Exploring Networks Using Mobile Agents

Balaraju J.[1]   S.Rahamat Basha.[2]

[1]Department of Computer Science & Engineering
RGM College of Engineering & Technology, Nandyal , Kurnoo-Dt., AP , India

[2]Department of Computer Science & Engineering
RGM College of Engineering & Technology, Nandyal , Kurnoo-Dt., AP , India

Abstract

Mobile Agents (MA) are rising because there are several benefits. In this paper, we describe a brief introduction about mobile agents and its applications. One of the most important applications in the domain of mobile agents is the research of information on the Web. In these applications (research of the hotels, reservation of a plane ticket, etc...), some agents move on different sites to search information for their clients. Many works have been elaborated in order to introduce the mobile agents' technology in distributed information retrieval.
Keywords : Mobile Agents, information retrieval

1. Introduction

An agent is any program that acts on behalf of a (human) user". In general, an agent is an autonomous entity that performs one or several tasks in order to achieve some goals. Agents can be implemented in many ways. Agents are Autonomous, Interactive, Adaptive, Proxy, Coordinative, Cooperative, Trustworthy and One of the main properties of agent is
Mobile -able to transport itself from one environment to another.

2. Software Agent

A software agent is an intelligent program that acts as a user's personal assistant. Software agents endowed with the property of mobility are called mobile agents. Mobile agents perform a user's task by migrating and executing on several hosts connected to the network. Software agents can be classified as *static agents* and *mobile agents*.
Static agents achieve their goal by executing on a single machine. On the other hand, mobile agents migrate from one computer to another in the network and execute on several
machines. Mobility increases the functionality of the mobile agent and allows the mobile agent to perform tasks beyond the scope of static agents.

3. Mobile agents

Mobile agents are agents that can physically travel across a network, and perform tasks on machines that provide agent hosting capability. This allows processes to migrate from computer to computer, for processes to split into multiple instances that execute on different machines, and to return to their point of origin.
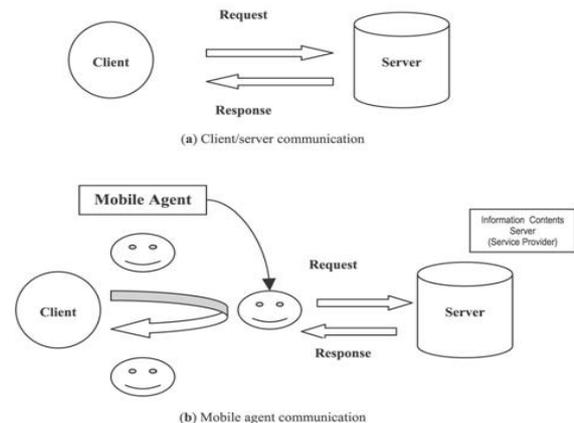

Figure 1. Client-server and mobile agent communication

The "client/server" model where exchanges are given by sending messages through the network is the most used model. This model has the disadvantage of increasing network traffic and it requires a permanent connection. Building applications with mobile agents often reduces the bandwidth required for the application, and improves performance. However, a fundamental problem exists with the approach client/server with regard to the management of distributed information. If the server does not provide the exact service that the customer needs, for example the server only provides low levels, then the client must continually poll the server. This can lead to increased waiting times.to overcome these problems in client-server method .this mobile agent application is used.

4. The Life Cycle of a Mobile Agent

1. The mobile agent is *created* in the Home Machine.
2. The mobile agent is *dispatched* to the Host Machine A for execution.
3. The agent executes on Host Machine A.
4. After execution the agent is *cloned* to create two copies. One copy is dispatched to Host Machine B and the other is dispatched to Host Machine C.
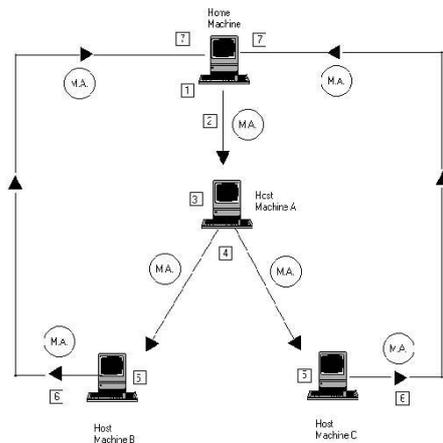
Figure 2. The life cycle of a mobile agent.

