ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

DESIGNING A COOPERATIVE DISTRIBUTED SYSTEM USING THE MULTI-AGENT SYSTEMS

Cicerone Laurentiu POPA[1], Lidia Florentina PARPALA[1], Costel Emil COTET[1]
[1]University Politehnica of Bucharest, Faculty of Engineering and Management of Technological Systems, Machine and Production Systems Department, Virtual Enterprises Management and Engineering Training Laboratory
E-mail: laurentiubest@yahoo.com, Lidia.Parpala@gmail.com, costel@mix.mmi.pub.ro

Keywords: agent technology, cooperative system, virtual enterprise

Abstract: A cooperative system represents a system where different users or agents work together at the same project from different locations. Agent technology involves building complex applications from autonomous, interacting components. It is particularly suitable for modeling, large-scale distributed simulations, analyzing complex systems, and improving and optimizing their behavior. This paper presents the main steps and the main elements needed for designing a cooperative system; we present a new classification for agents that are used in distributed environments and some solution for problem resolving in distributed system using the agent technology.

1. INTRODUCTION

Enterprises in today economy context must consider collaboration with others to realize the product development in short time, with a lower cost, a short delivery time and a product that satisfy the client demand. Actual tend is to realize multidisciplinary cooperative systems for collaboration in real time between all professions involved in product development at the enterprise level. This collaborative environment actually constitutes a virtual enterprise. [1]

2. COOPERATIVE SYSTEM DESIGN

The design of a cooperative system should start from:

- activities type;
- the number of the partners involved in the project;

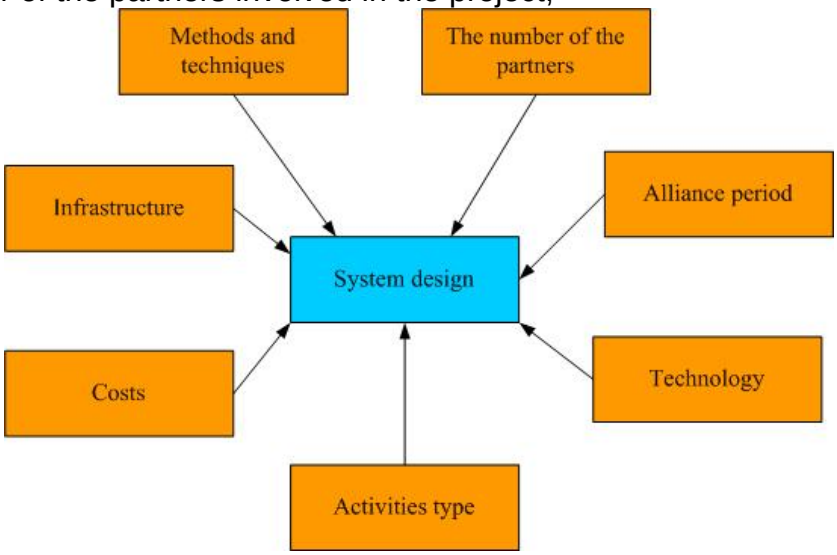

Fig. 1. Cooperative system design.

- a better knowledge about de technologies needed in the system and their implementation;

- the infrastructure and the relation with the outside the system partners;
- what techniques and methods will be used in the system;
- the cost of design, realization, maintenance and development of the system;
- the lifecycle time of the product. [6]

All the partners from the virtual enterprise should answer to the following questions:

- what methods should we use to realize new and innovative product?
- how the workflow can be accelerated?
- how can we make a better product with a lower cost?
- how can be sure we will be first on the market with this product?
- how can we prevent the delays in fabrication?

3. AGENT TECHNOLOGY

Agent technology involves building complex applications from autonomous, interacting components. It is particularly suitable for modeling, large-scale distributed simulations, analyzing complex systems, and improving and optimizing their behavior. It can be perceived as a modeling paradigm, a problem-solving paradigm, or a software-engineering paradigm.

In agent-based programming, the agent is the basic element of distribution. Each agent serves as an independent component with its own local state and execution model. The agent designer can choose to assign a particular set of functionalities to an agent, specify the types of events and messages the agent may invoke or respond to, and implement those triggers and/or responses. In building an agent-based system, each agent behaves independently, interacts with other agents through the events and messages that are communicated from one agent to another. [7]

In agent field we can find many ways of classifying intelligent agent software. Nwana provides a typology defining four types of agents based on their abilities to cooperate, learn, and act autonomously; these are: smart agents, collaborative agents, collaborative learning agents, and interface agents. [3]

Agents have also other characteristics [8]:

- - autonomy: agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state;
- - reactivity: agents perceive their environment, (which may be the physical world, a user via a graphical user interface, a collection of other agents, the Internet, or perhaps all of these combined), and respond in a timely fashion to changes that occur in it;
- - pro-activeness: agents do not simply act in response to their environment, they are able to exhibit goal-directed behaviour by taking the initiative;
- - social abilities: agents interact with other agents (and possibly humans) via some kind of agent-communication language;
- - mobility: the agent is able to transport itself from one machine to another;
- - coordination;
- - communication;
- - cooperation.

