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Abstract

This paper reports research on the integration of Help Desk systems with the Simple Network Management Protocol (SNMP). The research develops an architectural framework for the deployment of SNMP protocols integrated with a help desk infrastructure.

The methodology involves case study evaluations and research towards the development of a SNMP network management application framework integrated with the Help Desk. This is accomplished in two parts: part one involves the identification of human roles and tasks (scenario analysis) followed by an interaction analysis of representative scenarios. Part two involves the investigation of the network management support tools currently used for Fault/Change management in telecommunication networks. This leads to the identifications of gaps in the support tools of existing systems. A case study methodology is adopted to analyse practical scenarios based on concepts, such as roles, interactions, artefacts and tools in a real application environment. Finally an integrated architectural framework for SNMP based Help Desk network management is proposed and analysed.

Keywords: SNMP, Help Desk, Network Management, troubleshooting.

1. Introduction

The initial motivation of this research was to design and analyse an architectural framework for Help Desk–based SNMP network management. The overriding question of this study was "how and why are SNMP-based network management systems integrated to the Help Desk?". The objective of this research was to develop a new support infrastructure for the management of SNMP-based networks. In this research, three organizations were studied using a "cross case analysis" methodology (Yin, 1994). The evaluation involved contextual interviews with experienced network managers. The research study follows Yin's multiple-case design as the intent of the research is to explore how and why organizations utilize their Help Desk for effective network management. This will allow for cross case analysis and improved research findings (Benbasat, et al, 1987).

The three organizations differed in that one was based in the telecommunications industry, one was a university and the last one was a commercial entity. All the organizations were similar in that they all used SNMP-based management systems to manage their networks. A variety of network management tools and human roles were involved in the management of the organization's networks. Each organization utilized the services of experienced in-house help desk teams. Due to space restrictions we will focus on the Telecommunications Company. The name of the company has been concealed to protect the organization's identity for confidentiality reasons. We will call it TML.

The methodology used consisted of several steps:

- Identification of human roles and tasks (scenario analysis) followed by an interaction analysis of representative scenarios
- Investigation of the network management support tools currently used for fault and change management
- Proposed support tools to fill the gaps in existing systems
- Develop an architectural framework incorporating recent advances in software engineering, Human-Computer Interaction (HCI), Computer-Supported Cooperative Work (CSCW), and communication protocols.

Yin's strategy of pattern matching is adopted to observe similarities and differences in the findings in order to develop a new framework. The structure of the paper is as follows: Section 2 presents the scenarios studied, section 3 presents and analyses the proposed

framework, and section 4 contains the conclusions of the study.

2. Process Study

This section detail some practical scenarios involved in network management of TML's help desk environment.

- **Scenario 1 - Problem diagnosis and resolution (Fault Management)**

In this case, the following interactions amongst various human roles can be noted:

1. Customers contact TML's Customer Services Center and report the problems
2. Operators at the Customer Services Center create an Electronic Trouble Ticket (ETT) and forward it to the Technical Assistance Group (TAG).
3. TAG group analyzes, tests and repairs the fault and notifies the Customer Services if the problem is resolved within stipulated time
4. If the problem is not resolved, it is referred to the external experts for resolution
5. External experts notify TAG group of problem resolution
6. TAG group notifies Customer Services Center of problem resolution
7. Customer Services Center notifies customers of problem resolution

- **Scenario 2 - Upgrade Problem (Change Management)**

This involves upgrading an existing wide area link to a higher version. For example, upgrading a wide area link on an existing 2Mbps link on a lower version Network Termination Unit (NTU), to a higher version NTU. The following list of interactions among various human roles can be noted:

1. Change initiator sends a service order to Network Systems Engineer
2. Systems Engineer discusses with a remote Test Coordinator about a suitable time
3. Systems Engineer places change request with proposed time and user impact statement to Change Manager
4. Change Manager takes up with the affected Users
5. Users discuss impact and examine proposed time
6. Users may resubmit request to Change Manager with possibly an altered schedule
7. Change Manager sends approval to all concerned
8. Help Desk Operator notified before start of change
9. Work coordination between local and remote sites
10. Testing the change with users
11. Change Initiator notified of completion
12. Help Desk Operator notified of completion

Existing tools and artifacts do not adequately support the majority of the interactions shown in the above figures. It can be noted that a number of interactions require cooperation of multiple human roles.

