AN INTERMEDIATION SYSTEM BASED ON AGENTS MODELLING TO SHARE KNOWLEDGE IN A COMMUNITY OF PRACTICES

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Abstract: This paper presents an intermediation multi-agent system to manage the distributed collaborative design environment like a CoPs. The JADE-based intermediation system (JAIS) uses community enactment mechanism and agent integration mechanism. The community enactment mechanism is the system kernel and follows the specifications of the CoPs reference model. The system kernel supports four agents (moderator, user, expert and newcomer agents) to manage the community, whereas the integration mechanism supports an intermediation agent to interact, coordinate and monitor the activities between agents. JAIS facilitates the team interaction in a collaborative and distributed environment.

1 INTRODUCTION

We describe an intermediation system able to design distributed and collaborative environment in a community of practices.

Agent modelling is a good candidate to highlight emerging knowledge coming from the CoPs' different members.

JADE (2006) is used as the agent platform for linking the heterogeneous system in a distributed environment like CoPs.

This paper is organized as follows: Section 2 presents the state of art and section 3 describes our proposal. Section 4 defines the intermediation system framework, the communication model, and the agent intermediation model. The last section summarizes contributions and provides some suggestions for future works.

2 LITERATURE REVIEW

A community of practices is defined as a group of agents (human) having quite strong common points such as their social aptitude, skills, and cognitive capacities and which share a set of problems on a given subject, and look further into their knowledge emerging (Nonaka, 1995) and experiments by the daily interactions they maintain. A CoPs provides a "forum" aiming at sharing ideas, solving problems, disseminating best practices, and organizing knowledge (Wenger, 2002). CoPs can be defined as a group of agents which share a substrate of knowledge related to their professional skills, interacting via virtual spaces. The actions performed by the members to reach a consensus on a subject are confronted to enrich agents' knowledge and know-how. Through their actions, the bases of common and individual knowledge are built, and the practices of the community are developed. The context of CoPs refers to a range of rich agents' behaviours which belong to the community (Yildizoglu and al, 2004).

The CoPs ***organisational model***. In a classical manner the terminology used in a CoPs is:

A domain, as defined in (Wenger, 2004), is the area of knowledge that brings the community together, gives it its identity and defines the key issues that the CoPs members need to address. It is the "focus" of the CoPs and evolves over its life span in response to new, emerging challenges and issues (Henri, 2006).

A field: It is the "context" of the CoPs; it can be referred to as the "discipline" or the "branch of knowledge" of the CoPs members.

The practice represents standards, rules, ideas, frameworks, languages, accounts, and documents

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shared by the members. We can affirm that the practice represents knowledge which the community creates, shares and maintains (Wenger and al, 2002).

***Objective (Activities)*:** related to the CoPs as a whole, or to a part of it (a group, a project, a team, depending on the CoPs organisation and functioning modes), an objective can be permanent or temporary.

***CoPs is Characterised* by:** *Membership* and *Cultural Diversity* (from homogeneity to heterogeneity): the nationality, the profile and the organisational culture (Langelier and Wenger, 2005).

Policies: The policies are expressed by standards, rules defined within the community; for example policies to leave/join a community.

Role Member: A role is a behaviour identifier, which represents a whole of actions and the constraints of their appearance. In short in UML a role is a stereotype of class that expresses a collection of operations. It can include constraints on the operations.

The benefit get through the share of information makes possible for the members to develop a single comprehension (common language, and practices) in their field. The process of negotiation is made by a broadcast of the subjects discussed within the whole community. Roles can be allocated to members according to both their experience and level of confidence. In that case, attribution of roles can be done by vote or through a consensual way. Furthermore, members of the community use technological tools which can be synchronous or asynchronous.

Generally, within a community following process occur from the interventions of the members (Deale, 2006):

Exchanges occur when a participant asks a question or proposes an observation made at his workplace or a problem. Furthermore exchanges can lead to experiences sharing where participants develop their observations of their own context.

Agent technology is a good candidate to model CoPs because he offers a great flexibility concerning development of complex and distributed systems. An agent is a software entity that can autonomously perform routine tasks with a level of intelligence (Boudriga 2004) Wooldridge (Wooldridge and Jennings, 1999). Nwana (Nwana, 1996) divides agents into five types: collaborative agents, interface agents, mobile agents, intelligent agents, and smart agents. Goal driven agents typically possess three key characteristics which are autonomy, cooperation, and learning (Etzioni, 1995) (Liang 2002) (Nwana 1996). They are able to acting autonomously, cooperatively, and collectively.

