Design on Multi-Agents Systems Interacting Model under Distributed and Heterogeneous Environments

Tong Peng¹, Han Feng-wu²
1. Baoding Technical College of Electric Power, Baoding 071051, P.R. China;
2. North China Electric Power University, Baoding 071003, China;

Abstract With the rapid development of e-business, net communication safety is becoming more and more important. At the same time, the communication ability is needed to satisfy all kinds of operation systems and net structures. According to the analyzing the communication process and interaction mode of multi-agent systems existed and combining the advantages of exchange markup language (XML) with CORBA technology, a layering multi-agent system communication model under distributed and heterogeneous environments is put out. The model can freely communicate under among all kinds of operation system and net structures because of its excellent designed theory. Then the information exchanging process of the model is introduced and a corresponding example is presented. At last a communication experiment between multi-agent systems proved primarily the feasibility and validity of the interacting model.

Key Words Multi-agent System; Communication; Interaction; XML; Heterogeneous

1 Introduction
Lots of enterprises develop their own multi-agent system which have different structures and functions and operate on different platforms. When these systems under distributed and heterogeneous environments are applied into more extension, the communication among them becomes more and more important because lots of information must be exchanged each other. How to build a multi-agent systems model which can satisfy the needs of communication and dealing with information under distributed and heterogeneous environments becomes a key problem.

According to the analysis of multi-agent systems communication and information interaction modes existed now, and at the same time utilizing the advantages of XML language made by W3C organization, such as opening, separability and independence of platforms, and CORBA technology as soft-bus and can screen bottom communication and exchange information among different operation systems, a layering interacting model of multi-agent systems based on XML and CORBA is put out. The model implements interaction among multi-agent systems and a corresponding example proved the fact. And the process of exchanging information content and format is also detailed described.

2 The Communication Model and Exchanging Information Format of Multi-agent System Existed
Now, some matured multi-agent systems have appeared, such as OAA¹, ZEUS² and AGELTS³ and so on. According to the analysis of the systems, five communication models are got, such as without communication, delivering message, delivering case, by blackboard and agent communication language (ACL). The defaults of the first four ways⁴ are that it’s hard to clearly define the semanteme of the problem space and agent communication language and its communication language has a close relation with agents self solving problems ability.

The last one can presents the knowledge about environments and itself goals and abilities and wishes by a special ACL and also can implement basic consults and cooperation in multi-agent system, such as main languages KQML and FIPA-ACL at present. Though the two kind of ACL can satisfy basic requirement of multi-agent communication and agilely commonly support knowledge share and multi-agent cooperation, they have some limitations.

(1) Lack of clearly defined common facilities;
(2) Don’t support dialect and translation of variation languages;
(3) Don’t explicitly support mobile-agent communication;
(4) Don’t implement information exchanging between different kinds of multi-agent system under
distributed and heterogeneous environments.

In addition, according to the way of dealing information and the format of exchanging information of multi-agent system, two kinds are existed. The first one, such as ZEUS, AGELTS and so on, the way limits the cooperation and consults of agents when they are in different multi-agent systems and is not good for the integration of the multi-agent system.

The second one decreases the efficiency of reception and transmission. Because both sides need to encode and decode messages, the complicity is increased. Simultaneously, the high frequency of exchanging information adds the load of the system and drops the efficiency of delivering information.

As a result, for implementing communication of multi-agent systems, a communication mechanism required by multi-agent systems between different platforms should have an united exchanging information format.

3 Brief Introductions of CORBA Technology and XML Protocol

3.1 Brief Introduction of the CORBA Technology

Common Object Request Broker Architecture is a set of object technology protocol which was put forward by OMG (Object Management Group). Its has more synthesized advantage in agility, cutting across different languages and operating systems and security than DCOM and other distributed object technologies[5]. So the protocol can be used to solve the communication and interaction of the multi-agent systems.

CORBA has five main parts:

(1) ORB (Object Request Broker): Make the objects can be delivered and received transparently in the distributed environment; (2) Object Service: Supply basic services for implementing and using objects and define the basic systematic functions. (3) Common Facilities: Provide shared service set for lots of applications and define the functions which can be directly used by the applications; (4) Field Interface: A kind of service for the special application field; (5) Application Interface: The interfaces which take CORBA as operating environments for the particular application.

![Figure 1 the Structure of CORBA](image)

The basic functions and structure of the ORB which is the core part of the CORBA include IDL (interface define language), IDL Stub (static invoking interface), ORB interface, DII (Dynamical invoking interface), SSI (Static Skeleton Interface), DSI (Dynamical Skeleton Interface), IR (Interface Repository), OIR (Object Implementation Repository) and IIOP (Inter Invoking ORB Protocol). The relation among all these parts is just like figure 1. The arrow in the figure means invoking or executing.