2.1 Analysis

The purpose of this section is to identify the gaps in the support for interactions in the existing systems. This analysis will contribute to the design of a CSCW-based framework for SNMP management integrated with the Help Desk.

- **Repositories (tools)**

Repositories are available in the form of:

- **1** - Management Information Base (MIB) in the Management Platform
- **2** - Customer Information Base in the Help Desk System
- **3** - Trouble-ticket History in the Help Desk System
- **4** - Electronic mail part of the Help Desk/other standalone system
- **5** - Network Record System (NRS) integrated to the management platform

The following repositories were needed as stated by the network management personnel at TML:

- **6** - Solution database implemented as part of Help Desk System
- **7** - Discussion database in the Help Desk
- **8** - Network news facilities via Internet Access
- **9** - WWW-based documentation via Internet Access

- **Group Communication Interfaces**

The following group communication situations can be seen in this network management workplace. Communication interfaces can be classified as:

- **1** - face-to-face meetings
- **2** - telephone
- **3** - mobile phone
- **4** - voice mail
- **5** - asynchronous email
- **6** - fax
- **7** - pagers
- **8** - network management problem meetings
- **9** - letters, handwritten notes

The following group communication interfaces were also suggested:

- **10** - Desktop Conferencing
- **11** - Video Conferencing
- **12** - Group Decision Support Systems
- **13** - Shared Whiteboard tools
- **14** - WWW based user interfaces

2.2 Interaction Analysis

This section analyses the interactions of the human roles involved in the two scenarios described above, with a view of identifying gaps in collaborative services in the existing systems. The study provides an analysis of direct feed back received from practicing network management professionals on the utilization of various collaborative tools in this environment. Tables 1 and 2 presents this information for the interactions (column 1 in each table) described in the Process Study section.

While 2, 3, 4 and 5 communication devices represent the most common group communication situations; these have a number of limitations such as visual cues for collaboration/annotation using other artefacts. Therefore, user recommendations on future group communication support mobile and multimedia conferencing technologies. Users also suggest a number of new collaborative tools for management situations. Many of these tools would consist of specialised repositories with automatic learning capabilities (for example, knowledge bases).

The analysis of the three case studies revealed that the existing integrated management frameworks are not capable of handling such a wide range of dynamic management requirements involving people, data, software and hardware. In answering the broad question of integration we can present three specific research questions as they apply to the TML case:

Question 1: How is the organization's help desk currently integrated to SNMP management?

The Help Desk staff is equipped with a number of tools including an automated trouble ticketing system (IBM3270). The faults reported in the regular monitoring of the network by the NOC are also logged into this system. Help Desk staff is responsible for tracking the problem until resolution. However, there is no facility in the system to automatically generate task orders and send them to corresponding support groups within TML.

The NRS integrated with OEMF provides efficient alarm correlation and event management services of the TML network. This integration allows the isolation of faults with minimal human intervention. NRS provides a graphical representation of the devices on the network. However, the information held by NRS is not available in a format that the Help Desk personnel can understand.

The OEMF platform performs configuration, event and fault management at TML. It's been integrated to a Transport Alarm Management System (TAMS) to view alarms from the network. This integration allows TML support groups to find the root cause of a problem with minimal human intervention. However, these network alarms are manually escalated to the TML support group.

The TML Help Desk uses various group communication interfaces to communicate with different groups of people. The organization under study is a telecom provider and hence allows free use of mobile phones and pagers to all its network management personnel. However, most of the interactions are supported by the old typical telephone system, asynchronous email and voice mail. As in the previous case, most of the fault management tasks at TML, including creating and allocating trouble tickets through dispatching a technician are manually performed by the Help Desk staff members. The Help Desk is not fully automated to handle complex network problems and to coordinate human interactions.

Question 2: Why is it necessary to integrate the organizations' help desk to SNMP management?

