Improving Management Performance by Using Multiple Mobile Agents

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1. INTRODUCTION

Most network management systems use SNMP (Simple Network Management Protocol) [3] and CMIP (Common Management Information Protocol) [4] protocols, which are based on a centralized paradigm. These protocols use the client-server model, on which the management station acts as a client that provides a user interface to the network manager and interacts with agents, which are servers that manage remote access to the Management Information Base (MIB). The operations available to the management station for obtaining access to the MIB are very low level. This fine grained client-server interaction, called micro-management, generates an intense traffic that overloads the management station, resulting in scalability problems. At the same time that the networks grow, the computational power of the managed element increases, making possible to perform management functions in a distributed way.

In this sense, mobile agent is an option to distribute and scale the network management. These agents move to the place where data are stored and select information the user wants by using intelligence; saving bandwidth, time, and money. They decentralize processing and control, and, as a consequence, reduce the traffic around the management station, turn asynchronous the communication between the agent and the manager, distribute processing load, and increase the flexibility of the management agents' behavior.

In this paper, we assess the performance improvement obtained by using multiple mobile agents. The network is partitioned into domains and one mobile agent is assigned to each domain. Transit-stub topologies, which are similar in shape to the Internet ones, are used in the simulations. Response time results show that the management performance increases when using multiple mobile agents.

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2. NETWORK MANAGEMENT USING MOBILE AGENTS

Mobile agents perform their tasks in different network computers. A mobile agent can migrate from a machine to another, carrying data about its state that include information obtained from previous task executions. As the number of visited nodes grows, the mobile agent size also increases, turning migration harder. One possible solution to this problem is to visit a fixed number of nodes, return to the agent home or send all data to it (reducing the mobile agent size), and start the task again on the remaining nodes [2]. Another solution is to use multiple mobile agents to manage a partitioned network (Section 3). The initial size of a mobile agent also affects agent performance since the larger the size, the more difficult the migration. This size depends on the task to be carried out and on the language used to implement it.

In the SNMP, network management does not scale when the size or the complexity of the network increases because of the centralized processing and control. Mobile agents can be used in order to solve this problem and it is important to investigate when they improve the management efficiency.

2.1 Simulation Model

The applicability of mobile agents in carrying out network management tasks is assessed by simulation studies. The Network Simulator (NS) is used [1]. This discrete-event simulator provides implemented protocols and mechanisms to simulate networks with node and link abstractions.

All simulations use transit-stub topologies, which are similar in shape to the Internet. The GT-ITM [5] generates random topologies, on which each node represents switches or routers and edges represent forwarding paths between switches (Figure 1). Each routing domain in the Internet can be classified as either a stub domain or a transit domain. A domain is a stub domain if the path connecting any two nodes u and v goes through that domain only if either u or v is in that domain. Transit domains do not have this restriction. The purpose of transit domains is to interconnect stub domains efficiently.

We consider that the management station belongs to a node of a stub domain and managed network elements are located in other stub domains (Figure 1). Three different 272-node topologies are used. The management station controls groups of 16 network elements, which is the number of nodes of a stub domain.

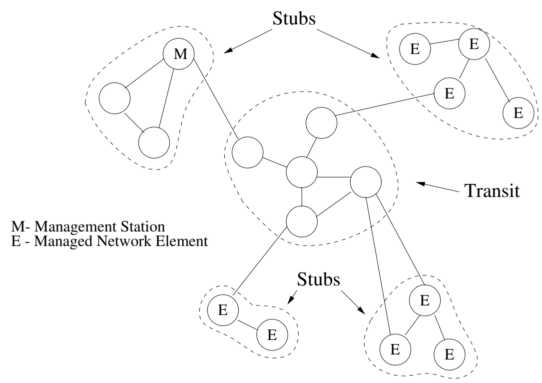

Figure 1: Network management on a transit-stub topology.

The simulation model assumes that links and nodes have no load, links are error-free, and processing time in application layer is not taken into account. UDP is used in all simulations and UDP and IP headers are considered. The Maximum Transmission Unit (MTU) used for all links is 1500 bytes, therefore, there is no fragmentation of SNMP messages. Every request or response of a variable is sent on a different message.
SNMP sends requests to all elements to be managed (one after receiving the response from the other); the mobile agent goes to an element to be managed, gathers the variable, and visits all other elements, from a stub domain to another. After finishing, the mobile agent returns to the management station.

3. SIMULATION RESULTS

The mobile agent size increases with the number of visited nodes, and, as a consequence, the migration becomes difficult. In order to improve the management performance, we divide the network into domains and assign one mobile agent to each domain. The number of mobile agents used in the simulations is 1, 2, 4, and 8. In order to also analyze the effect of the task on the management performance, tasks t_1 and t_2 are associated with a 50 and a 150-byte-long variable.

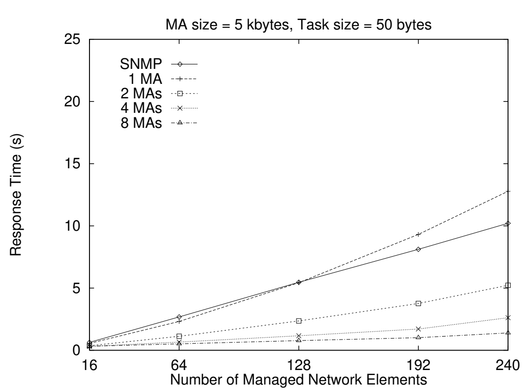

Figure 2: Response time per number of mobile agents for T = 50 bytes.

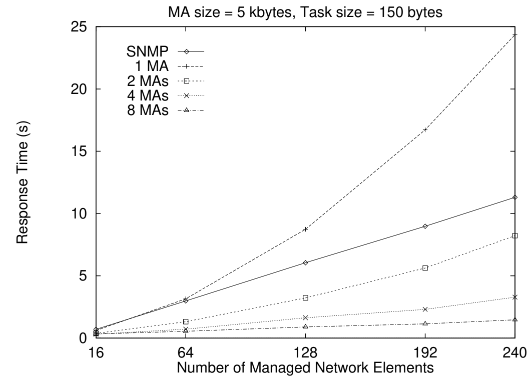

Figure 3: Response time per number of mobile agents for T = 150 bytes.

For the SNMP, the task does not have a great influence due to the fact that the number of bytes exchanged between the management station and the managed network elements is small; but for the mobile agents, as the number of bytes exchanged increases, the response time also grows since the mobile agents will move with higher difficulty (Figures 2 and 3). Also for the mobile agents, as the number of managed network elements increases, the performance difference among response times for the different number of mobile agents increases faster. For example, when T = 50 bytes (Figure 2) and the number of managed network elements doubles from 64 to 128, the response time for 1 and 8 mobile agents goes from 2.3209 to 5.43483 s, and from 0.518067 to 0.778 s, respectively.

4. CONCLUSION

Response time results show that the management performance increases when we use multiple mobile agents. For an initial size of a mobile agent equal to 5 kbytes and a 50-byte-long task, response times for gathering 240 variables decrease by 59, 80, and 90%, for 2, 4, and 8 mobile agents, when comparing with using one mobile agent.
Network management using mobile agents seems to be a good approach and the use of multiple mobile agents enhances the management performance.

5. REFERENCES

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