Chapter III
Towards an Integral Approach of Organizations in Multi-Agent Systems

Jacques Ferber
LIRMM – University of Montpellier II, France

Tiberiu Stratulat
LIRMM – University of Montpellier II, France

John Tranier
LIRMM – University of Montpellier II, France

ABSTRACT

In this chapter, we stress the importance of thinking a MAS in all its aspects (agents, environment, interactions, organizations, and institutions), using a more integral vision. We show that a genuine organizational approach has to take into account both the environment and the institutional part of MAS societies. Then, we propose the MASQ (Multi-Agent System based on Quadrants) meta-model, which constitutes an abstraction of the various aspects of an OCMAS (Organization Centered Multi-Agent Systems), extending AGR (Agent/Group/Role). MASQ is based on a four-quadrant framework, where the analysis and design of a system is performed along two axes: an interior/exterior dimension and an individual/collective dimension. We give a conceptual definition of this approach and we will show that it is possible to apply it to practical models.

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1. INTRODUCTION

Multi-agent systems (MAS) are often considered as collections of agents that interact together to coordinate their behavior to achieve some individual or collective goal. The research in MAS domain focuses therefore on the study of the agent-based interaction, which roughly could be divided in agent-centered interaction and mediated interaction. Agent-centered interaction is the most known and well understood as the works of FIPA (2005), the standardizing body of the MAS domain, reflect it. The interaction is considered from the perspective of a single agent communicating with another agent in isolation. The research in mediated interaction tries to complement this perspective and concentrates rather on distributed and social aspects, when many agents are in interaction. Mediated interaction is based on the idea of structuring the interaction by adding a sort of middleware responsible to manage the complexity of the interactions between many agents. Depending on the kind of interaction, we can further have two types of mediated interaction: environment-based interaction and organization-centered MAS (OCMAS) interaction.

In the case of environment-based interaction research has concentrated on the physical distributed aspects of interaction. The environment is considered as a first-class abstraction at the same level as the agents, and has its own state and laws of change (Weyns, Omicini & Odell, 2007). The main reason of using an environment as a medium of interaction is to control (independently of the agents) the effects of external events or parallel actions produced simultaneously by two or more agents (Ferber & Müller, 1996). The works on environment-based interaction concentrate mainly on how to represent objects in an environment, how to specify the actions of agents and the various laws of change, and how to execute the overall system dynamics. The other problems in environment–based interaction are similar then to those of distributed systems: openness, security, coherence, load-balancing, etc.

In the case of OCMAS, an emphasis has been put on the social aspects of interaction and inspiration comes from human forms of organization. It becomes more and more accepted that the interaction can be specified and structured in terms of organizations, roles, groups and norms (Dignum, 2004; Ferber & Gutknecht, 1998; Ferber, Gutknecht & Michel, 2004). In this view, an organization is seen as a collection of agents that can be considered together in groups, playing roles or regulated by organizational rules. For instance, in AGR model (Ferber & Gutknecht, 1998) the agents can interact only inside a group in which they play roles. An agent can play one or many roles and enter into one or many groups. A role is a general concept to which a MAS architect can associate various semantics (i.e. rights, obligations, norms, powers, patterns of behaviour, etc.). Similarly, in the family of MOISE models (Hübner, Sichman & Boissier, 2007) an organization is considered coherently under its functional, structural and deontic dimensions (for all these aspects, see also Chapter II, Modelling Dimensions for Multi-Agent Systems Organizations, by Coutinho et al.).

Although the initial studies of organizational interaction have not suggested explicitly the use of an organizational environment, the specification of an organization is made however independently of the participating agents and therefore at the execution time it is necessary to introduce a way to handle it. For instance, an organization could be designed architecturally as an organizational layer to keep trace of the events and information that are organizationally important. In MadKit (2004) the core layer (kernel) which implements the organizational environment has as basic functionalities to let agents join groups, associate roles to agents and let only members to the same group to interact. Another way to represent an organization is to reify it at the same level with other agents within a socially constructed