In this case, a lot of efforts have been taken to develop an integrated network management environment. However the following drawbacks can be noticed in these efforts:

- Fault management has short time frames (solutions are expected quickly) and needs better techniques to locate and communicate with busy people, such as experts on the move.
- Most of the existing communication tools are equipped for person-person communication, group communication techniques need to be integrated with the system because many network management functions require a number of people to be contacted repeatedly. Network service problems are often caused by failure to inform the right people at the right time.
- Some tasks are routine and have well-developed procedure tools, while other interactions among human roles are manual and evolve with the situation.
- Network management uses a variety of repositories, such as customer information base, trouble-ticket history, solutions knowledge base etc. Management platforms, groupware systems, and help desk systems should support these repositories.
- Existing systems do not have adequate learning capabilities to solve problems in many novel situations.

Question 3: What enhancements can be proposed to the organization's existing Help Desk?

The varied organizational backgrounds presented an opportunity to review any deficiencies that may exist in the integration processes for network management. By comparing the three case studies it can be seen that deficiencies exist in the following areas:

- Lack of support for interoperability of multi-vendor management applications
- Inadequate group communication techniques
- Lack of information available to the help desk personnel
- Inadequate learning capabilities provided as part of Help Desk systems
- Lack of coordination among support group members
- Inadequate automation for problem escalation
- Customer information bases, problem history logs, and solutions knowledge bases are not integrated to the organizations help desks and management platforms.
- Inadequate documentation of the actual work process flow
- Lack of automated procedures for configuration management
- Lack of human knowledge and expertise
- Lack of automated processes for event filtering and alarm correlation
- Lack of understanding about information assimilated in alarms and alerts

The network planners in all three cases expressed the importance of the integration of the Help Desk with SNMP management, especially in the TML case study. Therefore, a new management framework needs to be proposed with the following broad features: interoperability, support for a wide variety of group communication mechanisms, groupware facilities, management of alarms and alerts, knowledge base, change management database, and coordination of tasks.

3. Proposed Framework

The framework consists of the following major blocks:

- ***Integrated Management Platform***
- ***Real-time computing functions***
- ***Help Desk Facilities***
- ***Repositories***
- ***Application Programming Interfaces (APIs)***
- ***Group Communication Interfaces***
- ***Distributed Object Model***
- ***SNMP Management***
- ***Network Management System***

Figure 1 shows an overview of the proposed framework incorporating the above major blocks.

3.1 Analysis of the Proposed Framework

The proposed Help Desk based management architecture provides the following characteristics and requirements over traditional network management architectures.

- **Flexibility**

An integrated management platform incorporating standard object models such as CORBA provides flexibility through its Object Request Broker (ORB). The ORB provides interoperability of multi-vendor objects in heterogeneous distributed environments (OMG, 1999).

- **Completeness**

The framework exhibits completeness by encompassing all the different objects and interactions involved in enterprise networks. All the different object models are supported by CORBA. The interactions such as queries, alarms, alerts, events and SNMP traps are also supported by the integrated management platform. Human interactions are supported by incorporating groupware and multimedia technologies into the framework.

- **Management Standards**

The proposed framework relates to management standards such as OSI (at the conceptual level), Internet and web-based technologies. The CORBA-based integrated management platform enables the incorporation of these standards to SNMP management through APIs.

- **Integration**

Integration is facilitated at multiple levels in this framework. Some of these levels are integration at the Menu Bar level, Help Display Option level, MIB level, database usage level and SNMP API level. Alarm and alert management systems are integrated at the integrated platform level. Support for mobile and multimedia computing functions are integrated to the framework through APIs. The integration of the Help Desk to the management platform is performed by incorporating a CSCW layer, a knowledge base, groupware facilities and APIs to convert information associated with alarms/alerts.

- **Efficiency**

The proposed framework enhances efficiency in the network by providing intelligent filtering in multiple steps. This facility is essential in order to deal with

network "storms" (rapid escalation of cascading failures). The key to the detection of such storms is event correlation (Yemini, 1993) and that's the main task of intelligent filtering. The filtering of alarms is facilitated through the transaction alarm management system integrated to the management platform. This system provides filtering of alarms from different element managers. The integration of knowledge bases to network management and its deployment throughout the organization increases the productivity of management personnel.