In the field of multi-agent system for knowledge dissemination and management, some systems have already been realized.

Most of such systems are specialized for information retrieval from heterogeneous databases such as SIMS (Arens *et al*., 1996), InfoMaster (Genessereth and al., 1997) RETSINA (Decker and Sycara, 1997) and InfoSleuth (Nodine and *al*., 2000). They are composed of agents that wrap these information repositories, combine and translate information through mediation techniques.

Another important set of systems such as SAIRE (Odubiyi and al., 1997), UMDL (Weinstein and al., 1999), CASMIR (Berney and Ferneley, 1999) is specialized to facilitate information retrieval and to gathering information. Such systems help the user supporting retrieval of the relevant information from one or more information repositories and adapting the interaction with the system to the user's preferences.

Roda (Roda and al, 2003) proposed an agent-based system designed to support the adoption of knowledge sharing practices within communities.

Hammond (Hammond and al, 2004) proposed an approach for virtual communities based on JADE.

3 OUR PROPOSAL

3.1 System Model

This specification is based on the modus operandi of the practices presented in the previous parts. The generic model proposed is used to define the models of the entire system. It also takes into account the composition of the community, the types of interactions, knowledge treatment, themselves and the internal structure of the agent.

This specification has identified the models of our system; it defines the organizational model for the community of practices and some others models like cooperation model, interaction, coordination, and agents models.

As for the models of intermediation system, it is composed of the cooperation model which includes the agent model and the coordination model (communication structure, Knowledge base).The interaction model specifies in the interaction structure the agent activities in terms of agreements between the roles played by members; moreover it

describes the operational interactions results as well as the interaction protocol and social standards applied to the interactions between agents.

The interaction structure controls the interactions and reinforces the policies within the community. It therefore describes in our model all the interactions that represent the activities of the participants through their agents in the community of practices and the activities of agents in the intermediation system. These interactions require coordinated action of several roles in the task resolution. This interaction structure gives the sequence of events which specifies the intent of the interactions between the roles that take place according to the norms, rules and policies. The interaction model can be used to compose an interaction protocol consisting in a set of messages based on the communication acts.

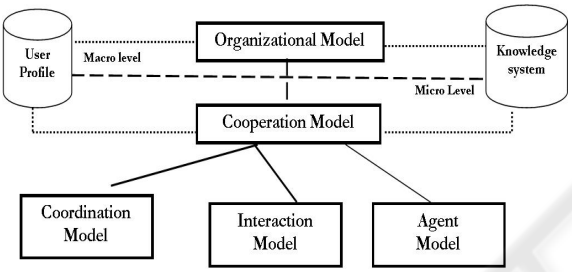

Figure 1: System models.

As we see in the figure 1, the macro level corresponds to the organizational modeling aspect of the community of practices i.e. its offers a description of the themes of the community, to his field, protocols resolution of the tasks, activities, members of the community. When at the micro level it models the cooperation progress between members (cooperation model) while describing the process of cooperation, active in the community, the roles played by members, their skills, as well as the characteristics of agents in the cooperation, as well as their roles. The process of cooperation of all the agents of the system will be modeled through models of coordination and interaction

3.2 Intermediation System

At first we provide here a definition of the concept of intermediation system.

By drawing on the work of E. Rigaud (Rigaud, 2003) which relates to the application of multi-agent systems for virtual organisations for the risks management of SMEs, we define the intermediation system as *"a system that allows all members of the CoPs to create interactions between them, even in geographically dispersed locations, in order to promote the co-construction of meaning, enrich their common knowledge base, improve their skills, share, exchange and the acquire knowledge. To do this, the system must be able to provide the mechanisms needed to manage constraints to be imposed by the functioning of the community"*. These constraints can be tasks allocation, the profiles management, the control the access to the knowledge base, and the processing requests.

The key issues in multi-agent systems are communication, cooperation, and coordination (Papazoglou, 2001). Specifically, communication enables an agent to exchange messages and coordinate activities. Communication allows cooperation and coordination among agents involving in a conversation.

The following figure represents the three layers of our prototype.

