FIPA Based Agent Communication in Distributed Information Retrieval System

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Abstract

Agents have ability to communicate with one another in order to tackle the collectively problem that no single agent can, individually. They communicate with each other using Agent Communication Language (ACL). Agents also have ability to travel from one host to another in order to perform their jobs completely. This type of agent, called mobile agent, can beneficially use in distributed information retrieval system. However, mobile agent has interoperability problems such that the mobile agent has limited interacting with stationary agent and with information source. Nevertheless, ACL can solve these interoperability problems. By deploying the abilities of mobile agent, this paper is developed a distributed information retrieval system based on mobile agent who can find and give the information of the user requested car from different Toll-gates relevant with the user location. In this system, mobile agents communicate with stationary agent by using FIPA ACL in order to avoid the interoperability problem. This system developed using Java programming language and Java Agent Development framework (JADE).

1. Introduction

The growth in network information resources requires information system that can be distributed on a network and interoperate with other systems. Such system cannot be easily realized with the traditional technologies because these technologies have limitation for distribution and interoperability. The agent-based technologies seem to be a promising answer to facilitate the realization of such systems because they were invented to cope with distribution and interoperability.

An agent is essentially a special software component that has autonomy that provides an interoperate interface to an arbitrary system and/or behaves like a human agent, working for some clients in pursuits of its own agenda [7]. Agents have ability to interact with each other either directly or indirectly. They usually communicate directly with each other using Agent Communication Language (ACL). Communication with each other can tackle the collectively problems that no single agent can, individually.

Besides the communication, some agents require traveling from their current machine to another machine where an execution environment is set up for them and has resources needed by agents. On each machine, the agents communicate with stationary agents or with information resources. In such cases, interoperability problems can be arrived because there may have limited interactions. An ACL can handle these interoperability problems.

Comparing with traditional client-server technique, mobile agent can reduce the network traffic and execute asynchronously and autonomously. Due to these advantages of mobile agent, this system uses mobile agent to get the information of the car from different Toll-gates related with the user car location. This system also uses FIPA ACL in the communication between stationary agent and mobile agent by avoiding interoperability.

The remainder of this paper is scoped as follow. Section 2 describes related work. In Section 3, we briefly described agent, agent communication, mobile agent and its interoperability problems and tools, FIPA ACL and interaction protocol. Section 4 describes the proposed system architecture, communication with master agent and Toll-gate agents. We conclude the paper in Section 5.

2. Related work

Mobile agents community and wider agents community have interoperability issues. These interoperability concerns are different between the two communities. Y. Labrou et al [5] explored the interoperability problems for mobile agents community and agents community and also

proposed the ACL can be used as interoperability tools. They also explored the integration of ACLs into mobile agent frameworks.

Societies of agents cooperate to collectively perform task by entering into conversations. In order to allow the agent to enter into these conversations, the concept of interaction protocols has emerged. S. Cranefield et al [4] proposed reducing the degree of human interpretation currently necessary to understand an interaction protocol by describing at an abstract level the required agent actions that must be plugged into the protocol for it to be executed.

H. Htoon and M. M. T. Thwin [3] proposed a mobile agent based system that can control and manage the distributed information retrieval processing in order to search for the required technical papers from distributed databases. They pointed that mobile agent can save bandwidth length and overcome network latency due to the mobile agent moves data only not all databases.

3. Theoretical background

3.1 Agent

An agent is a computer system that is capable of independent action on behalf of its user or owner [8]. The agent operates autonomously and cooperates with humans or other agents in order to achieve its task.

3.2 Agent communication

Agents need to be able to communicate with users, with system resources, and with each other if they need to cooperate, collaborate, negotiate and so on [7]. Agents usually communicate with each other using some special communication language called Agent Communication Language (ACL). Agent Communication can be defined as a form of interaction in which the dynamic relationships between is expressed through the intermediary of signals, which, once interpreted, will affect these agents [1]. Agent Communication is based on message passing, where agents communicate by sending individual message to each other.

3.3 Mobile agent

A mobile agent is an executing program that can migrate during execution from machine to machine in a heterogeneous network. On each machine, the agent interacts with stationary service agents and other resources to accomplish its task [3]. Mobile agent can transport its state and code with it to another host where it resumes execution. The "state" typically means the attribute value of the agent that helps it determine what to do when it resumes execution at its destination. The term "code" in an object-oriented context means the class code necessary for an agent to execute [2]. Since the state information is also transferred to the host, the agent can resume its execution from the point where it stopped before migrate.

