

A SURVEY OF NETWORK FAULT MANAGEMENT

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Abstract

The communication and sharing of information is a fundamental need to computer users. The number of users who have needed to communicate with others has rapidly increased. Over the last decade, the network domains have become very complex structures. Hence, many faults may occur, which cause them to operate outside their required quality of service. The use of management techniques is required to handle the complexity of computer networks in order to detect and control the behaviour of system resources. Currently, the management systems run on a central station (client-server), where data needs to be transferred from the client to the server and vice versa. This may lead to inefficiency if the network is very large in scale. The use of Mobile Agents (MA) is a new technology based on mobile code that can migrate from one node to another in order to collect, analyse and make decisions locally or remotely on behalf of a centralized network management station.

Keywords

Fault Management, Mobile Agents, SNMP, RMON, MIB

1. Introduction

The growth of the Internet in the last decade gives an indication of the growth of computer networks. More than 500 million users use the Internet and the figures are growing at the rate of one million new users a month[1]. The market is full of large numbers of network components with varying capabilities in software and hardware. As computer networks grow in size, heterogeneity and complexity, the management of those components becomes more sophisticated. Currently, network management systems are based on the client-server centralized paradigm, where a server collects and analyses the retrieved data from the network elements. The collected data is stored in a standard structure, such as a Management Information Base (MIB) Objects Tree in Simple Network Management Protocol (SNMP).

There is an agent in each network element that collects and sends management data as a response to the manager request. However, these operations reasonably require transferring large amounts of management data between the manager and the managing. This large amount of data not only needs a suitable bandwidth but can also cause a bottleneck at the manager station. The distribution of the management system can be used to overcome the limitations of the Client-server architecture. There are several solutions, such as: Remote Monitoring (RMON), Management by Delegation (MbD) and the use of Mobile Agent (MA) technology.

The MA is a persistent agent which is typically limited in size and which, most importantly, is able to migrate. That is to suspend its execution, move to another location and continue execution there[2]. MA can be used to improve the manager workload and reduce the bandwidth usage, by giving the MA some authority to take some decisions on behalf of the manager. It is more flexible, can visit all the network elements, perform tasks locally and, as a result, only the important information returns to the manager node. By moving the intelligent code to the nodes where the data is resident, many of the management decisions could be taken locally, thus avoiding the transferring of large amounts of data from the remote nodes to the central management [3]. Furthermore, Artificial Intelligence (AI) techniques have been successfully applied in the area of fault management. However, these systems are not flexible enough for today's evolving network needs.

The primary goal of this paper is to clearly define the fault management problems, explore issues related to those problems and review existing approaches that have been addressed in network fault management and as well as the future of the fault management methods.

This paper will briefly describe the main areas of network fault management followed by an introduction into traditional systems of network management. Also new approaches to fault management are explored.

2. Network Fault Management

A modern computer network is not just a group of computers that are connected together, But also it must meet the users' and the administrators' requirements. Combining different institutions and organizations makes the networks more complex; this growing complexity creates a high demand for network management services. Previously, the performance issues for networks had been addressed by increasing the bandwidth. However, this approach cannot be efficiently maintained in the growth of the complexity and heterogeneity of today's networks.

Fundamentally, network management is a service that employs a range of tools and applications to identify existing and potential loss of service, as well as help the managers in monitoring and maintaining the network. Fault management tools can help to increase the reliability of the network by identifying the fault and then help initiate the recovery process to over come these faults. For example, when an alarm from a node is detected, a technician should be dispatched to locate and resolve the fault at the node location. However, by using more advanced tools, the network manager would be able to go many steps further to isolate and correct a software fault from the manager location. Consequently, the manager can return the network to normal status in a short time with minimal effort. Kelley.D [4] defines most end users' concerns as: *“Network management components perform specific tasks to monitor and manage the security, health, and availability of various aspects of the network.”*

Fault management is the process of locating, analysing, fixing and reporting network problems such as collisions, bad packets and other larger problems, which in turn makes the network more efficient and productive. Fault management can save repair costs during detect, isolate and faults correction. It provides more detail by identifying a problem, collecting some data about the current state of the network through the management protocols. Then the manager station can apply first aid to re-establish any services that have been lost. This can be accomplished by deciding if the fault could be managed or isolated and finally corrected reporting the fault. These are the steps of reactive fault management Moreover; proactive fault management can be prepared for potential faults that might occur in the future improving the network uptime.

3. Traditional System of Network Management

Current network management systems adopt a centralized paradigm to manage the network domain, it has three main components:

- ✓ Network Manager Station (NMS),
- ✓ Network Element
- ✓ Management Protocol (as shown in figure1).

The management information is stored in the MIB, each device has its own MIB, the manger station can obtain this information by using the management protocols, for example SNMP, afterwards, it can apply its functions probe the network status in order to give clear reports or statistical graphs.

