AN ARCHITECTURE BASED ON MOBILE AGENTS FOR RETRIEVING INFORMATION FROM DISTRIBUTED SOURCES

Nadia Ben Seghir, Okba Kazar
Department of computer science, University of Biskra
07000, Biskra, Algeria
inf_nadia@yahoo.fr
kazarokba@yahoo.fr

ABSTRACT

Nowadays, the demand of information can be divided on several distributed systems, where it needs a reconstitution of response by a managing entity. Further, an exchanges data in a distributed application requires interaction between various entities through the network. 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. In this article, we propose a new approach which uses the mobile agents’ technology. This last appears in this context as a promising solution facilitating the implementation of distributed applications. In this paper, we describe our architecture based mobile agents for searching information from distributed heterogeneous sources. Each mobile agent of research will be used to visit the site server of the application in order to collect information for its client, which allows him to interact locally with server, so it reduces the delay of the client waiting and the network traffic.

Keywords: Mobile agent, Information retrieval, Distributed systems, Web.

1 INTRODUCTION

The evolution of the networks on a big scale permitted the birth of a grand number of new applications that develops around this type of network: electronic commerce, research of information on the web, platform for distributed calculation, etc. These distributed applications need to communicate and to exchange information between various entities.

Today, the “client/server” model where exchanges are given by sending messages through the network is the most used model. In this model, only the client represents an application to the proper sense of the term and the server’s role is to answer the demands of the clients. The server constructs his responses regardless of the client, so a part of the sent data is useless which increases the network traffic. Besides, this model requires a permanent connection between the client and the server, what is not the case of the mobile terminals that is exposed to the loss of the connection. In this article we propose a new approach which uses the mobile agents. These agents are the entities that move from a machine to another on the network, without losing their codes or their states.

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. The mobile agent concept appears in this context like a solution facilitating the implementation of distributed applications.

We approached our architecture according to these view-points. In this paper we propose an approach based on mobile agents permitting to search for pertinent information from distributed heterogeneous sources.

The presented article is structured like follows: in the next section we are briefly going to present a certain number of works that links mobile agents and the research of information, this part is consecrated to the comparison of our approach with relatively near works. Thereafter, our new approach will be detailed in the third section, first we present the general architecture followed by its components. Finally, a conclusion shows the result of this research and presents the considered perspectives.

2 RELATED WORKS

Since the first publications, the information retrieval has been presented like a potential important application of the mobile agents as the
“killer application” [1]. Various significant works have been led in the domain of the research of information and lean on the mobile agents’ technology. Among these ones we distinguish:

- In [4], the authors present an application of research of textual documents based on mobile agents. It is about an application of simple research in a local network (with centralization of information on the servers via a mechanism of yellow pages, without constraint security, nor dynamic discovered of new servers). The research agent leans on observation agents of the state in the network and on a stationary agent that acts as interface with the local information server.

- The DBMS-Aglet system [10] implants a solution based on mobile agents in Java for interrogation of heterogeneous data bases via the Web. A mobile agent transports the request on the site server where he dynamically acquires the pilot JDBC, then it puts its request and returns the results on the client site.

- M3 “Multimedia Database Mobile agents” [9] is a system of data multimedia research by the content that rests on the mobile agents, Java and CORBA. Mobile agent can memorize the information collected on a site, use them on the visited sites, and make them evolve during the course. The problems of security are processed via mechanisms of independent sessions, the mechanisms of security of CORBA, and via the restrictions of rights.

- Finally other works as AGATHE [8], ARCADIA [5], JAVANE [2], NETSA [6], and ISAME [11], propose another alternative for the research of information: models of mobile agents and multi-agents.

3 PRESENTATION OF THE PROPOSED ARCHITECTURE

In this section, the objectives of proposed system are firstly presented, its general architecture putting in evidence its four main layers, its general functioning, and finally some details of implementation are provided.

3.1 Objectives of the System

To search, find and integrate information from resources of data geographically dispersed is a difficult problem, which are confronted a numerous organizations. These last years, the size and the variety of accessible data by networks have considerably increased. New solutions became necessary to manipulate information descended from dynamic resources as the World Wide Web. The mobile agent appears in this context as a promising solution, allowing the construction of flexible applications, adaptable to the constraints of the application and to the execution environment. In this model “mobile agent”, an agent is a process possessing a context of execution, including the code and data, capable to migrate during execution from machine to machine (called servers) in order to realize its task that is assigned [7].

