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Multi-agent collaboration for B2B workflow monitoring

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Abstract

Business-to-business (B2B) applications environments are exceedingly dynamic and competitive. This dynamism is manifested in the form of changing process requirements and time constraints. However, current workflow management technologies have difficulties to solve the challenges problems, such as: how to deal with the dynamic nature of B2B commerce processes, how to manage the distributed knowledge and recourses, and how to reduce the transaction risk. In this paper, a collaborative multi-agent system has been proposed. Multiple intelligent agents in our system can work together not only to identify the workflow problems, but also to solve such problems, by applying business rules, such as re-organizing the procurement and the transaction processes, and making necessary workflow process changes. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Business is moving rapidly into the Internet age as it has moved in the information age and industrial age before. Business-Intelligent (BI) is a key element for organization development, and ‘sharing knowledge is power’ becomes a critical environment for the business development [2]. At the early stage in the evolution of business-to-business (B2B) commerce, there is a combination of isolated data points and well-researched predictions. According to Forrester Research, US B2B commerce on the Internet will increase from \$43B in 1998 to \$1.3T in 2003 [1]. B2B commerce on the Internet is generating a lot of interest and moving quickly, many companies are developing their business via this new tool. On the B2B commerce platform, an open, end-to-end infrastructure of interoperable software solutions and hosted web-based commerce services has been built. Companies can do online trade efficiently, and can integrate and collaborate among B2B marketplaces, buyers, suppliers and commerce service providers. Such globally reached B2B eCommerce platform creates economies for companies around the world.

“For B2B to become a successful channel for a business, all of the processes within that business have to be integrated and streamlined,” suggested Jean-Marc Fav-

nec, IBM’s Director of Software Marketing for Europe, the Middle East and Africa. “B2B is also highlighting many instances of inefficiency within businesses, especially in the areas of procurement and ERP, that need to be addressed through process redesign or process integration,” he added.

In addition, many companies are exploring B2B commerce and make their existing business more efficient, by improving customer service, reducing inventory, increasing market depth and liquidity, and eliminating geographical and temporal barriers. How to manage the workflow processing taken in such eCommerce marketplace is a big issue to get benefits mentioned earlier. Due to such B2B eCommerce Marketplaces provide dynamic trade, the traditional workflow management, that is, one to many models could not fit this flexibility requirement. In our study, we address intelligent multi-agents to monitor the dynamic nature of transaction processes in B2B eCommerce marketplace.

2. Background

2.1. Workflow and workflow management

A workflow is a composite activity consisting of tasks involving a number of humans, databases, and specialized applications [9]. Workflow refers to group activity automation by task sequencing and information routing [10].

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Thus, workflow is a collection of tasks organized to accomplish some definite business processes. An activity can be performed by one or more software systems, one or a team of human, or a combination of them [11]. This definition applies the workflow concept to automate business processes. Workflow management involves the (re)design and the (re)implementation of workflows as the needs and the goals of an enterprise.

When managing running workflows, a lead engineer might have to adjust a workflow by adding, removing, or reordering tasks. This requires highly adaptable workflow functionality. Therefore, the workflow meta-model must be expressive and flexible and workflows can be defined and managed easily [4]. However, most of today's Workflow Management Systems (WFMSs) rely on one-dimensional flat process models, in which a process definition includes every detail of the process from beginning to end. It is hard to specify that several resources can collaborate for executing a task [16].

Currently, most B2B workflows arise on the Internet. How transaction is taken place effectively and efficiently in B2B eCommerce marketplaces is a major issue of WFMSs. However, most WFMSs lack the functionality to support the dynamic nature of automating B2B transaction processes. The following lists a number of important issues need to be addressed in the future:

- *Information sharing.* Workflow processes and WFMSs need to share their internal and external resources.
- *Chained execution.* A workflow process is divided into a number of sequent sub-processes, which are executed one by one.
- *Process changing.* A workflow process needs to be changed automatically, when some special situation comes.

2.2. Intelligent agents

Software agents represent a relatively new computational technology and are not yet well defined [15]. The concept of intelligent agents is rapidly becoming an important area of research [3,5,6]. Informally, the work performed by intelligent agents carry intelligent behavior of software agents and intelligent systems. Various researches have been conducted to apply intelligent agent-based technology towards real world problems.

The communication between agents is considered a sequence of communication and computation steps [14,19]. The communication capabilities of the mediator agent are generating and sending message to other mediator agents and the local domain agent, as well as receiving and decoding messages from other mediator agents and the local domain agent, incorporating beliefs, commitments and information from all other agents in the network. However, agents are developed from a template design that consists of five individual layers [8]: transport (agent message trans-

port), message (agent communication), protocol (conversation policies), agent (basic agent components, such problem solvers), and detailed agent (domain-specific or agent specific tasks) [17,18].

Formally, the term agent is used to denote a software-based computer system that enjoys the following properties [12,13]:

- *Autonomy.* Agents operate without the direct intervention of humans
- *Co-operability.* Agents co-operate with other agents towards the achievement of certain objectives
- *Reactivity.* Agents perceive their environment and respond in a timely fashion to changes that occur
- *Pro-activity.* Agents do not simply act in response to their environment; they are able to exhibit goal-directed behaviors by taking the initiative
- *Mobility.* Agents are able to travel through computer networks. An agent in one computer may create another agent in another computer for execution. Agents may also transport from computer to computer during execution and may carry forward accumulated knowledge and data.

2.3. Knowledge level collaboration

Communication, collaboration, and co-ordination are different layers of interaction. Communication allows participants in the decision process to share information (this involves networking infrastructures), collaboration allows participants to collaboratively update some shared set of decisions (this involves support for tele-conferencing, etc.) and co-ordination ensures the collaborative actions of the individuals working on a shared set of decisions are co-ordinated to achieve the desired result efficiently [7]. Each layer is built on the top of the next layer. To simplify, collaboration means more than just instantaneous communication, or total asset visibility or leveraging resources and the talents of experts from different fields. Collaboration means all of these, and synergy effects of these. Another concept of collaboration entails a situation, where agent is a potential equal contributor to a discussion transcript that becomes important as a memory for the group. Ideally such a transcript can evolve to become a knowledge base for the collaborators and those who use the results of the discussions [11].

Collaboration involves creativity, innovation and decision-making. Unfortunately, it also involves looking for files, locating and scheduling resources and populating databases. Automated collaboration lets the human collaborations do what they do best think, create, and decide and lets the computers take care of the data and resource management. A complete collaboration environment has all the components necessary to ensure that knowledge can be shared and used at the moments, when it can best impact the product. The term of 'collaboration' is used to a set of

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