

Mobile agent based project schedule optimization system

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Abstract. Scientific and technological schedule makes the products' life cycles be becoming shorter. The companies should make product research and putting into the market more rapidly. Product rapid development and popularization depends on project management, and project schedule optimization is the core of project management. The structure of the project schedule optimization was detailed analysis and mobile agent was import in project schedule optimization system. The event model of mobile agent, the moving process, the model of aglet and the implement method of mobile agent in project schedule optimization system were introduced. This analysis shows the mobile agent the internal structure and negotiation algorithm abundantly. On the Aglet platform, the code of the agent internal structure is programmed and optimized, and the negotiation algorithm is realized. The system makes full use of the characteristics of mobile agent in the process of project schedule optimization. It will play an important guiding role for the development of the whole project schedule optimization system and the application of the mobile agent in the project schedule optimization system.

Key words. placeMobile agent; Project schedule; Architecture; Aglet; Multi-agent system.

1. Introduction

Project management is the core content of the schedule management. In order to effectively control the project time, resources and costs of the process, the project schedule must be optimized throughout the entire process of project management [1]. Schedule management covers the organization and quality assurance of the project implementation process. It includes the allocation of project factors of production, but also reflects the continuity of project implementation and balance. The

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preparation of the schedule plan is an important part of the project management activities. It is already forming a complete system of preparation and preparation tools. Therefore, how to prepare the scientific schedule plan are great significance for the construction and the benefits of the project. Project schedule management, also known as time management or project duration management, refers to the allocation of resources according to the principles and the overall goal of progress, to the construction of the various stages of the content, procedures, duration and overlapping relationship planning and put into practice. Project schedule management is also a process of coordinating and adjusting the content of all aspects of the project implementation process to a certain extent.

The popularization of computer technology makes the project management information system widely used. With the Agent technology in network management, e-commerce, workflow and business process management and other fields are more and more widely used. It is of great practical significance to introduce agents into project schedule optimization [2].

In recent years, with the theory of network manufacturing, cloud manufacturing and so on, as well as mobile agent, radio frequency identification technology, the application of mobile terminal products, a large number of scholars from the concept and application point of view put forward more theoretical models and technical means for manufacturing industry to information, intelligent transformation provides a theoretical basis and development direction. With the increasing complexity of modern engineering projects, the traditional schedule management has been difficult to meet the needs of project management, the progress of the phenomenon of the prevalence of delay. In this context, for the collaborative construction, the use of emerging information technology on the progress of management theory and method innovation has important theoretical and practical significance.

2. Overview of Mobile Agent

With the development of computer technology, agent and multi-agent system become the hotspot of research [3,4]. In general, Agent is a soft and hard entity in a certain environment. It can automatically sense, reason, plan, communicate and react to the environment according to the knowledge and surrounding time. It has the autonomy, initiative, reactivity sociality, and other characteristics. Multi-agent system is composed of multiple agents coordinated with each other, mutual cooperation, and mutual service composition of the loosely coupled system collection. Agent technology is suitable for dealing with complex, cooperative and unpredictable problems. It solves the problem of information resource sharing and effective use of expert knowledge, and can realize the simultaneous operation and interaction of multiple systems. Multi-agent system provides decentralized control and parallel processing, which can quickly solve the problem [5]. Multi-agent system can solve different problems through the combination of multiple agents. Agent for different problems can be modularized, thus enhancing the system maintainability. Mobile Agent is characterized by mobility, which can move and run autonomously among different machines in a heterogeneous network environment. This model can effectively re-

duce the network load and improve the communication efficiency and adapt to the dynamic changing network environment.

3. Current research

The project portfolio selection problem (PPSP) has been widely studied during the last decade. Most studies on the PPSP generally dis sever the inherent relationship between portfolio selection and project scheduling. Inclusion of project activity scheduling as a subproblem of project portfolio selection helps improve the overall organization performance even though it increases the complexity of decision making [6].

Project scheduling problem is a typical NP-hard problem. Generally, the artificial intelligence solutions to solve scheduling problem include heuristic algorithms, intelligent optimization algorithm, and MAS-based method [7]. There are many algorithms have been used to solve the problem of project scheduling optimization. Among all the heuristic algorithms, Lagrangian relaxation algorithm performs well on scheduling problem due to its high efficiency to get high quality resolutions [8]. The performance of intelligent optimization algorithm on the aspects of rapidity and validity is outstanding to search optimal resolutions in scheduling problem [9].

