MULTI-AGENT ORGANIZATIONAL MODEL FOR eCONTRACTING

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Abstract: This paper covers development and analysis tools, software and system architecture engineering and development methodologies. It introduces the $\mathcal{M}$OISE$^+$(Model of Organization for multI-agent System) model seen under three points of view : structural, functional and deontic. In practical, this model is available as a JAVA component. The original contribution of the paper is the extension of the model to take into account the notion of sanctions. These ones are necessary in order to control the respect of normative specifications (obligation, permission, prohibition) of behaviors. The results of the generalized model are implemented on an eCommerce application dealing with eContracting.

1 INTRODUCTION

Nowadays only conducting eBusiness is still not obvious because of numerous obstacles. To assist users in conducting these transactions, we often associate them with software. In our works, an agent-based system is proposed due to the natural decomposition and abstraction of intelligent agents that mimic a human organizational structure and behavior. We can say that the need for intelligent agents has never been as greater as pressures to make business grow. Research and development activities in this area increased due to the market demands as well as systems needs to solve various and complex problems related to the domain.

This paper offer a complete organizational model, called $\mathcal{M}$OISE$^+$(Model of Organization for multI-agent System) (Hubner et al., 2002), that considers the structure, the functioning, and the deontic relations among them to explain how Multi-Agent Systems (MAS) organization collaborates for its purpose. The objective is to control agents behaviors and respect of rights and duties described by deontic relations. This model practice is represented by a JAVA component which provides an empty definition of an agent able to organize itself regarding the society and others agents.

2 MULTI-AGENT SYSTEM DOMAIN

Within Multi-Agent Systems (MAS) domain, an agent is a real or virtual entity which interacts with a shared environment or directly with others agents by perceiving and acting. Its behavior can be considered as autonomous because of its ability to have a local self-control (Jennings et al., 1998). The capacity of each agent to determine its own goals expresses the concept of agent autonomy. These goals can be determined according to environment configuration, agents motivations, agents included in the system or contracted engagements.

Multi-Agents System can be defined as a distributed system composed by a set of agents interacting according to cooperation or competition modes. Nevertheless the agents of a MAS do not compose a collection of juxtaposed entities but a structure of entities able to work together to solve a problem too difficult for an agent left alone (Chaib-draa et al., 2001). Consequently we can say that there are different kinds of dependencies networks between agents.

Interfering managements and conflicts are the main problems of this domain research due to agents autonomy. These lasts relate to shared environment and common resources between the agents and to agent striving towards personal goals that can be incompatible, complementary or in competition. Sophis-

ticated models of such conflicts management have been elaborated in the domain. These models reveal themselves for example by protocols of negotiation (Zlatev, 2002), organizational models (Dignum et al., 2002), etc.

Our work deals with the development of models that are common to the whole agents. These models define and structure the issues of autonomous agents overall activity. The objective contains two steps: the first one is the construction of contract models, scenarios or institutions in which the common rules governing the operation of the agents could be implemented in a declarative way. The second one is the construction of models and architectures of agents able to conform to these rules. These problems are approached in a context of open and dynamic systems.

The objective of our research activity takes into account the development of a set of models in order to constrain and control the behavior of autonomous agents while making the agents reasoning and preserving their autonomy towards constraints interpretation. We present in the next section an extended model of $\mathcal{M}$OISE$^+$to introduce the notion of sanction. It is necessary in order to control the respect of normative specifications (obligation, permission, prohibition) of behaviors.

3 $\mathcal{M}$OISE$^+$ORGANIZATIONAL MODEL DESCRIPTION

$\mathcal{M}$OISE$^+$is composed by two core notions: an Organizational Specification (OS) and an Organizational Entity (OE). An OE is a population of agents functioning under an OS. We can see an OE as an instance of an OS, i.e., agents playing roles defined in the OS (role instance), aggregated in groups instantiated from the OS groups, and behaving as normalized in the OS. Following this trend, a set of agents builds an OE by *adopting* an appropriate OS to easily achieve its purpose. $\mathcal{M}$OISE$^+$OS is formed by a Structural Specification (SS), a Functional Specification (FS), and a Deontic Specification (DS). Each of these specifications will be presented in the following subsections.

3.1 Structural Specification (SS)

In $\mathcal{M}$OISE$^+$three main concepts, *roles*, role *relations*, and *groups*, are respectively used to build the individual, social, and collective structural levels of an organization.

As shown on the Fig. 1, the SS of a MAS organization is formed by a set of roles, a set of group root specifications (which may have their sub-groups, e.g. the group specification *team*), and the inherited relation on the set of roles.