3.3.1 Mobile agents' interoperability problems

Mobile agents reside in a highly heterogeneous environment. Mobile agents migrate to a host where an execution is set up for them. Upon arriving there, they make Remote Procedure Calls (RPCs) in order to access the resources of the host, collect data and eventually initiate another process of migration to another host. While residing on a particular host, the agent might have limited interaction with other agents on the host through an RPC-type mechanism [5]. Another interoperability problem arises when a mobile agent needs to communicate with an information source.

3.4 ACLs as an interoperability mechanism

Agent communication languages (ACLs) can be used as interoperability tools:

- Between static and mobile agents.
- Between mobile agents designed for different agents platforms
- Between mobile agents and static agentified information sources.

3.5 FIPA agent communication language (FIPA ACL)

FIPA agent communication language (FIPA ACL) is drawn on speech act: messages are actions or communicative acts, as they are intended to perform some action by virtue of being sent [6]. FIPA ACL specification consists of a set of message types and the description of their pragmatics, that is, the effects on the mental attitudes of the sender and receiver agents. FIPA ACL messages can be characterized by:

- Intention, e.g., REQUEST,INFORM
- Attendees, i.e. the sender and a set of receivers.
- A content, i.e. the actual information that is exchanged.
- Content description, i.e. an indication of (i) the content language used to express the content and(ii) the ontology by means of which both sender and the receiver ascribe a proper meaning to the terms used in the content.

• Conversation control, e.g. interaction protocol and conversation identification.

(REQUEST
:sender (:name dominicagent@whitestein.com:8080)
:receiver (:name rex-hotel@tcp://hotelrex.com:6600)
:ontology personal-travel-assistant
:language FIPASL
:protocol fipa-request
:content (action
movepick-hotel@tcp://movepick.com:6600
(book-hotel (:arrival 5/11/2009) (:departure 05/12/2009))))

This message is expressed with intention REQUEST; attendees dominicagent and rex-hotel; content as expression about the booking the hotel action; FIPA-SL as content language; an ontology about the personal travel assistant; and conversation control.

3.6 Interaction protocol

Interaction protocols (also known as conversation policies) are descriptions of standard patterns of interaction between two or more agents. They constrains the possible sequences of messages that can be send amongst a set of agents to form a conversation of the possible sequences of messages that can be sent amongst a set of agents to form a conversation of a particular type [4]. There is eleven FIPA defined standard interaction protocols. The proposed system use FIPA request interaction protocol for exchanging the messages between mobile agents and stationary agent.

4. System architecture

The proposed system is a mobile agent based distributed information retrieval system. Software agents endowed with the property of mobility is called mobile agents. Network load can be reduced by using mobile agents. Mobile agents also execute asynchronously and autonomously. Thus, we use the mobile agent for the proposed system. To avoid the interoperability problems, we also use FIPA ACL between mobile agent and stationary agent.

In this system, one stationary agent name Master agent and a number of mobile agents depending on the user requested location are used. Master agent communicates with Toll-gate agent (mobile agent) by sending request ACL message. The overview system design is shown in Figure 1.

Let assume that a user want to search her car. In this situation, the user inputs the car no, car type, search date, and location and then sends these to Master agent. When the Master agent receives the user request, the agent prepares the message sends to Toll-gate agents relevant with the user requested location. After that, Master agent sends the REQUEST message to Toll-gate agents using FIPA request interaction protocol.

When the Toll-gate agents receive the REQUEST message sent by Master agent, the agents migrate to their destinations. Upon arriving there, the Toll-gate agents search the information related with the requested car. After completely performing their tasks, the agents migrate back to 'home'. Then Toll-gate agents send INFORM messages including the result of performing the actions to Master agent. Master agent creates a result when it receives the INFORM messages. After creating the result, Master agent send the result information to requested user.