Sun Chengshuang *et al.* bring forward an overall framework of the project risk management system (MACPRMS) based on multi-agent technology on the basis of analyzing the risk management process of the project. Based on the analysis of the collaborative management of construction project organization, Chen Jianhui researched the modeling and algorithm implementation of the organization and cooperation management of project management by using multi-agent techniques. Through the combination of the concept of collaborative management and modern optimization technology, they achieve the multi-objective collaborative management and reasonable allocation and use of construction project resources. On the basis of analyzing the system requirements, Li Li *et al.* using Agent technology, studied the agent model, structure and basic task of construction project management system. Keesoo Kim studied the impact on project progress of the behavior of subcontractors, general contractors when the progress of the project changed and the schedule was not matched to the resource supply. They developed an agent-based distributed collaborative framework to solve this problem with a currency-based compensation negotiation method that would reduce the subcontractor's additional costs, improve the subcontractor's work motivation, and be able to complete the project on schedule.

Although these researches have gained amounts of approaches to solve scheduling problem, they cannot totally give a systematic solution of mobile agent based project schedule optimization.

4. System architecture

4.1. Agent architecture

Figure 1 shows the mobile agent-based project schedule optimization system structure. In the Agent platform A, the project managers use the Project Decomposition Agent, Task Assignment Agent and Optimization Control Agent realize the management operation and get the Process Agent and Experience Agent. The project staff works on the Agent platform B to generate the Process Agent and the Experience Agent. All the Process Agent and Experience Agent can achieve two-way data exchange with the Database server.

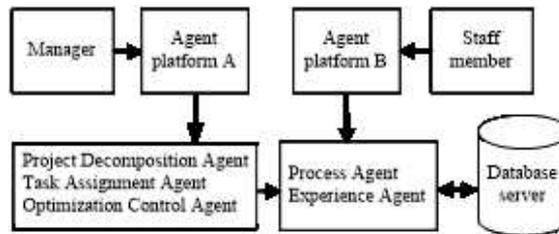


Fig. 1. project scheduling optimization system architecture based on mobile agent

Figure 2 shows multi-agent architecture of the project scheduling optimization system based on the mobile agent. The agents in the system include project decomposition agent, task assignment agent, process agent, optimization control agent, quota agent and experience agent.

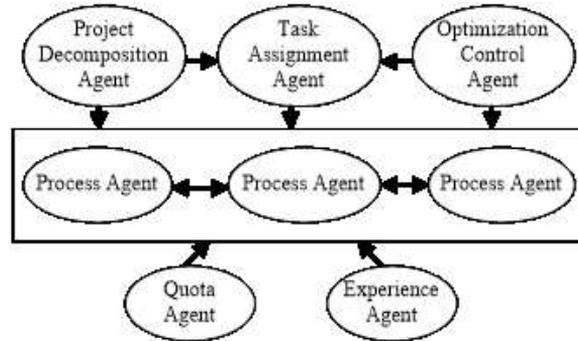


Fig. 2. the multi-agent architecture of the project schedule optimization system

4.2. Project Decomposition Agent

The project decomposition agent has the knowledge of WBS. It decomposes the project from top to bottom layer by layer, and decomposes the whole task from the project task to each specific work process according to the level, and forms a work breakdown structure model. It works as follows: After inputting the project infor-

mation in the computer terminal, the project manager automatically generates the auxiliary project of the project decomposition agent and interacts with the system. The agent identifies the state information of the project through the perception, and then the internal decision module decomposes the project. Figure 3 shows the internal structure of the project decomposition agent and its communication relationship.

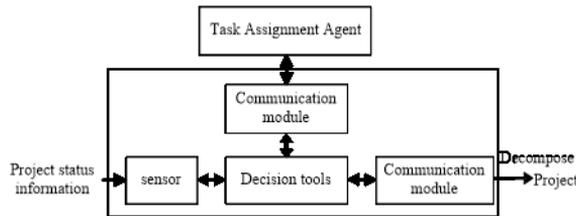


Fig. 3. the internal structure of Project Decomposition Agent and its communication relationship

4.3. Task Assignment Agent

Task Assignment Agent itself has the knowledge of PERT/CPM. It divides the process activities of the project decomposition into different agents, that is, different agents to represent the various processes, and the Agent itself contains the project logic relations. It works as follows: After decomposing the project, the system automatically generates the task distribution agent to communicate with the project decomposition agent to get the information of each process after decomposition. Meanwhile, the process constraint is also taken into account to allocate the process. The task assignment agent interacts with the system and creates a process agent, assigning each process agent to the work machine for work. Figure 4 shows the internal structure of the task assignment agent and its communication relationship.