5. The cloned copies execute on their respective hosts.
6. After execution, Host Machine B and C send the mobile agent received by them back to the Home Machine.
7. The Home Machine *retracts* the agents and the data brought by the agents is analyzed. The agents are then *disposed*.

5. Mobile Agent Communication Mechanism

The mechanism prevents the communication failure using home server which manages information (host location, host status, agent state etc.) of each host and sub-server that has function such as home server. Mechanism that is proposed in this paper is followed with Fig.3 First, the home-server exchange information periodically with sub-server so that the home server shares same information at the same time with sub-server.

And each host concurrently has address of home-server and sub-server. Home-server has the buffer to temporarily store the message when MA is the migrating state. If there are problems in home-server, sub-server performs the home-server's role on behalf of home-server. Sub-server possesses the same information at home-server through periodical information exchanges between the home-server and the sub-server. In the case of problem at home -server, sub-server delivers the messages instead of home-server. Sub-server also broadcasts its own IP address to each host. When a host does not receive the response for the message delivery request, the host requests message delivery to sub-server by using the subserver's IP address.
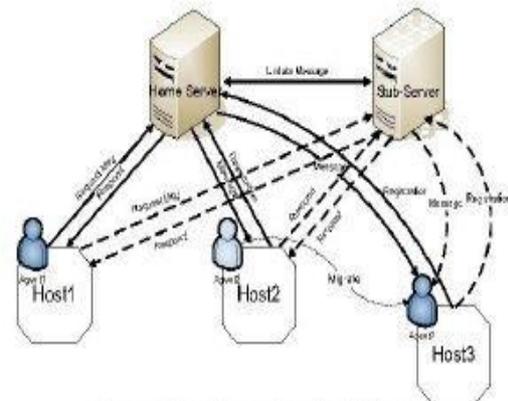

Figure. 3. Mobile agent communication mechanism

6. Properties of Mobile Agents

Adaptive Learning: Mobile agents can learn from experiences and adapt themselves to the environment. They can monitor traffic in large networks and learn about the trouble spots in the network. Based on the experiences of the agent in the network the agent can choose better routes to reach the next host.

Autonomy: Mobile agents can take some decisions on its own. For example, mobile agents are free to choose the next host and when to migrate to the next host. These decisions are transparent to the user and the decisions are taken in the interest of the user. *Mobility:* Mobile agents have the ability to move from one host to another in the network.

7. Applications of Mobile Agents

Parallel Computing: Solving a complex problem on a single computer takes a lot of time. To overcome this, mobile agents can be written to solve the problem. These agents migrate to computers on the network, which have the required resources and use them to solve the problem in parallel thereby reducing the time required to solve the problem.

Distributed data mining: Distributed data mining is a complex system which is related on the distribution of resources over the network as well as data mining processes. A distributed data mining structure in e-commerce environment based on Web services and mobile agent. In this context of data in heterogeneous environment, mobile agents can resolve problems of integration and communication. There is method that explores the capabilities of mobile agents an algorithm that better suits the Distributed Data Mining applications.

Data Collection: Consider a case wherein, data from many clients has to be processed. In the traditional client-server model, all the clients have to send their data to the server for processing resulting in high network traffic. Instead mobile agents can be sent to the individual clients to process data and send back results to the server, thereby reducing the network load.

Grid computing and grid services: Mobile agent

technology has been used to develop agent based Grid services. The services are delivered using a standard interface which is compliant with the common services. Agents use the ACL (Agent Communication Language) message to migrate in Jade platform. In order to enter the Grid node, the agent must be transmitted as a SOAP message.

The agent can migrate from the Grid node the any nodes outside the Grid by the http default transmission protocol used by Jade. For example, the Geographic Information Grid System (GIGS) based on mobile agent. This system provides services and improves sharing distributed resources.

E-commerce: Mobile agents can travel to different trading sites and help to locate the most appropriate deal, negotiate the deal and even finalize business transactions on behalf of their owners. A mobile agent can be programmed to bid in an online auction on behalf of the user. The user himself need not be online during the auction.

Mobile Computing: Wireless Internet access is likely to stay slow and expensive. Power consumption of wireless devices and high connection fee deter users from staying online while some complicated query is handled on behalf of the user. Users can dispatch a mobile agent, which embodies their queries, and log off, and the results can be picked up at a later time.