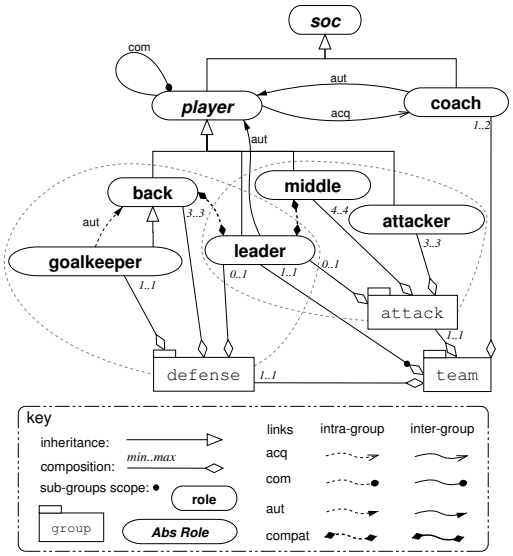

Figure 1: A structure example of a soccer team

3.2 Functional Specification (FS)

The FS in $\mathcal{M}$OISE$^+$is based on the concept of missions (a set of global goals) and global plans (the goals in a structure). These two concepts are gathered in a Social Scheme (SCH) which is a goals tree where the root is the SCH goal and where the responsibilities for the sub-goals are split into missions.

Two types of SCH are necessary to express the various missions:

- The social diagram of execution which defines the missions to be used for the achievement of the root goal.
- The social diagram of sanctions which defines the missions to be used in the sanction part of the deontic specification (see next section).

3.3 Deontic Specification (DS)

The DS explains the way the organization contributes to achieve common goals. The DS is the link between the SS and the SF by defining relations between roles and missions. The deontic specification of the contract expresses rights and duties of the participants in terms of obligations, permissions and prohibitions with time constraints. For instance with a deontic expression, we can express the fact that a role has the obligation to execute a mission by meeting a deadline.

In order to avoid agents lack of deontic expressions respect coming from their ability to reason and to decide autonomously, each deontic expression is associated to sanctions (penalties and rewards). An agent which does not respect an obligation is punished and

if the MAS provide such service its reputation could be prejudiced. These sanctions constitute tools to guide the agents behaviors and to obtain a quite stable society.

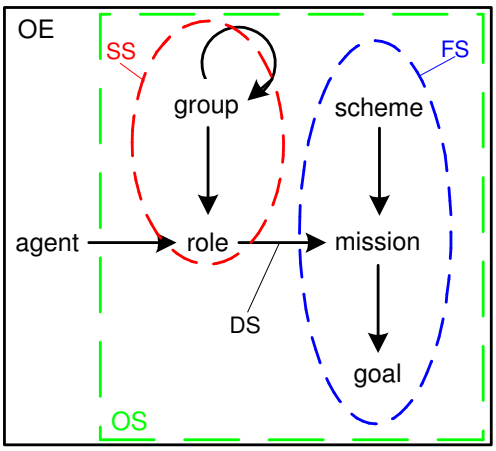

Figure 2: Organizational Entity

Within the $\mathcal{M}$OISE$^+$extension we achieved a sanction is a special deontic expression with a condition. A sanction could be positive or negative. As said in the previous section, we could have a social diagram of sanctions because these special deontic expressions are linked between them. The root deontic expression is generally an obligation. According to the respect of the obligation or not there is a positive or negative sanction. According to the result of this sanction there is another sanction, and so on.

The structural, functional and deontic specifications (SS, FS and DS) constitute an organizational specification (OS). An organizational entity (OE) is an OS instance and the result of agents playing roles. Fig. 2 summarizes the actual organization model.

4 CASE STUDY : ECONTRACTING APPLICATION

Our aim goal is to apply our model on an eCommerce platform used to trade intangible assets. It is basically an eContracting application dedicated to translation services, as described in (Khadraoui and Dubois, 2003)). The model of contract presented hereafter is based on the organizational model $\mathcal{M}$OISE$^+$. Within this framework a contract is seen like an Organizational Entity i.e. like the assignment of an Organizational Specification with a set of agents. The OS could be seen as a *template* of contracts. It defines constraints on groups, roles and missions.

A contract is made up of:

- an unique identifier;
- an header which gathers:
  - a list of agents' identifiers participating in the contract and playing roles appearing in the SS;
  - a list of services involved in the contract with attributes specification defined during the contract negotiation. Services improvement appears in the FS as goals;
  - a list of products involved in the contract with attributes values defined in the contract definition phase. The action of producing these goods appears as goal in the FS.
- some general conditions;
  The contract general conditions represent the whole requirements relating to the provided services or products. The negotiation step of the contract introduces partly the definition of these attributes.
- a Structural Specification (SS) :
  The structural specification of the contract expresses the organization in term of roles (*Employe*, *Employer* or *Arbitrator* for instance), links between roles and groups.
- a Functional Specification (FS) :
  The contract functional specification describes missions to carry out for the services or products realization. The FS consists of social diagrams.
- a Deontic Specification (DS) :
  The DS is a set of deontic expressions which can be an obligation, a permission, a prohibition or a sanction[1] :