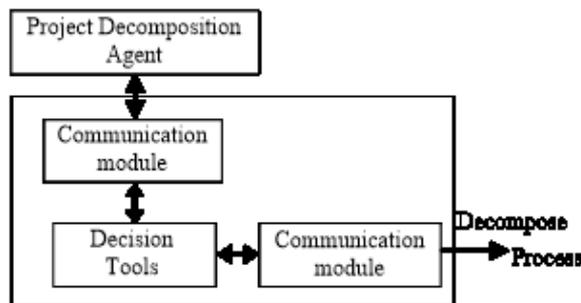


Fig. 4. the internal structure of the Task Assignment Agent and its communication relationship

4.4. Quota Agent

Quota Agent contains the quota library; the quota library reflects the average level of social production. Quota Agent's personality analysis tools are provided by Process Agent. The Quota Agent is connected with the Process Agent, the Control Agent and the Experience Agent to obtain the exact information of the existing process. By querying the quorum library, the Quota Agent compare and match the personality analysis tool with the knowledge to obtain the relevant data of each process in the project and to analyze the result to the Process Agent, and to guide the calculation of the duration of the process agent. Figure 5 shows the internal structure of the Quota Agent and its communication relationship.

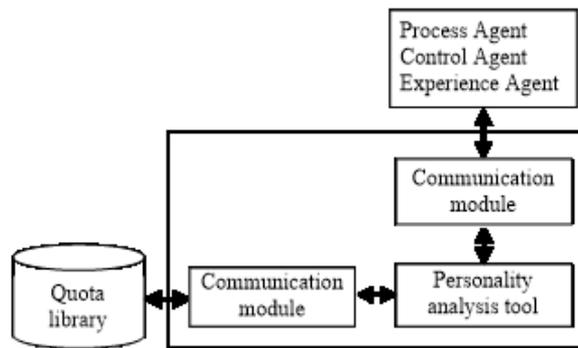


Fig. 5. the internal structure of the Quota Agent and its communication relationship

4.5. Experience Agent

An Experience Agent contains the similar work of the previous case information, such as duration, number of workers, materials used, costs, and so on. Experience is a summary of a great deal of work practice. As an expert, an Experiential Agent can provide great support and help for project control and decision-making. The working process is mainly to communicate with the Process Agent and the Optimization Control Agent, get the basic and individual information of the existing project, compare with the database information, and pass reasonable data to the Process Agent. Figure 6 shows the internal structure of the Experience Agent and its communication relationship.

4.6. Optimization Control Agent

Initially generated duration plan is usually not in line with project duration, cost and other aspects of the constraints, it must be further optimized. It mainly includes: time optimization, cost optimization, and resource optimization. This paper mainly study the time optimization. It works as follows: First, at the computer terminal of the project manager, the Optimization Control Agent obtains the planned duration

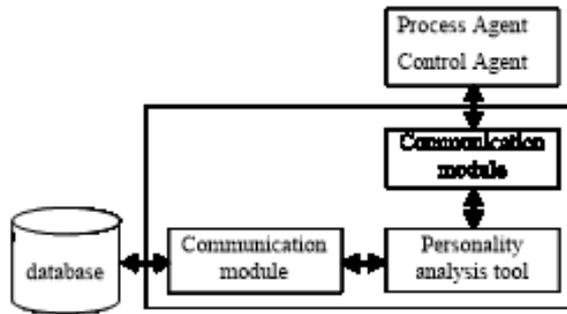


Fig. 6. the internal structure of the Experience Agent and its communication relationship

from the other end, and the decision-making tool is responsible for the comparison of the construction period and the contract duration. Time requirements and the task of each agent in the system are completed. If not meet the requirements, the Optimize Control Agent needs to return the unqualified information to the Process Agent in consideration of various constraints. The Process Agent with the duration requirements and programs were re-assigned to the process machine for duration calculation. This process is repeated until the duration of the contract is met. Figure 7 shows the internal structure of the Optimal Control Agent and its communication relationship.

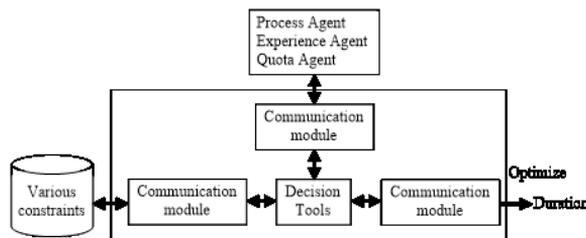


Fig. 7. the internal structure of the Optimal Control Agent and its communication relationship

4.7. Process Agent

The Process Agent can automatically negotiate with other agents to acquire enough knowledge to calculate the duration, cost of resources and costs. The purpose of each Process Agent is to minimize the costs. Its main task is to calculate the time limit and feedback information to the optimization control agent. When the duration needs to be adjusted, the appropriate process agent can be selected by the algorithm set by the system. Figure 8 shows the internal structure of the Process Agent and its communication relationship.