Mobile agents have several advantages in distributed information retrieval applications. By migrating to an information resource, an agent can invoke resource operations locally, eliminating the network transfer of intermediate data. By migrating to the other side of an unreliable network link, an agent can continue executing even if the network link goes down, making mobile agents particularly attractive in mobile computing environments. Most importantly, an agent can choose different migration strategies depending on its task and the current network conditions, and then change its strategies as network conditions change. Complex, efficient and robust behaviors can be realized with surprisingly little code.

In short, the true strength of mobile agents is not that they make new distributed applications possible, but rather that they allow a wide range of distributed applications to be implemented efficiently, robustly and easily within a single, general framework.

As already evoked, the proposed architecture in this work is an approach based mobile agents conceived for searching information from distributed heterogeneous sources. It defines a set of components (agents) and all functional modules described in term of their behaviors and interfaces, as well as the way of interaction of these components in order to accomplish the set of tasks of the system correctly.

3.2 General Architecture of the System

The general architecture of our system, illustrated in figure 1, articulates around four main layers in interaction.

3.2.1 Interface layer

This layer contains the application that allows client to interrogate the system. Its essential role is to capture the user’s goal in order to respond his need. It contains interface agents interacting with the user to help him to realize the precise task. This interaction results in a transformation of the user’s demands that transformed in XQuery requests which facilitate the function of mediator agent.

3.2.2 Mediation layer

This layer regroups all necessary elements to the execution of reformulating process of a query written in global schema to a query written in sources schemas. At the end of information research process, the mediator agent reassembles the information found as a global response that represents information demanded by the user.
Our mediator is achieved by integration process that can rest on GAV approach (Global As View) [3]. With this approach the treatment of user queries is very easy. GAV consists on a mediated schema (the global schema) which is defined as a set of views over the data sources. The definition of a mediator schema on heterogeneous sources requires the use of: (i) common interrogation language; (ii) common result format. To facilitate our mediator’s work, we chose to use:

- XML: as common result format in which the resource agents will respond the mediator agent. The advantages of using XML as model of results integration from the wealth of this language: abundance of the descriptions, data structure, clarity, extensibility, etc...
- XQuery: as common language in which the mediator will interrogate the resource agents. XQuery is a rich query language that permits to interrogate some XML documents, its features allow to categorize the main elements of language. It is descended of Quilt and takes the advantages of XQL, and XPath [12].

3.2.3 Research mobile agent layer

This layer contains set of research agents generated by the mediator agent. In this level, and for each sub-query, the mediator agent activates one of the created research agents. The researches agents are the mobile agents browsing web to find appropriate information to each received sub-query on different distributed data sources.
3.2.4 Information sources layer

It is a class that is capable to receive some requests, treat them and return the results. This layer regroups first a set of resource agents that is distributed on several sites to manage the set of associated data to each site, and secondly the multiple sources that provide the system basic data.

Now, we are going to detail the different agents that include these layers.

3.3 Agents Specification

Our architecture includes four types of agents, as indicated in figure 1, in variable concentrations.

3.3.1 Interface agent

This agent can be seen like a simplifying that allows the users to interact with the system (see figure 2). It is a stationary agent that is mainly responsible to acquire all users’ requests, send these requests to the adequate agents and present the results to the users.

![Figure 2: Interface agent structure](image)

3.3.2 Mediator agent

The mediator agent is an intelligent agent that treats the distribution of data, it does a set of treatment on user query written in global schema in order to reformulate it in sub-queries written in the sources schemas. It plays the role of interface between the user who puts a request and the set of data sources. For each sub-query the mediator agent will generate a research mobile agent to be displaced toward the site server in order to find the adequate information to the acquired sub-query.

![Figure 3: Mediator agent structure](image)

When the execution of the sub-queries is finished, the mediator reassembles the results found by the group of research agents as a global response that represents information demanded by the user (see figure 3).

The mediator agent has the faculty to control the motivations of research mobile agents that arrive to it, which permits to increase the level of system security.

3.3.3 Research mobile agent

The research agents are the entities that can migrate during execution from machine to machine in network in order to satisfy the need of their clients. On each machine, they do some exchanges and treat the collected information.