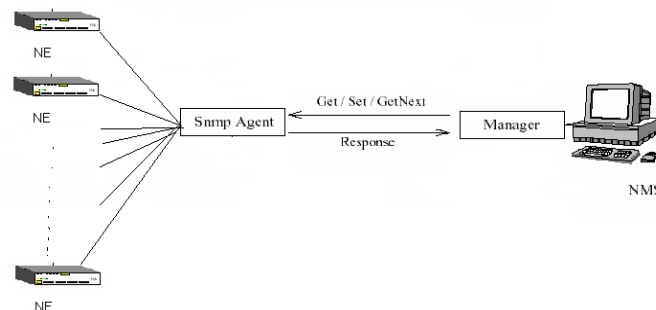


Figure 1 Traditional System of Network Management

But, the centralization paradigm is suitable for the applications with a limited need for distributed control. Fault management includes discovery, isolation and fixing the problems that develop in the network area, tracing faults, given many alarms in the system, and using error logs via the log reports. However, it is not accurate enough and it is also more generic[5]. The efficiency of fault management is crucial to guarantee

the recovery of errors/faults that may occur during the network life cycle. In previous research [6-12] in Network Fault Management (NFM), the scalability limitations of centralised Network Management (NM) is addressed and it becomes significantly more pronounced when transfers of bulk network monitoring data is considered. Moreover, they have covered approaches in areas of fault management such as: expert systems, finite state machines (FSMs), advanced database techniques and probabilistic approaches.

Expert systems have been successfully applied to some types of fault management, now a well-developed technology. However, these systems are not flexible enough for today's evolving network needs, in addition, expert systems have some weak points such as; brittle in unforeseen situations, unable to learn from experience, hard to maintain (adding/deleting/modifying rules), knowledge acquisition bottleneck and finally cannot handle incomplete or probabilistic data. Consequently, a hybrid AI solution was proposed, which employs both neural networks and case-based reasoning techniques for the fault management of heterogeneous distributed information networks. Additionally, an intelligent and distributed fault management system is presented for communication networks using belief networks as a fault model and inference engine. To illustrate this point, the managed network is divided into domains and for each domain there is an intelligent agent, called a domain diagnostic agent, attached to it which is responsible for this domain's fault management. Belief network models are embedded in such an agent and symptoms observed, the probabilities of each candidate fault node being faulty are computed.

In addition, the use of a Bayesian network is proposed as a mechanism to combine information from different variables, for the purpose of detecting anomalies. Furthermore, it is possible to use an adaptive learning machine to detect network faults without using models of specific faults. The use of the Bayesian network approach is able to accomplish early detection by recognizing deviations from normal behaviour in each piece of the information in a probabilistic framework.

4. New Approaches to Fault Management

Recently, the use of MA technologies to automate the fault management functionality in Network Management has been taken into consideration. The MA has the ability to migrate from one node to another, in order to read some information from the network. Then the MA can start to investigate to determine the current state of the network, the intelligent and portable capability can help the MA to perform the latter tasks and send acknowledgement to the manager node for the purpose of archiving. MA technology can offer a new paradigm for communications over heterogeneous network channels. A number of advantages of using MA computing paradigms have been proposed and identified. These advantages include: overcoming network latency, reducing network load, executing asynchronously and autonomously, adapting dynamically, operating in heterogeneous environments, and having robust and fault-tolerant behaviour[13].

Potentially, MAs provide better efficiency for the whole system. A client program migrates to a server node, directly communicates with a server programme, and returns to an original node with a result. In that approach, the number of remote interactions and the amount of data communicated over the network is reduced; consequently, the network traffic is reduced. Furthermore, better reliability is achieved, because the connection between nodes need not be established constantly.

5. Research Direction

This research covers two main areas; reactive and proactive fault management. At the reactive side, the research will focus on fault detection, diagnosis, isolation, recovery, reporting and repairing faults within the network. As well as, creating an agent model, each agent will monitor local environments, and also sense conditions within a domain. The elements that are monitored can range from simple monitoring, such as local Central Processing Unit (CPU) loading, to complex service provision monitoring, such as E-mail or World Wide Web (WWW). The monitoring of the conditions will map to the faults that can occur within the domain. Along with this, an IT professional will be interviewed to determine the major sources of faults within large and complex domains. Furthermore, at the proactive fault management side. The results that have been collected from the monitoring process will be analysed by the manager node. By using some of the AI techniques like; fuzzy logic with genetic algorithm, the manager node can predict the situation of the domain in future.

6. Summary

Network management systems that use traditional management paradigms (Client-server) have some problems in efficiency and flexibility, since data management needs to be transferred from the agent nodes to the manager and vice versa. This may lead to inefficiency if the network is very complex. However, using MA is a new technology based on mobile code that can travel around, collect, analyse, and make decisions locally or remotely on behalf of the manager station. Only high-level information will need to be transferred to central management nodes. To summarize, we believe that MA could provide a new range of opportunities in the future to enhance the network management systems responsibilities. However, further research is still required to ascertain an acceptable utilization of MA technology in the network management area.

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