Performance Evaluation of Mobile Agents by Applying its Newfound Measures

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Abstract— Agent oriented technology is a strong way of approaching large-scale commercial problems of software industry. This technology has exciting features like social ability, reactivity, autonomy, intelligence, proactivity and mobility. Mobility can be defined by the agent's ability to migrate autonomously from one environment to other to compute on behalf of user. Mobile agent is an agent that can move in a communication network. These agents must be too smart in order to act efficiently. Network management and network load balancing are its major applications. Mobile agents are cooperative, autonomous and interactive. These complex systems require a lot of analysis for their good performance. Some relevant measures may help in evaluating the performance. The objective of this paper is to assess the performance of mobile agents with a set of proposed measure that may check each aspect of mobile agent's complexity and its quality.

Key words: Mobile Agent, Mobility, Performance Measures

I. INTRODUCTION

Agent technology represents one of the most consistent approaches to distributed software development. And although there is no generally agreed upon definition of the term, software agents can be described as executable software entities with various degrees of intelligence, that act autonomously in order to reach their design objectives. Agents live in an environment which enables them to execute their tasks. These environments, called multi-agent systems (MAS), control the agent lifecycle, incorporate security mechanisms that protect both the agent and the environment itself, provide the inter-agent communication infrastructure, and so on. An important feature of some software agents is mobility which means movement of agent into network. Mobility can be achieved through the help of mobile agents. We have various techniques for information retrieval in internet community; one of them is with the help of mobile agent. Metrics measures are used to enhance and test the quality of the agents. In this paper we present two measure at design level and two at working level, after presenting proposed metrics measures we analyze their effect on system performance and complexity. The aim of our attempt for defining metrics is basically to analyze and compare aspects of complexity of mobile agent systems.

The outline of this paper is as follows: section 2 describes mobile agent in brief which includes characteristics and application of mobile agent, then Section 3 gives the definition of proposed measures. Section 4 identifies the effect of measures with subject to performance and complexity of mobile agent system. Finally a short conclusion is reached in Section 5 by presenting lessons learned and future work.

II. MOBILE AGENT

Mobile agents are programs being sent across the network from client to server and server to client. They can move within network and act on behalf of user or another entity to perform asynchronous interaction [1]. Mobile agents communicate with other agents, with users and with the hosts in the network, merely results are returned to the user. They can implement specific network protocols for communication and offer an alternative to save network bandwidth. MA helps in network traffic reduction and load balancing. Some design and implementation issues must be kept in mind like security, reliability, secrecy, privacy, stability, and resource management, and communication language, control of mobile agents, transfer mechanisms and performance. Mobile Agent paradigm proposes bringing the requesting client closer to the source to reduce traffic. These complex systems require lot of analysis for keeping up the good performance. With regard to mobility research issues, two kinds of code mobility are to be outlined. The former one is called strong mobility and requires that the code, the data state and the execution state of the moving active entity are transferred. The later one is called weak mobility, and in this case only the code and the data state are transferred. Mobile agents are implementing using platform independent language like java. Mobile agent systems are generally computer and network independent, they support transparent operation.

A. Characteristics of Mobile Agent

Mobile agents have different kinds of characteristics [2, 3]. They should be:

- Autonomous: an agent is able to take initiative and exercise a non-trivial degree of control over its own actions.
- Interactive: it should communicate with other agents and their environment. In addition, mobility is the most important property in the Mobile agent concept, where agent migrated from one node to another within the same environment or in different environment
- Coordinative: performing data transfer with other agents in a given environment.
- Proxy: Mobile agents may act on behalf of someone, so they should have certain degree of autonomy.
- Ragged: Mobile agents should have the ability to deal with the errors whenever occurred.
- Proactive: means they should be goal oriented.
- Cooperative: means coordinate with other agents to achieve a common goal. Mobile agents should have the capability of learning the current environment and modify its behaviour based on this information.

- Intelligent: means Mobile Agent should be too smart in order to act efficiently.

B. Applications of Mobile Agents

- Electronic Commerce i.e. buying and selling online
- Service customization and user localization in wireless networks
- Follows its user who is moving from cell to cell
- Network management
- Network load balancing
- Distributed simulation

III. MEASURES FOR MOBILE AGENTS

In this section number of parameters associated with the performance of mobile agents is mentioned. These parameters are directly or indirectly associated with performance of mobile agent. These parameters are identified from the general architecture, working and implementation of mobile agents. Existing measure which influence the performance of mobile agent are Static Message Size, Average Message Size, Communication Setup Time, Agent Life Spam, Agent Executable Size, Knowledge Update and Usage [4].

A. Proposed Measures of Mobile agents

1) Number of Mobile Agent (NMA)

A multi agent system may have more than one mobile agent that is able to move itself in environment and other environments by preserving its internal states. To achieve a central goal of a multi agent system many sub goals are required, for this reason the system may require more than one mobile agent.

This measure may be defined as the total number of Mobile Agents created in a multi agent system. This measure indicates how large a mobile agent system is.

NMA = Total Number of Mobile Agent Created (1)

Where, NMA is the total number of mobile agents.

2) Clone Life Time(CLT)

If a system has some kind of security issues then cloning of mobile agents will help in decreasing related risks, by not moving the mobile agent itself and move its clone everywhere outside the system, here clone will execute and transit in network. More than one clone may be created. This measure will help in measuring mobile agent lifespan with cloning.