- **Scalability**

The proposed framework scale up to meet the growing needs to incorporate management platforms and management applications. The platform architecture provides facilities to delegate and distribute management functions in order to deal with the growth in the number of managed devices on the network.

- **Robustness, reliability and availability**

The proposed framework could have high standards of robustness, reliability and availability enabling fault detection, correction, diagnosis and adequate alarm correlation. The integration of the Help Desk to the management platform provides easy access to management information and facilitates alarm correlation and diagnostic management functions.

4. Conclusions

SNMP has many weaknesses in the areas of manager-to-manager communications, remote troubleshooting, security, accounting and configuration management (Yemini, 1994). Let us check how the proposed framework can enhance the performance on those areas:

- **Manager-to-manager communication**

SNMP management has not adequately addressed the collection function of SNMP MIB data and trap filtering to remote management systems or collection stations. The proposed architecture allows manager-to-manager communication through a CORBA-based architecture. The management platform has the capability to delegate and distribute management functions across a network.

- **Configuration management**

The proposed framework can overcome some limitations of SNMP by supporting real-time configuration changes to network and system elements. The integration of a change management database at the platform level improves the performance of help-desk based SNMP management over the original SNMP-based management. This integration enables automation and simplification of remote configuration for all kinds of devices on a network.

- **Fault management**

The proposed framework allows remote troubleshooting, which is not adequately addressed by SNMP management, Additionally, Help Desk staff is able to access management information from any workstation through user interfaces or web-based interfaces provided through Help Desk systems. One of the key advantages of this approach is that the responsibility of problem resolution is passed on to the Help Desk personnel, where it can be dealt with properly.

- **Data repository interface and data modeling**

The proposed framework allows data repository interfaces through web-enabled user interfaces or APIs implemented as part of Help Desk systems. Data modeling capabilities can also be integrated at this level. SNMP management doesn't allow this capability through interfaces.

The proposed Help Desk-based SNMP management framework provides the following major advantages:

- Location independent solution for network management
- Provides easy access to network information through APIs or Web-enabled user interfaces.
- Provides better interoperability by incorporating open standards and technologies
- Reduces the utilization of experts in network management
- Provides customized and uniform presentation of network information
- Improves better utilization of resources within network management environments

In summary this research highlights the need of an integrated management platform, the need of distributed data repositories, and the need to facilitate group communication among multiple human roles involved in the network management environments of organisations.

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	Tool	Group Communication Interfaces	User Recommendations	
			Group Comm	Remarks
1	None	2, 3, 4, 5, 6	5, 14	-
2	4	5	11, 14	Automatic trouble report allocation and escalation
3	2, 3	2, 3, 4, 5, 7	10, 11	Tool needed for group communication
4	4	2, 3, 4, 5, 6, 7	10, 11, 12, 13, 14	Tool needed for group communication
5	None	2, 3, 4, 5, 6, 7, 8, 9	10, 11, 12, 13, 14	Tools needed to access remote knowledge base, and group communication

Table 1 - Interactions in Scenario 1

	Tool	Group Communication Interfaces	User Recommendations	
			Group Comm	Remarks
1	5	5	10, 14	Automatic means of processing change
2	None	2, 3, 4, 5, 6, 7, 8, 9	10, 11, 12, 13, 14	Tool needed for group communication
3	None	4, 5, 6, 9	14	Automatic change impact notification
4	None	2, 3, 4, 5, 6, 9	11	Automatic change impact notification
5	None	2, 3, 4, 5, 6	11	Automatic Change impact notification
6	None	4, 5, 6	11	Automatic Change Impact notification
7	None	4, 5, 6	4, 5, 6	No Acknowledgement from users
8	4	5	5	Automatic means of informing change initiation
9	5	2, 3, 4, 5, 7	11	Tool needed for group communication
10	None	2, 3, 4, 5, 6, 9	14	Automatic means of informing change completion
11	4	2, 3, 5, 6, 9	5	-
12	None	2, 3, 4, 5, 6, 9	5	Automatic means of informing change completion