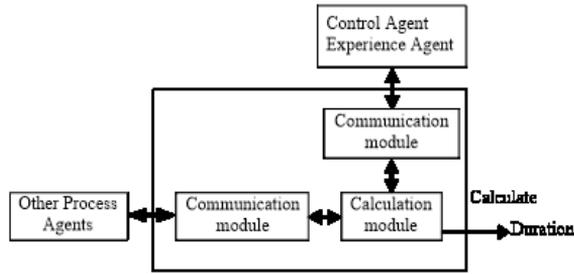


Fig. 8. the internal structure of the Process Agent and its communication relationship

5. Realization of the placeMobile Agent System in Project Scheduling Optimization

5.1. Event Model of the Agent

Aglets is a Java-based mobile agent system developed by IBM. The source code and documentation are completely open to the public, making it ideal for learning and developing applications. Aglets is an Applet object, with agent behavior, and also has the characteristics of agent and Applet object. Aglet is a mobile agent. Aglets system provides a visual proxy service interface Tahiti, can be moved between the machines installed Tahiti, can also be moved between the different Tahiti servers of the one machine [10]. Figure 9 shows an Aglet event model.

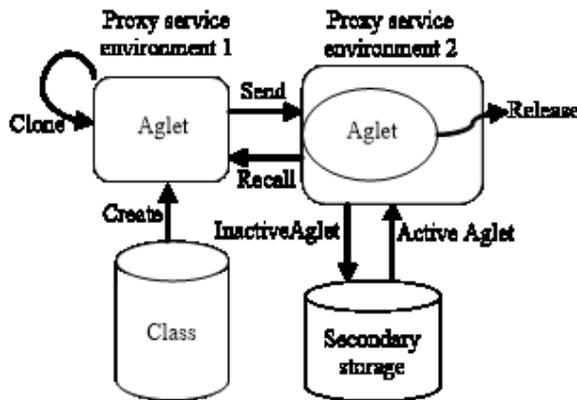


Fig. 9. an Aglet event model

5.2. Event Model of the Agent

Move can be divided into two types: strong mobile and weak mobile. A moveable process consists of three segments: code segment, data segment, and execution segment. A strong move consists of a movement of code segment, data segment,

and execution segment, while a weak movement contains only movement of code segment and data segment. Aglets is a weak mobile system, the requirements of the target machine is able to run code independently, and can simply move. So that the amount of data transmitted less, the operation cost less, it is high efficiency. The lines and conditions of the Aglet moves are included in the task code. Figure 10 shows the Aglet movement process.

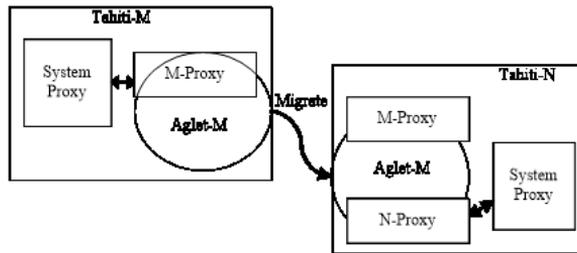


Fig. 10. the Aglet movement process

The codes of Client Aglets send email-Aglet are as follows:

```
AgletContext context=getAgletContext();
AgletProxy proxy=context.createemailAglet (null."example".getProxy());
URL url=new URL();
remoteProxy=proxy.dispatch(url);
```

5.3. Aglet Model in the Project Scheduling Optimization System

The mobility of the Aglet can be realization by dividing the supported environments into three layers: Aglet Proxy, Agent Transfer Protocol and Aglet Context. Figure 11 shows the Aglet object model.

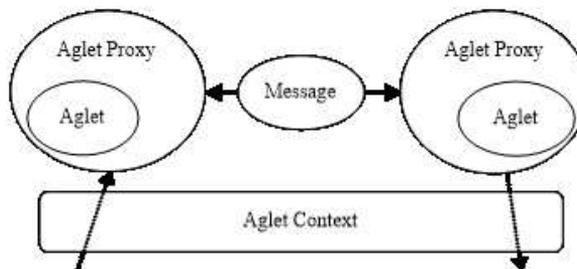


Fig. 11. the Aglet object model

The security protection that the Aglet achieved is one-way. The Aglet focus on the system protection, and the protection of the Aglet itself is lack. Aglet internal events use the delegation model of the Java system, and use ATP as communication languages between the Aglets. Figure 12 shows the Aglet communication model.

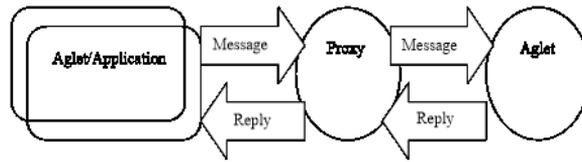


Fig. 12. the Aglet communication model

6. Summary

According to the technical characteristics of the current project schedule optimization, a mobile agent-based project scheduling optimization system architecture is proposed. The mobile agent is introduced and the internal structure of the mobile agent is designed. On the Aglet platform, the code of the agent internal structure is programmed and optimized, and the negotiation algorithm is realized. The development of the whole system is completed. The system makes full use of the characteristics of mobile agent in the process of project schedule optimization.

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