Chapter X

On the Convergence of Analysis and Design Methods for Multi-agent, Component-based and Object-oriented Systems

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The general trend of the information technology evolution towards component-based and software agent-based systems calls for an integration of the analysis and design methods proposed up to now. As a step towards such an integration, we propose changing the paradigm on which analysis and design methods rely, shifting from the individual-centered notion of a "service" to the group-centered notion of a "game". Instead of designing a system on the basis of the services that each object or component can provide, we propose considering the whole game in which agents, components and users can play various roles in order to perform some common task. We first review the recent evolution of analysis and design methods used to develop object-oriented, component-based, knowledge-based and multiagent systems. We propose an approach to specify the service game of a system based on the use of an extended form of use case maps. We show how this simple technique could help to the convergence of analysis and design methods used to specify systems using object-oriented, component-based, knowledge-based and multiagent approaches.

INTRODUCTION

During the past ten years we have witnessed an important evolution in information system design methods both in the research and industrial arenas (Brodie et al. 1992, Huff et al. 1992). One of the main steps for the industry has been the adoption of object-oriented analysis and design methods (OOADM) for the development of software systems. Another important step was the adoption of the Unified Modeling Language (UML) (see for example Ericksson et al. 1998) as a standard notation for various kinds of models that could be used when applying an OOADM to a development process. More recently the attention of the industrial players has been focused on component-based development and several OOADMs provide techniques to build a software system from the assembly of software components (Szyperski 1998). On the technological side, we have witnessed the rapid evolution of the Internet and intranets and the proposal of several new types of web-based applications. Standards have been proposed for managing distributed objects (CORBA, DCOM, Javabeans) (Orfali et al. 1996) and the technology of software agents (static or mobile agents) receives more attention from industry (Johnson 1997). User requirements have also evolved, taking advantage of these new technologies (web-based applications, distributed objects, data-warehousing, etc.). Hence, software designers face new challenges resulting from the availability of this large variety of methods and technologies and from sophisticated users' needs leading to systems of an ever-increasing complexity. During the past decade most of the efforts have been devoted to the development of modeling techniques and tools applicable at the object-level. Now, there is a need for modeling techniques applicable at the "agent-level". These techniques will help designers to build complex architectures composed of objects and/or components, as well as agents that will be able to solve problems using distributed resources (data, behaviours, etc.) such as in distributed information systems and in electronic commerce applications. Let us remark that the only tool provided by UML for modeling systems and subsystems is the "package diagram" which is quite limited. Furthermore, beyond the mere representational aspects, designers need guidelines to develop complex architectures. At the object level practitioners proposed to use design patterns (Bushmann et al. 1996) to model and implement useful behaviors involving one or several objects. There is a need for useful architectural patterns involving software agents as well as objects and software components.

During the past two decades much work has been done on analysis and design methods for knowledge-based systems such as the CommonKADS method (Schreiber et al. 1994), on the development of libraries of so-called problem solving methods ("PSM") and on the use of ontologies to harmonize the use of different vocabularies by systems developed separately (Gomèz Perèz et al. 1999). Although these methods have evolved independently from OOADMs and component-based methods, they can offer several important mechanisms (problem solving strategies, use of ontologies) when it comes to the integration of components and agents in complex systems.

During the past ten years researchers in the field of distributed artificial intelligence (Moulin, Chaib-draa 1996) have extensively studied the behavior of groups of agents composing so-called multiagent systems (MAS). Such systems are composed of software agents interacting in order to solve problems that each

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