A Novel Workflow Management Model Based on Mobile Agents for Internet Electronic Commerce

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Abstract

Electronic commerce on the Internet receives much attention now. The workflow management is regarded as an effective mechanism for managing those business processes behind the electronic commerce. But today’s workflow management model has many drawbacks in this field. This paper gives a novel workflow management model based on mobile agents for Internet electronic commerce. And its advantages are also presented.

1. Introduction

Recently the electronic commerce on the Internet receives much attention. Enterprises use it to provide on-line business. Everyone can order or customize their products through Internet. When a company takes an order from its Web site, a corresponding business process behind the site should be handled. The process might include many procedures, for example, informing the depot to send the goods; selecting the best delivery agent; monitoring the delivery; answering the customer’s queries on the order status. There are many organizations and people that are involved in the business process.

Workflow management, which is an enabling technology for the integration of process-oriented tasks, is regarded as the effected mechanism for managing those business processes behind the electronic commerce. Some advantages are presented as follows.

(1) Automating the business processes based on Internet electronic commerce. By the integration with the Internet technology (such as CGI) workflow provides an opportunity to automate those processes, and provide the continuity between the requiring from the Web and the business process that will service it.

(2) Handling and managing the processes effectively. By taking charge of activity planning and assignment, workflow eliminates most supervisory tasks. Enterprises could improve quality, increase productivity, reduce the time for customer service and enhance operational control.

(3) Improving the security level of the business processes. In a workflow application, each

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Participant sees only those tasks assigned to him. Participant’s access can be controlled by the definition the rules of assignment for each activity.

Supporting long-running interaction based on Internet. Current Internet applications are suited to short-lived or runtime interactions between users and computer systems. With the workflow technology, Internet applications can provide long-running interactions that are needed in many electronic commerce.

From the customer’s point of view, if a workflow application is Internet-enabled, then the Internet becomes both the way to initiate a transaction and the way to trigger the business process for servicing it. Through Internet-enabled workflow, the Internet moves from a passive information role to an active role for supporting the execution of business procedures.

2. Current status and drawbacks

According to the definitions from Workflow Management Coalition[1] (WfMC), workflow’s primary mission is to handle the business process that span several areas in the company to support external demand. The following are the definitions given in the WfMC Glossary.

(1) Business Process: A set of linked-procedures or activities which collectively realize a business objective, normally within the context of an organizational structure defining functional roles and relationships.

(2) Workflow: The automation of a business process. During the process, documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.

(3) Workflow Management System: A system that defines, creates and manages the execution of workflow through the use of software, running on one or many workflow engines, which is able to interpret the process definition, interact with workflow participants and, when required, invoke appropriate application tools.

This workflow management model is applicable in the setting of well-structured and well-informed enterprises. However, it has many drawbacks when being used to manage the business processes in the Internet-based electronic commerce.

(1) Lack of the support to loose-cooperating architecture. The business process in the Internet-based electronic commerce might involve many worldwide organizations. They will not intend to tighten their cooperation toward a degree as those partners in the same company do. The loose-cooperating relationship might be changed or adjusted for their won business profit of the participants. The workflow management model above can not support this loose-cooperating architecture.

(2) Lack of the common communication framework. Separate companies may use different communication platform, system platform, and even workflow management software itself. The deployment of workflow applications and the interaction between the participants are much difficult due to the inevitable heterogeneity.

(3) Lack of the support to local autonomy. In the model above, the workflow process is defined
and deployed in advance. Then the cooperating partners lost their local autonomy at the run time. While it is acceptable within one enterprise, those loose-cooperating partners in the Internet electronic commerce need some local autonomy to handle exceptions for their own profit.

Some research institutions have done much work on these drawbacks in past years. WfMC[1] integrates the heterogeneous workflow management software products by standardizing the workflow development process and unifying the workflow management interfaces. And the WfMC members have also submitted an IDL-based workflow management standard to OMG. But the problem with the loose-cooperating architecture is not addressed. Merz etc.[2] did some research on the feasibility to use mobile agents in the interorganizational workflow management. However, each participant should set up an expensive CORBA-based communication platform. And all the workflow developer should master the CORBA specifications and developing environment. In this paper, we present an effective mobile-agent-based workflow management model according to the drawbacks mentioned above, which is suitable to the Internet electronic commerce.