Table 2 - Interactions in Scenario 2

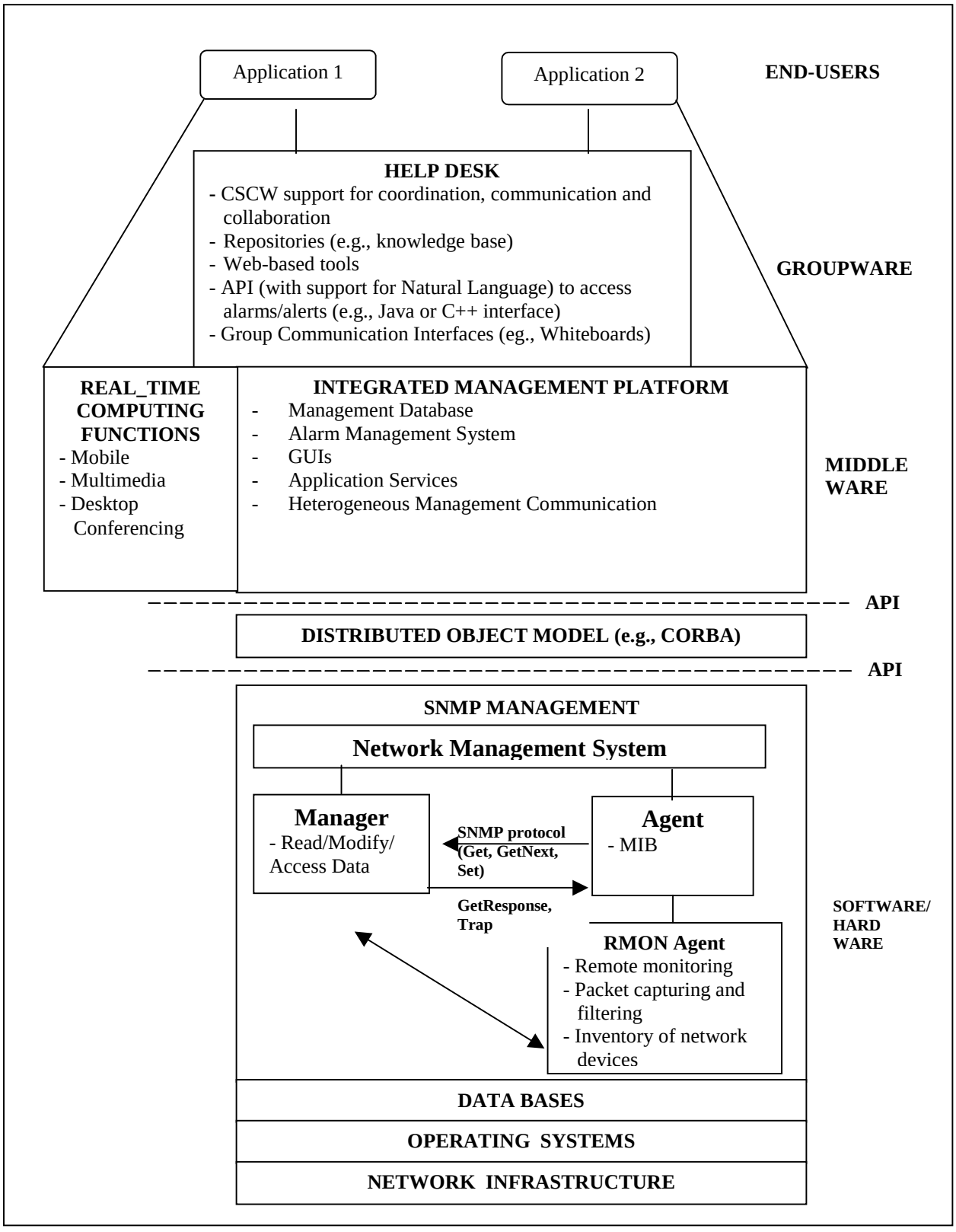

Figure 1 - Proposed Framework