Abstract. The paper presents the developed technology and software tool for design and implementation of knowledge-based multi-agent systems. The software tool comprises two components that are "Generic Agent" and "Multi-agent System Development Kit" (MAS DK). The former comprises reusable Visual C++ and Java classes and generic data and knowledge base structures, whereas the latter comprises several developer-friendly editors aimed at formal specification of the applied multi-agent system (MAS) under development and installation of the resulting application in particular computer network environment. The developed technology and MAS DK were used in the design and implementation of the MAS prototype for computer network assurance and intrusion detection and distributed attack simulator. Several other applications are currently under development.

1 Introduction

At present development of software tools for design and implementation of multi-agent systems (MAS) is the task of great concern. Till now a good deal of such software tools has been developed. Between them, the most known ones are such as AgentBuilder [1], MadKit [9], Bee-gent [2], FIPA-OS [10], JADE [3], Zeus [4], etc.

However, unless the great deal of such tools they do not meet wholly the present-day requirements. The latter can be divided in two groups ([11]). The first group corresponds to the properties of the technology supported by a software tool. They are ability to support for the entire circle of MAS design, development and deployment, friendly interfaces for all categories of users, visual programming style, concurrency of the development, automated documenting, etc. The second group of requirements concerns to the properties of the target MAS. These requirements are such as support for the ontology development, support for the development of the basic MAS components (agent mental components and inference mechanisms, agent behavior scenarios, communication component, etc.) and support for modifiability of MAS on the whole.

These requirements form the focus of the Multi-agent System Development Kit (MAS DK) that is being developed by authors. Below its first version and application examples are described. Section 2 outlines ideas implemented in MAS DK. Section 3 describes the basic phases of the supported technology. Section 4 describes generic

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Section 5 outlines capabilities of MAS DK in communication component development. Section 6 presents several applied MAS prototypes, which have already been developed or in progress of development now on the basis of MAS DK. The concluding remarks outline the future research.

2 Peculiarities of the Developed MAS Technology

In general, the life cycle of knowledge-based MAS, like any other information system consists of a number of standard phases. They are development of a business model and the requirements, analysis, design development and deployment, testing, maintenance, and evolutionary modification. The quality of any information technology (IT) is assessed over such properties as time spent for a system design, development and deployment and quality of the resulting system.

Despite the visible diversity of MAS applications, and variants of their implementations, one can notice a high percentage of common functionalities that are practically independent conceptually from application to application. It is reasonable to implement these "commons" within a software tool as generic classes and data structures, and reuse them as "ready software components" in various applications. Such "ready components" could decrease substantially the total MAS development time.

This view is the first idea of MAS DK. Its practical realization supposes to carry out a formidable work to find such "commons" over many applications. Within the developed MAS DK this principle is realized in the form of so-called "Generic Agent", which comprises a hierarchy of standard software classes and generic data structures. Generic Agent is a nucleus that is "bootstrapped" by the developer via specialization of the software classes and data structures and via cloning software agent instances composing MAS. These procedures are supported by a user-friendly editors of MAS DK, which is the second component supporting the MAS technology.

The second idea of the technology aims at providing for modifiability of an application during its life cycle. Sometimes it is necessary to modify an agent's knowledge base, to add a new template of message, to install a new agent, etc. MAS DK provides these capabilities due to formal specification of the target MAS in terms of so called "System Kernel". The latter contains the complete information about the developed MAS. It is stored and if necessary is capable to re-generate MAS software code in a semi-automatic mode. If MAS has to be modified, it is necessary to modify System Kernel and to re-generate the respective software code.

3 Summary of MAS Technology

The MAS technology comprises two main phases. At the first one the application is specified in terms of a MAS DK specification language resulting in so called "System Kernel". At the next phase System Kernel is used for MAS deployment. At this phase the software of MAS is generated and software agents are situated in computers of the network according to the MAS specification in System Kernel.