3. A workflow management model based on mobile agents

3.1. Mobile agent

The research on mobile agent is derived from distributed AI[3], and expands to the distributed computing field[4,5]. A mobile agent is an active autonomous computation entity that comprises code, data and execution state. The main properties of the mobile agent are autonomous, interactive and mobile. The agent is capable of initiating action independent of any other entity and responses to the environment with the property of autonomy. It also can communicate with the environment and other entities such as humans, machines and software agents thanks to the interactive capability. And the character of mobility enables the agent to transport itself from one machine to another in a heterogeneous network. The computing model of mobile agents is described in Figure 1.

![Figure 1 Mobile agent computing model](image1)

![Figure 2 Mobile agent lifecycle](image2)
The mobile agent is different from the migrating process at operating system level, while it can initiate the migration itself. It is also different from the remotely executed program (such as Java Applet), because it is an active autonomous entity and the execution state will be transported at the same time when the agent moves. The lifecycle model of mobile agent is presented in Figure 2, which defines the different states during an agent’s lifecycle. The computing action pattern of mobile agent could be much clearer with the lifecycle model.

3.2. A novel workflow management model based on mobile agent

To deal with the inevitable distribution, heterogeneity and the required scalability in the Internet electronic commerce, we give a novel workflow management model based on mobile agent. As showed in Figure 3, the model is composed of two parts. One is a workflow agent developing environment, the other is a workflow execution environment (WEE). And the later can be further divided into a workflow management environment and a mobile agent runtime environment.

![Workflow Diagram](image)

**Figure 3** A workflow management model based on mobile agent

**Workflow agent developing environment (WADE)** includes an agent developing module and a set of tools for defining workflow processes. The process definition tools deals with process analysis, modeling and procedure definition. It separates different roles and process objects from each other, and proposes a meta-data model which represents those objects. The agent developing module takes charge of the agent design and programming according to the result from process definition tools, and submits the consequent workflow agent to workflow management environment.
Workflow management environment (WME) comprises a workflow management module (WMM) and an agent base. The main tasks of the module are receiving workflow agents from the developing environment and storing them to the agent base; responding the customer’s request from Internet and fetching the corresponding workflow agent from the base; sending the agent to mobile agent runtime environment for execution. To monitor the workflow and answer the customer’s inquiry, the module also provides an interface to receive the workflow status from those agents initiated at the same site.

Mobile agent runtime environment (MARE) provides all the necessary means to support the mobility, execution, life-cycle management and other functions of the agents. It can initiate a workflow agent; send and receive it through the agent transport interface (ATI); support the interaction between the agents and the external workflow participants. These participants may be humans or other application tools. Most importantly the runtime environment brings agents the independence of the system platform by a virtual machine mechanism [5,6], which is necessary for agent execution in a heterogeneous network.

The flow chart of the workflow developing and running process based on mobile agent is presented in Figure 4.

![Flow Chart]

Figure 4 The flow chart of the workflow management model based on mobile

3.3. Advantages of the model

The new workflow management model based on mobile agent is well suitable for Internet electronic commerce. The advantages is stated as follows:

(1) Support the loose-cooperating architecture. The loose-cooperating relationship is the main character of Internet electronic commerce. In the traditional workflow model the match
between the roles and actual participants and the workflow application deployment are implemented in the process definition process. If any partner changes, these actions should be redone. Thanks to mobile agent mechanism in the new model the match operation could be delayed to the workflow runtime. It is convenient to adjust the workflow process for the changes of loose-cooperating relationship.

(2) Support the heterogeneous distributing platform. The migration and execution of agents is in the mobile agent runtime environment. The workflow agents are independent from the system platform since the runtime environment provides a virtual machine. Each participant in the workflow needs only a mobile agent runtime environment instead of a workflow management engine.

(3) Provide the autonomy. On the one hand, autonomy that is the essential character of agent gives the workflow agent the capability to decide the next destination or operate according to the current status of the environment and itself. On the other hand, the participants in the loose-cooperating architecture can influence the workflow course by changing the local data or strategy.

(4) Support the concurrent computing. Depended on the runtime environment an agent might concurrently spawn several sub-agents in order to reduce the overall process time. These spawned sub-agents could merge with the master agent to exchange data when finishing their tasks.

(5) Support workflow recovery and fault tolerance. The persistence store and the encapsulation of state enables workflow agent to always be saved on stable storage. It simplifies the recovery process and enhances the fault tolerance of the whole system.

4. Conclusion

The paper analyzed the effects of the workflow management in the Internet electronic commerce. And presented a novel workflow management model which was based on mobile agent, since the current model had many drawbacks while applying in this application field. The advantages of the model were also described. Later we will construct the realization environment for this model, and implement some actual applications to prove its advantages and feasibility.

Reference