3.2 XML Summarization and Its Advantage in Multi-agent System Interaction

XML (Extensible Markup Language) made by W3C is a common language protocol, which firstly structures information and then describes, transfers, transform and analyze them in text format way[6]. And XML has become the data exchanging standard of systems and applications and been used in exchanging information, defining document type, explaining information and so on.

These are the reasons, such as the opening, separability of XML, information exchanging standard,
object-oriented.

And there is not a standard and mature technology to support the development of the multi-agent system. So now they are developed by present technologies and methods, especially in interaction aspect.

4 The Interaction Model of Distributed and Heterogeneous Multi-agent System

4.1 The Communication Model of Distributed Heterogeneous Multi-agent System

According to the above analysis and research, the old organization and communication language are kept and CORBA protocol is introduced into the multi-agent system with XML. A new interaction model of heterogeneous multi-agent system with layering structure is put forward in the paper, just like figure 2. In the figure CDL (Content Definition Language) is a systematical special language which is relative with problems fields and can express basic elements such as objects, behaviors, actions, rules and so on. The model builds a simple, straddling operation systems and extendable interaction structure for the communication of the distributed and heterogeneous multi-agent systems.

![Figure 2: The Layering Communication Model of Multi-agent System](image1)

4.2 The Interaction Information Transforming Process of Multi-agent System XML-based

After building an interaction model, for understanding exchanging information each other between different agents the information format must be united into one. The module based on XML of dealing with messages is designed to solve the problem in the paper. The information transformation process is just like figure 3.

![Figure 3: The Information Transferring Process between Heterogeneous Agents XML-based](image2)

For example, there are two agents, Agent1 and Agent2, belonging to different heterogeneous
multi-agent systems. Now the interaction process will be particularly introduced. When Agent1 needs to communicate with Agent2, which is in another multi-agent system, according to its promises, abilities, intentions and so on, it firstly transfers relative data from inner data base and inner knowledge repository and then encode them to KQML messages and then transforms them to united XML format codes by the model of dealing messages. The transformation process includes two steps.

Firstly the local KQML messages are transformed XML format messages, and then according to the local mapping table local codes in the XML format messages are mapped into united standard codes. And then Agent1 packs the XML format messages and sends them to Agent2 in another multi-agent system by ORB bus invoked by DII of CORBA.

Agent2 receives the messages by ORB invoked by DSI of CORBA and unpacks them into XML format messages. According to the local mapping table, united standard codes in the XML format messages are local codes and then they are transformed to KQML messages. At last Agent2 pick-up the content of the messages and deals with them according to its data base and knowledge repository.

When above actions are finished, a side information exchanging process between two agents in different heterogeneous multi-agent systems is over. After some processes are finished, an interaction will be implemented. The mapping table built in the system is used to solve different names of a same object in heterogeneous multi-agent systems.

An example of transforming KQML messages to local XML format messages is followed.

KQML messages:
( ask-one
  :sender Agent1
  :receiver Agent2
  :reply-with result
  :language XML
  :content function( param1,param2, ……)
……)

Local XML format messages after transforming:
<performative>ask-one
  <sender> Agent1</sender>
  <receiver> Agent2</receiver>
  <reply-with>result</reply-with>
  <language>XML</language>
  <content><functionName parameter1 = param1 parameter2 = param2 ……>
  >function</functionName></content>
……
</performative>

4.3 An Application Living Example of Interaction Model

There are two different multi-agent systems which are used to different fields for special goals. One is a invading detection system programmed by C++ on Windows NT operation system and the other is a mail filtration system programmed by JAVA on Windows 2000 operation system. The invading detection system random requests the mail filtration system new mails information and the latter also needs to spontaneously require the former net security information. So the interactions between two multi-agent systems are needed.

Now let’s build the model in the two systems. Keeping the original functions and components are not changed, CORBA mechanism is introduced into the communication parts by C/S model and popular commercial ORB (Visigenic VisiBroker for C++ and VisiBroker for JAVA). The object interfaces are defined by IDL and simultaneously a set of server programs and client programs are built in every system. The contents used in the communication are unified and a standard code set and two codes mapping tables of the two systems are also defined. Combining the XML protocol and corresponding tools the module of dealing with messages is implemented. By interaction test between two multi-agent systems, the feasibility and validity of the interacting model are primarily proved. The further work is
needed for constructing the implementing model and improving communication efficiency.

5 Conclusions
At present, the research on multi-agent system doesn’t come down to the interaction on distributed and heterogeneous environments. Based on CORBA technology and XML, a new interaction model of heterogeneous multi-agent system with layering structure is put forward in the paper. And an example for transforming information has tested the feasibility and validity of the model. The model provides a valuable way to solve the interaction of heterogeneous multi-agent system. In the future, new methods, such as fuzzy [7-10], neural network [11-12] and so on, also can be added into the model for enterprises e-business development.

References