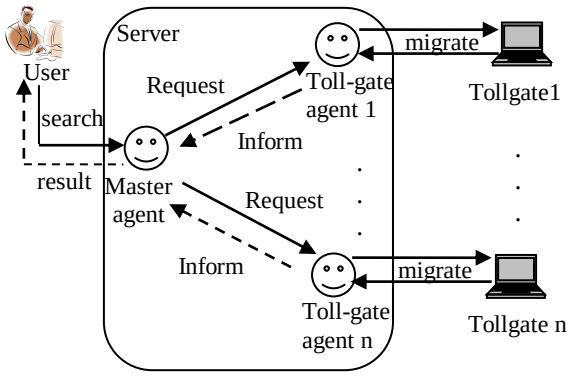

Figure 1 Overview of the system

4.1 Communication with master agent and toll-gate agent

This section describes how the agents communicate with each other using FIPA ACL over FIPA request interaction protocol. As already mentioned, Master agent communicates with Toll-gate agents using FIPA ACL. They are exchanging the messages using FIPA request interaction protocol. Figure 2 shows the FIPA request interaction protocol for defining a simple interaction between Master agent and Toll-gate agent. Master agent plays the Initiator role and sends a request for an action to be performed to Toll-gate agent which plays the Participant role. Figure 3 shows the REQUEST message sends from Master agent to one of corresponding Toll-gate agents for requesting the search car action that can only perform by Toll-gate agent. The message content includes the user requested car no, car type and search date. FIPA-SL0 is used as a language for content expressions and an ontology is used to express the meaning of the content of the message.

After receiving the request: Toll-gate can refuse or agree to the request or it may signal that it did not understand the request message. If it agreed, it

subsequently sends a second response: a message indicating that its attempt to fulfill the request action failed, a message signaling that the action has been performed, or a message containing the result of performing the requested action.

Figure 4 describes the INFORM message sends from Toll-gate agent to Master agent. In this message, Toll-gate agent sends the found result with date and time for entry and exit states of the car. If the Toll-gate agent did not found the information, the agent would send "not found" result.

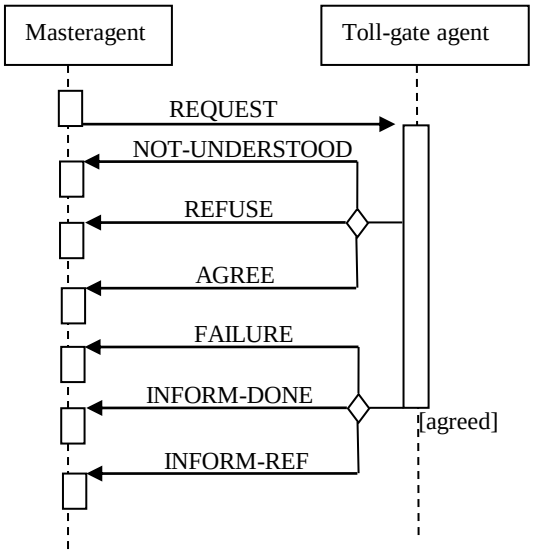

Figure 2 FIPA request interaction protocol

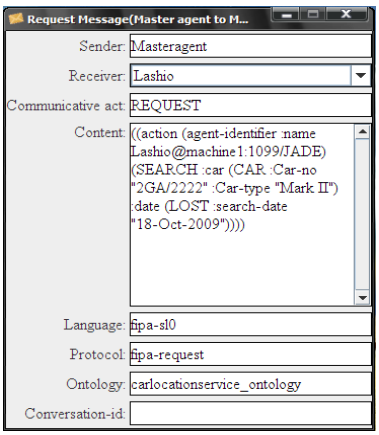

Figure 3 Request message send from master agent to toll-gate agent

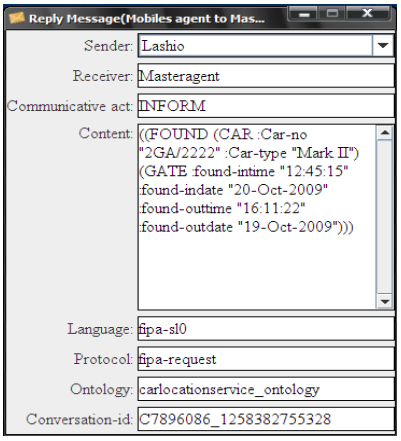

Figure 4 Inform message from toll-gate agent to master agent

5. Conclusion

This paper has presented a mobile agent based distributed information retrieval system. In this paper, mobile agent, agent communication, FIPA ACL, and FIPA request interaction protocol are applied. This system can give the information of the car from different Toll-gates relevant with the user requested location. Since mobile agent performs its task locally, the proposed system has huge bandwidth savings. This system used FIPA ACL as an interoperability tools, thus the interoperability problem between mobile agent and static agent can reduce. The agents, in this system, exchanged the sequences of message using FIPA-request interaction protocol. Thus, agents know what to do when the message is arrived. This system can help people to reduce their time and effort when they need to search their car.

6. References

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