We consider that the agent's environment is very important and talking from the environment perspective we propose a new classification based on three types of agents:

- - influence agent: is an agent with many privileges. The results of his action made for his own purpose realization will change the environment condition. Because of

these changes other agents will be affected, their action will be deleted, modified or delayed.

- - accessible agent: is the agent with a few privileges . When the environment will change he must wait for an other agent to realize the purpose and his action will be affected.
- - mixed agent: in his action the agent become accessible or influence agent as a result of the action of some elements.

The agent A influence starts when an Agent B is modifying his settings or is delaying his action, and ends when the B agent can continuing to do his action without changing his own purpose. [5]

From time perspective the influence can be:

- - a short term influence, for example an agent A can delay the agent's B action until he will realize his own purpose.
- - unlimited term influence, for example an agent S which manage the store department assign all the available material to the agent A1 (agent A1 manage a machine from the manufacturing department), if agent A2 needs the same material his action will be influenced for unlimited term.

To avoid these situations is better if an agent influence and freedom of action over the environment ends when the other agent's actions are affected. To do this the system must be able to determine if these actions are bad for the system.

4. CASE STUDY

We will suppose a problem that appear on machine 3 from the manufacturing department. To identify the problem, the agent that manages the machine activity will make a hierarchical verification and will eliminate the possible problem of interruption of machine functioning step by step. First the machine3's agent will announce the system that a problem occurred in the activity.

The supervisor agent must manage efficiently the crisis; he will communicate to the others agents involved in the process that a problem occurred in the system. The supervisor agent can decide: to interrupt all the activities from the system, or to overlying the operations. The supervisor agent will offer a solution by planning-programming-reprogramming the activities affected.

After the machine3's agent announces the problem to the supervisor agent he will make a check of the general situation of the machine:

- First he will have an exchange of information with the agent that manages the delivery of electrical energy in the system. If the delivering of electrical energy for this machine is interrupted the machine3's agent will ask for the reason and will try to find a way to resolve the conflict. If he is not able to do it he will ask to the supervisor agent to manage this conflict because he is an influence agent in the system and has more privileges.
- Machine3's agent with the supervisor agent's help will verify the workpiece and part supply. If the supply is interrupt maybe the previous machine from the system is damaged (the one that makes a previous machining of the part) or the conveyor is damaged. Also delay estimation is needed. In all this cases the machine3's agent will wait for new indications and solutions from the supervisor agent
- The agent will make verification for all the functions of the machine to find the operation that can't be made on this machine because of the damaged.
- Machine3's agent will make a part integrity verification using the data that come from the supervisor agent. If the workpiece is damaged or there is a machining

error for this part made on a previous machine the agent will decide the part dismissing. Also a material error may occur (if the workpiece is made from other material that was design). The agent will verify the machine's tool changer, if there is any problems with the tool transfer or tool assemble on the machine. For example to replace a tool from the machine tool changer the machine3's agent will contact the storage agent that can tell if there is a tool available, the time needed to transport the tool to the machine.

- The supervisor agent will also send a message to the troubleshoot agent that manage the human resource involved in the activity. The agent will generate a report and will supervise directly the human resource intervention and will give real time information and will make time estimation for fixing the problem.

5. CONCLUSIONS

Agent technology represents a new way of analyzing, designing, and implementing complex software systems. The environment has a direct influence to agent's action, so an agent approach from the environment perspective is very useful. In this paper we made a new classification of agents (influence agent, accessible agent and mixed agent) and also we described the main types of influence according with this new classification. Using this proposed taxonomy we intend to realize a distributed system architecture supporting the exchange of information and the sharing of knowledge between actors, in order to study the agent interaction and analyze their behavior in this system.

REFERENCES

[1] Dragoi, G. (2003). Intreprinderea integrata: metode, modele, tehnici si instrumente de dezvoltare si realizare a produselor, Politehnica Press, ISBN 973-8449-25-1, Bucuresti

[2] Caglayan, A.; Harrison, C. (2002) *Agent Sourcebook: Commercial Agent Software,* Wiley Computer Publishing

[3] Nwana, H. S. (1996). Software Agents: An Overview. Knowledge Engineering Review, Cambridge

[4] Popa, C.L. & Hadar, A (2006). A cooperative system design based on agent technology, Proceedings of 17th International DAAAM Symposium, Katalinic, B. (Ed.), pp. 311-312, ISBN 3-901509-57-7, Vienna-Austria, Published by DAAAM International, Vienna

[5] Popa, C.L. (2005). An Agent Classification From the Environment Perspective, Proceedings of 16th International DAAAM Symposium, Katalinic, B. (Ed.), pp. 309-310, ISSN 1726-9679, Opatija-Croatia, Published by DAAAM International, Vienna

[6] Russell, S. J., Stuart, J., Norvig, P. : Artificial Intelligence: A Modern Approach, Englewood Cliffs, NJ, Prentice Hall, 1995

[7] Weiss, G.: Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence, The MIT Press, ISBN 0-26223-203-6, Cambridge, Massachusetts, 2000

[8] Wooldrige, M.: An Introduction to MultiAgent Systems, John Wiley&Sons, 2002