Multimedia: This application is used to search of images in distributed databases using multi-agent systems. The mobile agents roam in the network to search relevant images and mark the relevant path in order to search of images in distributed databases using multi-agent systems.

The mobile agents roam in the network to search relevant images and mark the relevant path in order to guide to the interesting sites. The strategy is based on the behavior of ants and their marking of the environment by using pheromones. Mobile Agent and introduces the concept of Middleware for dynamically discovered, location dependent multimedia services for mobile devices. Mobile Agents perform tasks on behalf of mobile device over a fixed. The actions performed by the mobile agent are: configuration and reconfiguration, communication, downloading multimedia to mobile device and Quality of service handling.

Energy efficiency and metering: This application have applied mobile agent technology for controlling power of distributed generations in an isolated micro grid. In their solutions, the mobile agent has three role : acquire operation data and equipment parameters from all the distributed power, determine the output power order for each power source and distribute the output power order to all the power sources.

Human Tracking: To enhance video monitoring system in the automatic human tracking system. The mobile agents utilize the algorithm of determination of neighbor video cameras to pursue the human efficiently. Actually, since e-learning systems don't consider the emotional intelligence in the context of instruction, an emotional intelligent e-learning system based on mobile. the emotion of a student is recognized by facial expression captured by a camera. The get the student's learning psychology by analyzing the facial expression of students using two-dimension model to describe a student's emotion.

Others applications: Mobile agents been have applied in several other domain such as security especially in intrusion detection, affective computing, climate environment and weather, e-learning, location, recommendation and semantic web services.

8. Advantages of Mobile Agents

Reduction in Network Load
The interactions in a distributed system are often achieved using communication protocols. These protocols involve transfer of large volumes of data stored at remote hosts over the network to a central processing site resulting in high network traffic. An alternative to using communication protocols is the use of mobile agents. Mobile agents are dispatched to the remote hosts containing the data. The agents perform the computations at the remote hosts and return back with the results. Since computations are moved to the data storage location instead of moving data to the computing location, network load is reduced.

Overcome Network Latency
Consider a manufacturing plant in which many critical real time systems are controlled through a network. Controlling many systems through a network involves significant delays, which are not acceptable for critical real time systems. To overcome this problem, mobile agents can be directly dispatched from the central controller in the manufacturing plant to the real time systems. The agents act locally and directly execute the controller's directions.

Protocol Encapsulation
Protocols enable components of a distributed system to communicate and co-ordinate their activities. However, protocols evolve over a period of time and new features such as better security may be introduced in the protocol. It is a cumbersome task to upgrade the protocol code at all locations in the distributed system. Mobile agents offer a solution to this problem. The mobile agent code can encapsulate the protocol. When a protocol is upgraded, only the mobile agent has to be altered.

Asynchronous and Autonomous Execution
Mobile agents operate asynchronously. Once a mobile agent is dispatched from the home machine, the home machine can disconnect from the network. The mobile agent executes autonomously without the intervention of the home machine. The home machine can reconnect at a later time and collect the agent.

Fault Tolerance

Mobile agents react dynamically and autonomously to the changes in their environment, which makes them robust, and fault tolerant. They have the ability to distribute themselves in the network in such a way as to maintain the optimal configuration for solving the particular problem.

Better customization
A server may want to provide customized services to a client based on the capabilities of the client (for ex., different device types) or user profiles. An agent with the customization code can be supplied by the client itself which can move to the server to customize the service for the client. The server just needs to provide an interface to the services.

9. Disadvantages of Mobile Agents
The main drawback of mobile agents is the security risk involved in using mobile agents. A virus can be disguised as a mobile agent and distributed in the network causing damage to the host machines that execute the agent. One of the schemes proposed is to introduce a tracing mechanism that records the execution of the mobile agent at each host. When the agent is dispatched to the next host, the trace is also sent. Using this trace, malicious actions can be detected and the malicious host can be identified.

10. Implementation and platforms
Several platforms that implement the mobile agents have emerged since the 1990s. Some of them are no longer maintained or disappeared and others continued to be used in various research laboratories and even in some commercial products.

