A role-oriented service system architecture for enterprise process collaboration

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A B S T R A C T

Workflow management is a key technique for coordinating various business processes. Traditional workflow systems are often built with the client/server architecture, in which, a single workflow server takes the responsibility of the entire operation. This paper discusses a model-driven process enactment environment, which can support an enterprise businesses collaboration. Some key technologies regarding models and the system are discussed in the paper, including the mappings between activities in process models and the service function of applications, how to use XML in the process model, and other workflow engine techniques. A software architecture supporting role-oriented services within the process-driven enterprise enactment environment has been proposed and implemented. The proposed framework has been validated with a case study in the 4PL business system.

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1. Introduction

The rapid development of economic globalization makes enterprises to face the tremendous pressure of competition. An adaptive information system is urgently required to enhance the business efficiency, shorten the product development cycle, improve product quality, and rapidly adjust the business to the competitive market environment [2,5,6,18,21].

Workflow management based on dynamic modeling and operation is one of the key technologies for the coordination of various business processes [20]. By setting up the business process model and enacting it in the workflow server, a workflow system can be used to streamline the business process, deliver tasks, and monitor the overall performance of the process [34].

A complex workflow system employs the methods in system science and engineering that abstract, decompose, and refine the system in a top-down manner through a layer-by-layer enterprise process model [22,32]. Business process modeling can help deepening the understanding of the business processes. In an enterprise process model, the process enactment, the process modeling, and the process reengineering are the basic activities [3,7,8,24]. Research has been conducted on the industrial process modeling since middle 1980s. For example, a software framework of enterprises was proposed and developed [36]. Other studies include enterprise process modeling system (EPMS), dynamic business process modeling, and workflow-based process enactment for integrating enterprise information systems [28,29].

Business Process Management (BPM) has been emphasized to be used in conjunction with Service-oriented Architecture (SOA) [14,17,19]. Guo et al. [10] proposed a virtual enterprise management framework. Bae and Kims [14] proposed a new method of storing XML form documents whereby changes can be detected automatically and document versions can be reconstructed upon the user request. In the literature, an XML-based data exchange method to support heterogeneous integration was proposed, and the process operations in different point of views were discussed. Although these techniques provided theoretical studies based on model-driven work flow operations, there were still some topics needed to be addressed in-depth.

The existing research was lack of the process semantics description, organization coordination strategies, and the resource optimization analysis function. In the business process intelligence analysis, there are still many issues that need to be addressed. They include the lack of a formal basis [4]. The current methods provide visual modeling languages, but are not clearly distinguished between the different concepts of modeling and the semantics of the original languages, which lead to insufficiency

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in the expression capacity for system modeling. The other issues include the lack of automatic semantic analysis on system integration process.

Tan et al. [25,26,35] proposed a method for dynamic enterprise process performance evaluation within a Model-Driven Architecture (MDA) system, and discussed the business process intelligence system. In their research, they proposed using business process intelligence, which consists of business process definition, process simulation and analysis, and optimization technologies, for providing the scientific analysis on enterprise decision-making and ensuring the enterprise successfully implements business process reengineering and reorganization. However, more research is required for the simulation of process modeling as simulation has been a powerful tool for understanding the behavior of a system including service systems [12]. Simulation has received attention in service sectors where business solutions have been derived from both mathematical models and simulation modeling [11].

This paper presents an XML-based resource modeling method, through the establishment of business processes enactment environment, in order to simulate the execution of activities in automatic, semi-automatic, or artificial processes. In this paper, we propose a unified collaborative process simulation model to support flexible scheduling strategies and resolve automatic semantic analysis issues in the system integration process and the uncertainty issues in business processes. The model implemented automatic optimization of business processes based on process simulation.

The rest of the paper is organized as follows. Section 2 introduces MDA technologies. Section 3 discusses the mappings between process models and services. Section 4 describes a role-oriented enterprise process collaboration enactment environment. Section 5 introduces business process collaboration analysis, and is followed by an application example of in Section 6. We conclude our study and discuss the directions of future research in Section 7.

2. MDA

Model-Driven Architecture (MDA) is a framework driven by the model [9,13,15]. MDA is originated from the concepts of Unified Modeling Language (UML) and other industry-standard frameworks to support the software design. Compared with UML, MDA creates a machine-readable and highly abstract model, of which the realization of technology is independent of supporting the enterprise information standardization. MDA modeling language is a programming language, but also a modeling language. MDA is a reference model for software development process where it plays an important role. MDA provides a way to standardize platform-independent systems. Three main objectives of the MDA are separation, interoperability, and reusability. It has core components as shown in Fig. 1.

- *MOF* (*Meta Object Facility, MOF*) defines a standard means of exchange to generate the modeling language interpretation model. It is based on the XML exchange format, known as XMI (XML Metadata Interchange).
- *PIM* (*Platform-Independent Model*) mainly provides hidden platform details for the system analysis. Platform-independent view shows as integrity norms. The general view can be described by the common modeling language or special languages.
- *PSM* (*Platform Specific Model*) has referenced information of the PIM system, and also considered the tool for modeling enterprise information systems.
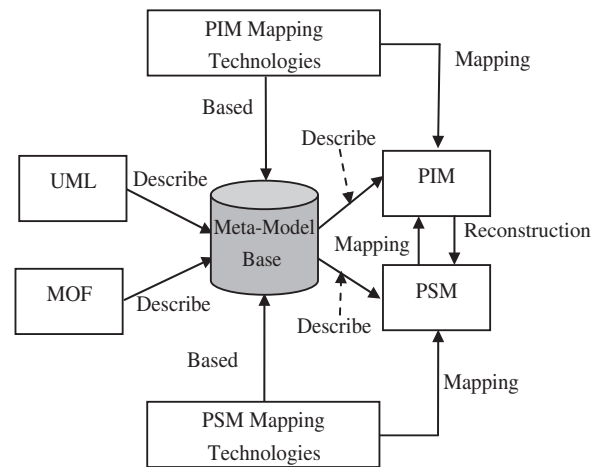

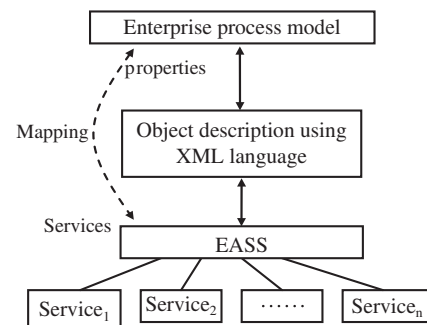**Fig. 1.** Model-driven architecture.

Fig. 2. Creation of model object.

3. Mappings between process models and services

The enterprise model defined by EPMS is visual, and can be used to emulate business process operation. Before using the defined working model to guide business processes, the mapping relationship between the process model and system services entity is required to be built first. According to the actual experiences of business process enactment and scheduling, we have implemented a process-driven enterprise application integration based on the coordination between business processes and the event-driven mechanism.

3.1. Object model

Adaptive enterprise services can be generated by the enterprise process models. In fact, enterprise operating systems can be used to guide enterprise operations. The relationships between system applications and process models are realized through the business object models, which are implemented as model-driven business process operation. Fig. 2 illustrates the creation of business object models.

All the services, activities and legacy applications of an enterprise information system can be integrated together via an EASS (Enterprise Application Service Set). The process of structuring relationships between the models and the services is called entity object mapping.

An object model serves as a bridge for the communication between the application systems and the process models. Through the process of mapping entities, an object model can be established as shown in Fig. 2.