⟨DS⟩ ::= '(' ⟨deonticExp⟩*')'
⟨deonticExp⟩ ::= '(' :id ⟨idDE⟩ '::'[⟨DCondition⟩]
' →' ⟨deonticRel⟩ ⟨roleId⟩
'('⟨deonticAct⟩ ⟨relation⟩ ⟨deadline⟩')'')'
⟨DCondition⟩ ::= ⟨DCondition⟩ '&&' ⟨DCondition⟩ |
'Respect(' ⟨id⟩ ')' | 'NonRespect(' ⟨id⟩ ')' |
Valid('⟨actionId⟩')' | 'NonValid('⟨actionId⟩')'
⟨deonticAct⟩ ::= 'do''('(⟨missionId⟩ ⟨argument⟩|
⟨actionId⟩ ⟨argument⟩)')'

[1]We use the BNF meta-language (*Backus-Naur Normal Form*).

A deontic expression ⟨deonticExp⟩ consists in a condition ⟨DCondition⟩ and in an action that is realized if and only if the condition is met.

The field ⟨deonticRel⟩ defines the deontic relation that is activated if the condition is satisfied. It may take the values 'O' for an obligation, 'P' for a permission and 'I' for a prohibition.

The ⟨roleId⟩ refers to the role defined in the SS: the agent playing this role will have to behave according to the deontic relation that precedes this role with respect of the concerned deontic action. This last is defined with reference to the missions (⟨missionId⟩) or to the action (⟨actionId⟩) detailed in the FS. We added a temporal expression to this deontic relation. For the moment we only used the precedence operator '$<$' but an extension is possible.

This deontic specification enables us to specify and structure the contract execution. The setup of a contract is done by defining the header, the general conditions and the structural, functional and deontic specifications. In other words we describe the elements of the contract, the organization of the participants, the clauses and finally the contract execution methods.

Thanks to the structure of $\mathcal{M}$OISE$^+$our model proposal introduces independently the structural part and the functional part of it. The structural specification defines the roles and the obligations linking these roles within the contractual group. The FS defines the whole missions which will be involved in the contract. Missions are organized in the social diagram of execution which represents the contract execution structure. Other missions are located in the social diagram of sanction which specifies the ones related to the sanctions. This allows distinction between normal and exceptional scenarios of the contract (in case of non-respect of engagement). All necessary elements to the implementation of the contractual relation was defined beforehand in the header and the general conditions of the contract. Finally the deontic specification establishes the link between the structural and functional aspects to define the various scenarios of execution with an adequate representation that permits the course of the sanctions and to reason on the consequences of the non-observance of a clause.

5 CONCLUSION

We presented in this paper a new approach that provides an organizational model for Multi-Agent Systems. The concept of organization has been described through three views: an structural view (group, role and relations between them), a functional view (plans, goals and missions) and a deontic view (association of roles with missions involving a deontic operator and a concept of sanction in case of non-respect of commitments).

The notion of sanction has been added to the initial $\mathcal{M}$OISE$^+$model introduced in (Hubner et al., 2002). This constrains the agents behaviors and controls their autonomy. Actually an agent that has to execute its missions can loose commitment because of others missions allowing as well the achievement of local goals and takes priority. In order to avoid a community of airy agents, a reputation could be built on the sanctions associated with validation or not of an executed execution.

REFERENCES

Chaib-draa, B., Moulin, B., and Jarras, I. (2001). Agent et systèmes multiagents. In et Y Demazeau, J. B., editor, *Principes et architecture des systèmes multi-agents*. Hermes, Lavoisier.

Dignum, V., Meyer, J., Weigand, H., and Dignum, F. (2002). An organizational-oriented model for agent societies. In *International Workshop on Regulated Agent-Based Social Systems: Theories and Applications (RASTA'02) at AAMAS*, Bologna, Italy.

Hubner, J., Sichman, J., and Boissier, O. (2002). Moise+: towards a structural, functional, and deontic model for mas organization. In *Proceedings of the first international joint conference on Autonomous agents and multiagent systems*, pages 501–502, Bologna, Italy. ACM Press. ISBN 1-58113-480-0. URL: www.lti.pcs.usp.br/moise/.

Jennings, N., Sycara, K., and Wooldridge, M. (1998). A roadmap of agent research and development. *Autonomous Agents and Multi-Agent Systems*, 1(1):7–38.

Khadraoui, D. and Dubois, E. (2003). B2b econtract solution for teleservices. In *International Conference on Intelligent Agents, Web Technologies and Internet Commerce (IAWTIC2003)*, pages 12–14, Vienna, Austria. ISBN 1740880692.

Zlatev, Z. (2002). Examination of the negotiation domain. Technical report, EEMCS department, University of Twente.