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Cairo University
Faculty of Computers and Information
Information Technology Department

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**Enhancing Mobile Agents Performance in Distributed Systems
Environment**

**A Dissertation Submitted in Partial Satisfaction in the
Requirements for the Degree of Doctor of Philosophy
In Information Technology**

By
Yasser Kamal Ali Abo mandour

Under the Supervision of
Prof. Dr. Sanaa El Ola Hanafi Ahmed
Vice Dean for Education and Students Affairs

A.Prof.Dr. Hesham N. Elmahdy
Information Technology Department

Cairo 2008



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By
Yasser Kamal Ali Abo mandour

Examiners

Prof. Dr. Abd ELbadee Mohamed Salem

Prof.Dr. Sanna ELola Hanafi Ahmed

Prof.Dr. Imane Aly Saroit Ismail

Dr. Hesham Nabih ELmahdy

Signature

P. Salem

Sanna ELola

Imane Aly

Hesham

Abstract

Mobile agents are groups of executing objects that can migrate from node to node in a heterogeneous network. Mobile agent systems offer advantages such as better performance, lower usage of network bandwidth, and asynchronous processing. The migration of agents comprises the transport of data, code, and execution state from one node to another. In large scale communication, agents have to be generated frequently and dispatched to the network, thus they will certainly consume a certain amount of bandwidth of each link in the network. If there are a lot of agents' migrations through one or several links at the same time, they will introduce much transferring overheads to the links. Eventually, these links will be busy and indirectly block the network traffic. Therefore, there is a need to develop routing algorithms in order to control the traffic load

In this thesis, first we proposed mobile agent-based routing algorithm (MARA), we investigated how agents should behave if they have to set their decisions on possibly known traffic information. We presented agents migration processes based on decision tree on known traffic information. We compared performance evaluation of proposed mobile agent based routing algorithm (MARA) with existing solution (e.g. Open Shortest Path First (OSPF) routing algorithm). Experimental results were applied based on three cases, case one, when all nodes send a fixed numbers of agents to a certain node in a network. Case two, when running a fixed numbers of agents on a varying numbers of nodes, and Case three when running a varying numbers of agents on a fixed numbers of nodes.

The simulation results showed that our purposed solution (MARA) achieve performance in dynamic network better than existing solution (OSPF).

The second contribution in this thesis was presented to solve the problem of individual agents working in isolation. The contribution is done by finding the optimization of mobile agent collaboration effect. We used Reinforcement learning algorithm to change

mobile agent from random effect to organized effect. Our experiments tested three different approaches covering the movement of agents. First we implemented "random" agents, which simply move to a random adjacent node every update. Second we implemented "Organized" agents, which are more sophisticated, choosing at each time step to move to an adjacent node that they have never visited or have visited least recently. The third types of agents, "smart" agents, also move to the nodes that have not been visited before, but they use both their own experience and learned data from their peers in deciding which nodes to move to.

We developed simulation models based on planned implementing a discrete event scheduler,. In order to compare results across population sizes and algorithms, we chose a single connected network consisting of 145 nodes with 1850 edges. The simulation results shows that when two random agents interacting and learning from each other do almost twice as well as one alone. And while two organized agents working together are better than two random agents by more than six-fold, when the population size increases to 100 agents the organized agents finish 32% more quickly than the random agents. And 10 smart agents map the graph in 245 time steps on average, while ten organized agents take 271 time steps to finish.

Finally, interoperability optimization was produced; we introduced a framework for mobile agent integrated with web services. It can be considered as a Gateway, it is matter of fact a web application running within some servlet container. From the other point of view it is possible to consider the Gateway as a whole servlet container. It serves as an execution environment for Gateway Agents. The Gateway Agent does the actual transition from an agent service to a web service for the concrete Target Agent. We presented a Mobile agent annotated with metadata to describe services, and agent life-time is bounded to a service request.

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