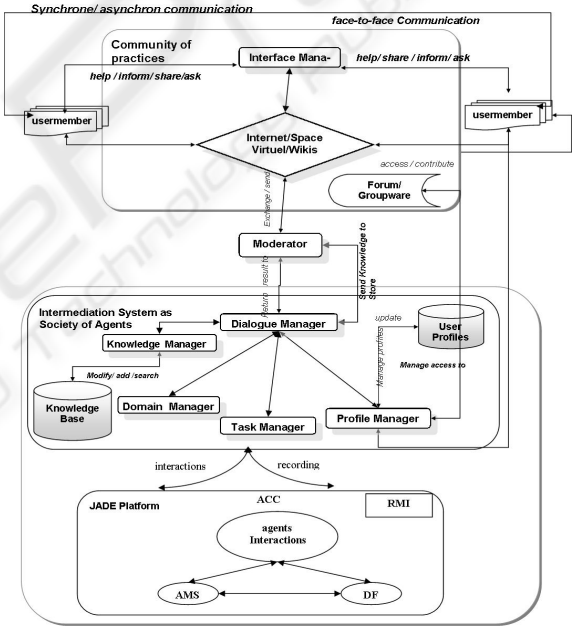

Figure 2: intermediation System.

4 SYSTEM COMPONENTS

Our aim is to design a system based on agent technologies able to respect the constraints imposed by the CoPs environment. These choices are motivated by the sociological approach claiming that the social behaviour of the agents is vital to model all the interactions that occur within a real organization (Lindemann et al, 2001). Our system is composed of three components (figure 1), but we

focuses on the communication model. First of all we defined some agents of our system.

4.1 Definition of Agents

The agents that we use have the capacities to treat their own tasks or to solve problems; that mean's agent's have the explicit capacity of knowledge representation and communication (Huhn, 1999).

Such agents can be adapted to the preferences, the members' needs of the community, based on past experiences and information on the interaction with these members.

Relatively to the models defined by Chun-Che and Huang Lai Gu-Hain (Chun-Che Huang and Gu-Hain Lai, 2004), we built our JAIS agents (Jade Agent Intermediation System) based on AOD models ('acquiring', 'organizing' and 'distributed') and those which are interactions objects like 'profiles' and 'external members'.

In case of ***acquiring*** we define:

(1) *An agent CompagnonModerator* ***(AgCM)*** whose role here is to collect knowledge from various sources (documents, databases, other agents).

(2) *Task manager agent* ***(AgTM):*** in charge of updating the tasks and knowledge. Broadcasted response to ActivMember collected from the community to the knowledge base.

In case of *organizing* we define:

(3)CompagnonModerator agent: ensures the coordination and dissemination of tasks, monitoring the finalization of these tasks. When the task is resolved it transmits retroactively the obtained answers to the *ActivMember*. It reproduces the moderator's features. It is the mediator between the intermediation system and *ActivMember* of the community. It supports the knowledge integration in the community knowledge base (this process is performed with the assistance of the agent knowledge manager.

(4) Task manager agent: in charge of the queries execution. It manages interactions throughout solving tasks.

(5) Domain manager Agent ***(AgDoM):*** he has the features and capabilities to identify the knowledge base questions depending on the field; it works closely with the Agent Task Manager.

(*6) Knowledge manager Agent* ***(AgKM)*** took over the treatment of the knowledge base of the CoPs and the Agent.

In case of ***distributing*** we define:

(7) Dialog manager Agent ***(AgDM):*** in charge to manage upstream exchanges between different agents of the system (via the technological tools used in the CoPs). It play interface role, which help him to treat messages sent from the *CompagnonModerator agent*, it sends and receives messages; he oversees the cycle of discussion in collaboration with the moderator.

(8) Interface / Expert Agent ***(AgI):*** its role is to interact both with other communities as ActivMember of the community in which it transfers knowledge from one practice to another (community to another community) it also plays an advisory role.

Agent responsible for the agent Profiles:

(a) *ActivMember profile Agent* ***(AcMP):*** it stores the information concerning the relationship between end users and specific knowledge (e.g., Thomas is interested in multi-agent system).

(b)*Agent Domain expert profile* ***(ADExP):*** it stores the information concerning the relationship between the domain expert and specific knowledge.

(c) *Agent Knowledge storage profile* ***(AKsP):*** it stores the information concerning the relationship between the Knowledge Storage Agent and the knowledge; e.g., the knowledge about informatics is in the database.

External Members: (a) *ActivMember* (***AcM***)*:* AcM within the community of practice.

In order to allow that these agents interact and share, knowledge, communication mechanisms are necessary to implement these processes.

5 COMMUNICATION MODEL

The Intermediation system is composed of different types of agents. Each of them performs a single task. Collaboration of agents is necessary. To facilitate multi-agent coordination and collaboration, it is vital that agents exchange information via communication about goals, intentions, results, and status to other agents. It is crucial that agents agree on the format and semantics of these messages. Jade follows FIPA standards so that ideally Jade agents could interact with agents written in other languages and running on other platforms.