CLT can be defined as the total time taken by a clone after initiation, visiting locations, transition and reporting followed by termination.

$$CLT = t_v + t_t + t_r \quad (2)$$

Where, t_v is time consumed in visiting location

t_t is the time utilized in transition and

t_r is the time required in reporting back.

3) Mobile Agent Size(MAS)

Mobile agents are programs that run by moving itself across the systems to access the data, if the data size is greater than mobile agent size only then mobile agents are advantageous, hence this measure plays an important role in deciding whether to use mobile code or not.

This measure can be defined as the total number of executable statements in a mobile agent program.

MAS= Number of executable statements of a mobile agent (3)

Where, MAS is Mobile Agent Size.

4) Location Search Time(LST)

Number of hosts may presents in a environment and mobile agent will visit to these location for task completion but MA should select one of them and selecting one of them which is most suitable is location searching.

This measure can be defined as the time taken by a mobile agent in searching a required location among available locations.

LST = Time required to visit the favorable location (4)

Where LST is the Location Search Time

IV. EFFECT OF PROPOSED MEASURES ON SYSTEM

Product performance metrics measures the agents and the system in terms of their design, description and working level. Our proposed measures can be categorized at two levels one is design and other is working that is shown in table1.

Measures	Design	Working
Number of Mobile Agent	Yes	No
Clone Life Time	No	Yes
Location Search Time	No	Yes
Mobile Agent Size	Yes	No

Table 1: Categorization of measures based on product performance metric

NMA and MAS metrics can be measured at design time of the system but CLT and LST can only be measured at working level.

A. Performance and Complexity Evaluation with the help of curves

We can evaluate the performance with the help of Curves. Curves make it more understandable to assess the complexity of a system. These curves may follow more than one form of equations such as a combination of constant curve and exponential etc.

Curve shown in Figure1 indicates that the measure increases up to a value defined by the parameter (k1). At this time the measure remains unchanged at the maximum value 1 as long as x is between parameters k1 and k2, then its value start to descends gently down to zero describing a exponential curve. The value 1 is chosen because the performance of any system can vary from 0-1.

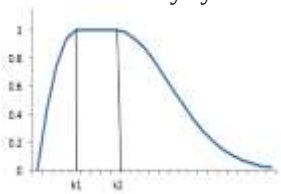

Fig. 1: Curve

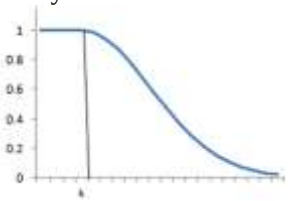

Fig. 2: Curve

Figure 2 Curve depicted in Figure 2 indicates that the value of the measure constant at 1 until x reaches a value k. As x grows then the value of measure gently descend to zero describing an exponential curve.

1) Number of Mobile Agents (NMA)

It is the total number of mobile agent presents in a system. The value of this measure shows how complex is the system. Effect of this measure on complexity of the mobile system is as follows:

Complexity of Mobile Agent System $\propto$ NMA

i.e. if the value of this measure is high , then complexity of the system will also be high and vice- versa.

This measure follows the curve in Figure1. Suppose x is the number of mobile agent in a system then the performance will increase up to k1 that is a constant value say 10 and will be 1 that is ideal performance of the system up to k2 i.e. 15. After k2 the performance will degrade slowly.

2) Clone Life Time (CLT)

It is the time taken by a clone in searching reporting and transiting

Performance of Mobile Agent System $\propto$ 1/CLT

i.e. if the value of this measure is high , then performance of the system will be low and vice- versa. e.g. working of clone, which is optimal for a period of time, say (k) then it start to fall due to more time consumption in location searching, transition and reporting. This measure follows the curve in Figure2.

3) Mobie Agent Size (MAS)

Number of executable statements which must be counted because mobile agents are beneficial only if data size is large than mobile agent size. Effect of this measure on system is as follows:

Complexity of Mobile Agent System $\propto$ MAS

i.e. if the value of this measure is high , then complexity of the system will also be high and vice- versa. e.g. number of executable statement ,which is optimal for a period of time, say (k) then it start to fall due to more agent size then data size. This measure follows the curve in Figure2.

4) Location Search Time (LST)

Time taken by mobile agent in selecting a location when more than one location is present

Performance of Mobile Agent System $\propto$ 1/LST

i.e. if the value of this measure is high , then performance of the system will be low and vice- versa. e.g. searching a location ,which is optimal for a period of time, say (k) then it start to fall due to more time consumption in location searching. This measure follows curve shown in figure 2.

V. CONCLUSION

Software metrics are measurement tools which are used to check performance and complexity of any system. Metrics are required to consider quality factors. Mobile agents are complex systems and are advantageous over conventional systems. Some existing measures are available for mobility to evaluate the quality of software agent systems. After analyzing behaviour of mobile agent system we have proposed four measures in this paper. The measures MAS, NMA, CLS and LST are proposed to measure the complexity and performance of the system. The effect of these measures is found out with the help of curves on complexity and performances. Complexity of the system is found to be almost directly proportional to MAS and NMA whereas performance of the system is almost inversely proportional CLS and LST. Our future goal is to evaluate these measures on some case study to determine applicability, correctness and efficiency of these proposed measures, so we may able to find global quality of software agent.

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