This treatment (filtering, sorting...) reduces the quantity of transported information with the agent and consequently the traffic on the network. The data demanded by mediator are transported by mobile agent.

![Figure 4: Research mobile agent structure](image)

The figure 4 presents our typical architecture of research mobile agent. This architecture has a very simple nature because the power of system doesn’t lean on the complexity of an agent’s architecture, but on the interactions between the different agents and their roles.

![Figure 5: Decomposition and recomposition of queries](image)
3.3.4 Resource agent

It is a stationary agent that acts locally during all its cycle of life in the machine where it has been implanted initially. This agent receives queries formulated in XQuery, and transforms them in native queries (proper for the source) in order to extract required information from the local database (see figure 5). The found information is translated then in XML as a response to claimant’s query (research mobile agent).

Mainly, a resource agent manages only one data source. Obviously, more the number of resource agents is big, more we will have an access to a complete and various information.

3.4 Implementation Details

The scenario for which our approach has been tested concerns the organization of voyage because it is considered like a typical example for information retrieval on the web. The scenario shows how our system can help a user in his research about hotels and restaurants in a city.

3.4.1 Hardware and software environment

The agents of our system are implemented using JAVA language, their development platform is JADE\(^1\). JADE supports the development of agents with the possibility to transport them from a system to another. The Development multi-agents respects the recommendations of FIPA\(^2\), notably that the retained communication language is ACL-FIPA. All programs are developed with JDK (Java Development Kit) version 1.6. We develop the corps of classes in the programming environment “JBuilder X”.

The tests are achieved on an Ethernet network that consists of 4 micro-computers Pentium 4, 3.2 GH zes, RAM 512 Mb, network LAN 100 Mbit/ses.

---

1 Java Agent DEvelopment Framework : http://jade.tilab.com
In order to understand clearly the function of our architecture, we present in figure 9 the graphic interface for agent “sniffer” of the platform JADE that permits to visualize the exchange of messages between different agents during treatment of user request.

**Figure 7:** Graphic representation of research mobile agents with its received sub-queries in XQuery

**Figure 8:** Graphic representation of resource agents with its found results in XML

**Figure 9:** Communication among agents of the system
4 CONCLUSION

In this paper, we were interested in mobile agents’ technology and its use for the information retrieval in distributed environments. The objective of displacement of these agents is generally to reach data sources locally, then doing a local treatment and displace only the useful data. For this reason, we propose in this context, a new approach based on mobile agents for the research of information from distributed heterogeneous sources.

Our proposed architecture has several strengths. First, it uses the mobile agents like an entity of communication. By migrating to the location of a needed resource, an agent can locally interact with the resource without transmitting intermediate data across the network, conserving bandwidth and reducing latencies. Second, by migrating to the location of a user, an agent can respond to user actions rapidly. In either case, the agent can continue its interaction with the resource or the user even if network connections go down temporarily. Finally, the decomposition of the user’s requests in a structure intern susceptible to be manipulated easily by the different components of the system, and the generation of mobile agents for each sub-query, permits to accelerate and facilitate the research process.

In order to show the feasibility of proposed architecture on one hand, and comprehend its function on other side, we chose as a case to study the voyage organization, because it is considered like a typical example for the research of information on the web. In this context, only one mobile agent is created. It is put in charge of moving to realize the task demanded by the client. We think that the use of several mobile agents for searching information permits to improve the quality of proposed solution and reduce the delay of client waiting. Two cases are considered: 1) the agents know themselves and can communicate between them in order to achieve the demanded tasks; it is about cooperative agents (it is a perspective). 2) the agents don’t know themselves and in this case, each agent achieves its task regardless of the other agents (it is the case of our approach).

The different results obtained during the related experience show that the mobile agents can contribute advantageously to the development of distributed information system. New research activities can be launched in order to improve the presented work. The perspectives that we propose can move toward the following directions:

- Integration of treatment techniques of natural languages notably at the level of user interface, this in order to make the system more effective.
- Take into consideration the aspect of adaptability of agents.
- Use cooperation mechanisms among mobile agents in order to achieve the demanded tasks effectively.

- Extend the architecture for the use of Web Services (WS).

5 REFERENCES