10.1 Voyager
Voyager is a Java platform that provides flexibility using traditional techniques and distributed computing based on mobile agents in order to create network applications for a range of equipment from computers to consumer devices. It includes various models of mobile computing: client / server, peer-based and agent-based. Voyager contains features or functions that can be found in other ORBs (Object Request Broker) and platforms based agents, include CORBA, RMI, Aglets and JADE.

10.2 TACOMA
TACOMA (Tromosø And Cornell Moving Agents) is a joint project being developed by the University of Tromosø and Cornell University and is primarily to provide a support system for farm workers. TACOMA considers agents, stationary or mobile, as units of computing system. The agents which are mobile operate stateless mode and each agent has three of memory mechanisms. When an agent moves between sites, the status information is stored within a data file called DATA, and the agent code itself is stored in a data file called CODE. At the receiving site, the agent code is extracted from the data file of CODE and executed the agent using the file data for its data and information on the status of the agent. When an agent wants to move to a new site, an entry is added to the data directory called HOST tell him where to move. It is a mechanism predetermined movement but the authors want to remove the directory HOST by implementing a mechanism that partially automates the process of transfer.

10.3 PIAX
PIAX (P2P Interactive Agent eXtensions) is an open source framework that integrates mobile agents paradigm and P2P structured overlay network. Using P2P and mobile agent advantages, PIAX allows to build a scalable and efficient federated system in a large-scale distributed environment (e.g., pervasive environment, cloud environment) where various kinds of data and processes are located in each device.

10.4 Trinity mobile agent framework
Trinity is mobile agent based framework which Allows to create for wide range of mobile agent types. It allows rapid development of non-complex agents.

10.5 JADE
JADE (Java Agent DEvelopment Framework) is a java software Framework. JADE allow implementation of multi-agent systems which complies with the FIPA specifications. The agent platform can be distributed across machines where the configuration is performed via a remote GUI. Several international projects, from different financing European frameworks (IST, ACTS,…), have been based on JADE.

10.6 Secure Mobile Agent Rapid Development
SMARD is a development environment oriented programming of on mobile agents based applications. Programmers can design, build and launch mobile agents using a graphical interface. The developed applications can be run on JADE platforms .
In JADE, all agents are owned by an authenticated user. It uses a policy file to protect host resources from an agent by specifying permissions to host resources and system operations in the same way as Aglets do.

10.7 Float's Mobile Agent
FMA is a free mobile agent platform which provide phone editing tool allowing users to easily manage all of the personal data stored in their phones, via a number of different connections methods. FMA also allows management of Phonebook (SIM and memory), SMS, Profiles, and Files stored on the phone.

10.8 Sensor ware
Sensor ware is an implementation of mobile agent environment for wireless sensor network. Sensor Ware's scripting language is based on Tcl , and Scripts can move their code and data from node to node, autonomously. The distributed algorithms are realized as control scripts that are autonomously replicated or migrated in the "proper" sensor.

10.9 MAF

Mobile Agent Framework (MAF) is a based Python research prototype which provide a set of primitives to facilitate the development of distributed mobile agent.. MAF should provide a mechanism to be able to incorporate and integrate effortlessly with a variety of "foreign agents" written in other languages such as C and C++.

10.10 TAgent

Travel Agent (TAgent) is a Java based platform which allows to develop Mobile Agent. These Mobile Agent can act on behalf of their owner without the requirement for the user to interact. TAgent provide an easy service extending, an easy Agent development platform and a secure design of the agents. TAgent is compliant with MASIF Standard of OMG.

Table 1 – Mobile agent platforms characteristics

Mobile agent systems	Programming language	Operating system
Voyager	Java .NET, C++	Unix, Windows
TACOMA	C, Tcl/Tk, Perl, Python, and Scheme	Unix
PIAX	Java	All (with JRE)
Trinity	.NET	Windows
JADE	Java	All (with JRE)
SMARD	Java	All (with JRE)
Float	Borland Delphi	Windows
SensorWare	TCL/TK	Unix
MAF	Python	Unix
TAgent	Java	All (with JRE)
Aglet	Java	All (with JRE)

11. Conclusion and future works

Thus the mobile agents are mobility and autonomy allow the agent to move from one point to another in the network and provide services and meet predefined goals without intervention. In this paper, a survey of mobile agents based applications in different domain areas and implementation platforms have been presented. Future work plans mainly concern on student information sharing. The mobile agents share and compare the data collected in an universities.

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