation between the different systems involved in the

running of the business processes. The Management Framework interfaces must enable the integration, definition and customisation of Management Services utilising the Process Guidelines Repository, Service Level Agreements and Management Statistics that provides existing guidelines. An implementation of the proposed Management Framework has to support the lifecycles of a network (i.e. initial planning and design, implementation, operation, extension and modification of infrastructure and services).

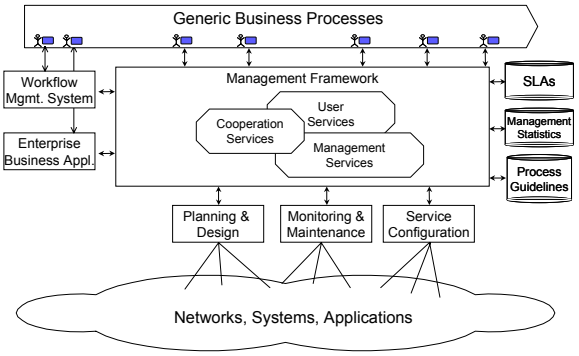


Figure 1: Process Integration.

The ISNMware planning and operation methodology consists of an initial model of a system based on the INSMware reference model followed by the addition of further implementation and process details during the design of a system. The methodology proposes an iterative development process and is based on INSMware Building Blocks (Knahl, 2004). Representing Building Block at an analysis level as well as at a design level enables Building Block reuse to become central to the analysis process and to relevant to the business process reengineering activity (Knahl, 2004).

# 4 SYSTEMS REALISATION

For the practical realisation of the INSMware model Software Components were used to implement Building Blocks (Knahl, 2004). A number of INSMware Building Blocks, such as those to provide error notifications are useful across different INSM environments (i.e. Horizontal Domain Common Building Blocks). Other INSMware Building Blocks (e.g. proprietary Configuration Management) are useful within a single or limited number of management environments (i.e. Vertical Domain Common Building Blocks).

Software reuse forms a basis to meet the challenges of developing software within cost and time constraints. One enabling technique is the reuse of commercial off the shelf Software Components developed by a third party. The INSMware Developer can further practise software reuse by reusing solutions to frequently occurring problems or by implementing standard management solutions popular with Management Service Providers. For the development and usage of Software Components different stakeholders have different roles and requirements (Knahl, 2004; Lewis, 2003). The Standard Provider develops standards to establish new technologies and as a response to requests from the other roles. The Service User requires standardised service management interfaces that enable it to move between INSM Service Providers easily and thus enabling competition. INSMware Developers and the Management Component Providers will further have an interest in using standards that promote software portability and integration (e.g. CORBA).

A prototypical implementation of the approach has been developed using a number of INSMware Software Components running on top of industry standard distribution architectures such as CORBA (Knahl, 2004). The design of the individual INSMware components is based on a domain specification that subdivides the entire application domain into sub domains and integrates SNMP Managed Objects.

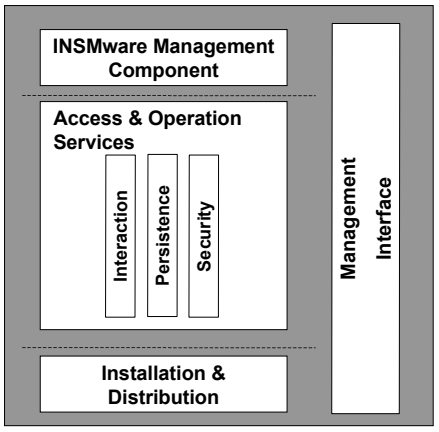


Figure 2: Distributed Management Entity.

Nodes that deploy Management Components must be instrumented with the appropriate execution environment. Management Systems consist of one or a set of management components that carry out management tasks of different levels of complexity

within the overall INSMware model. The services required for the distribution and communication (i.e. Installation and Distribution Services) are either provided by the middleware infrastructure or must be incorporated into the INSMware implementation (see Figure 2).

Based on this INSMware implementation several distribution scenarios have been realised and tested. In a basic configuration, all components are installed on one system. In this scenario, remote users connect to this system to receive all information. In the fully distributed configuration, all components are installed on different computers. However, in practical terms it is better to implement the Database, Communication and Event Manager component on one system. Using this distribution good performance is achieved as this distribution situation avoids heavy traffic through the network connecting the different computers (Knahl, 2004). Furthermore the performance requirements of the Management Interface could affect the performance of the overall system.

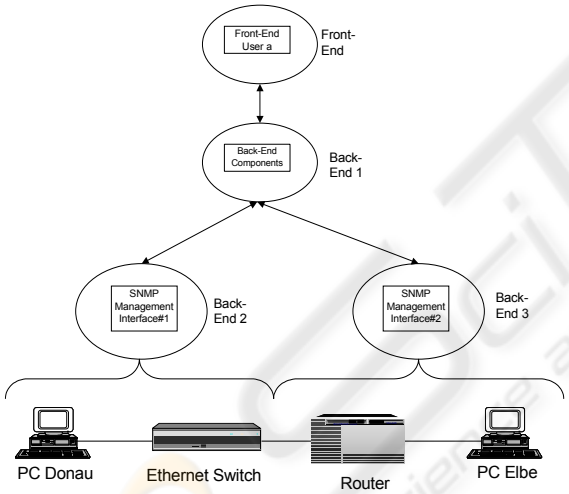


Figure 3: INSMware Monitoring of System States.

Figure 3 illustrates the implementation of a distributed INSMware environment to monitor the availability of an End-to-End connection. Two Management interfaces are being used to gather data from SNMP Managed Objects (for example the SNMP MIB II parameter 'SystemUpTime' can be used to gather general information about the time a system has been running). The data is received and analysed by the local Management Interfaces and then processed by the Back-End Components. Management Services can be modified with new component versions and additional Software Components can be linked to the core system and can migrate to other systems thus allowing the system to address new management requirements and network topologies.

# 5 CONCLUSIONS

The presented research provides a fundamental basis for the realisation of a new approach to Network and System Management. It has been illustrated that INSM development can benefit from a structured modelling approach and that Componentware based architectures for the provision of Management Services can offer a number of benefits. INSMware Components may be re-used and system solutions will become more modular and thereby easier to construct and maintain.

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