So, for our case the agent communicate as following:

(1) The ***AcM*** sends a message to request the AgCM to have access to the knowledge base. The

message requests the data required and the analysis technique to be used.

(2) The ***AgCM*** requests the ***AgKM*** via the AgDM to collects the data from the Knowledge base.

(3) The ***AgCM*** receives the collects data and send it to the AcM.

(4) The ***AgDoM*** requests the ADExP containing the information on the relationship between the knowledge and domain expert.

(5) The ***ADExP*** replies to the AgDoM with the information.

(6) The ***AgDoM*** sends the analytical information to the domain expert.

(7) When the domain expert receives the information, some comments are added based on expert knowledge. The domain expert submits the expert knowledge to the AgDM

(8) The ***AgDM*** sends the expert knowledge to the AgCM.

(9) The ***AgCM*** sends the expert knowledge to the Knowledge Storage Profile and requests the Knowledge Storage Profile to obtain information about the relationship between knowledge storage and expert knowledge.

(10) The ***AKsP*** replies with the information to the ***AgCM***.

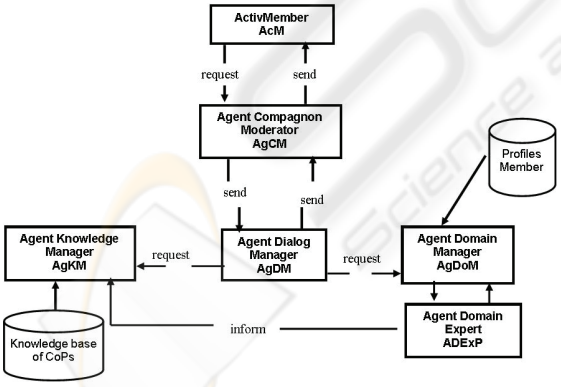

Figure 3: Agent conversation process.

The ***AgCM*** is an interface agent that manages the member's access authority and communication with other agents via the dialog manager. When users want to belong to the community, the system presents an interface based on role and authority. The ***AgCM*** is the core agent of JAIS. The members defined in JAIS can also ask the ***AgCM*** to provide predefined services. The following figure 3 shows how the different agents interact to exchange information in the system.

6 SYSTEM IMPLEMENTATION

The Java Agent DEvelopment Framework (JADE, 2006) was developed by TILab. This software framework uses the agent communication language (ACL) specifications proposed by the Foundation for Intelligent Physical Agents (FIPA) and provides a set of graphical tools that supports the debugging and deployment phases. JADE supports two types of agent containers, the main container and the normal container.

The JADE main container consists of a message transport system (MTS) used for communicating with other agents or agent platforms.

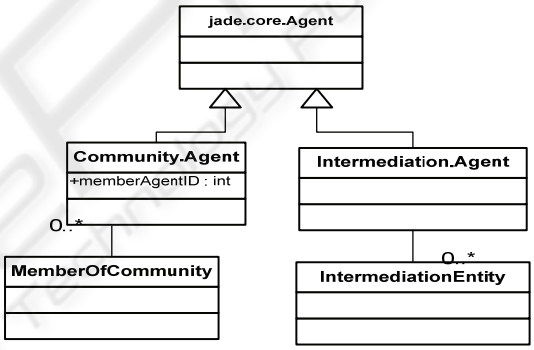

Figure 4: class diagram of the intermediation system.

The agent management system (AMS) is used for managing the agent life cycles such as starting and stopping, and the agent directory facilitator (DF) is used to record the services provided by an agent. Each JADE agent registers itself using the remote method invocation (RMI) provided by the JADE main container. Jade was chosen to implement the JAIS prototype. Agents are created by simply extending the *jade.core.Agent* class. The main class of our system is the *JAISAgent class* (see figure 4). It is an abstract class that all different types of agents must extend. We propose two extensions of the *JAISAgent class*: The *CommunityAgent* and the *IntermediationAgent.* These two different types of agent have different behaviours. The *CommunityAgent* represent all the members of the community of practices include in the organizational model (Macro Level) and the *IntermediationAgent* are the agents include in the Micro level our system.

7 CONCLUSIONS

In this paper we presented the modelization of our intermediation system. This model is composed of organizational model, cooperation model which includes coordination and interaction model. We focused on communication model involved in the coordination model. Interactions between intermediation agents require the implementation of the model belonging to the micro level. The result of our work deals with the implantation of the intermediation system for CoPs. To do this, the design of the system includes definition of the agent communication, the agent behavior, and interaction protocols.

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