Service-Oriented Workflow System for Inter-enterprise Processes Collaboration

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Abstract. Forming networks through co-operation between different companies has become an important business strategy for SMEs. This brings about the prospect of ad hoc integration of processes across organisational boundaries to support collaborations. This paper aims at providing a breakthrough in the support of SME networks for building up and executing collaborative business processes in dynamic virtual organisations based on service-oriented workflow system.

Keywords: Inter-enterprise processes, collaborative product development, service-oriented workflow.

1 Introduction

The way of cooperation between different companies has become a strategic component, especially with regard to enable the cooperation of enterprises situated in different locations and having a different cultural background (e.g. Chinese and European companies). Not only the purchase or the supply of a product, but particularly the ability to find a matching supplier and its integration into the development process of a manufacturer during the whole product development process plays a more and more important role.

Every company usually follows its own proven strategy for the management of processes and information during product development. As soon as the boundaries of a company are crossed, the management of the processes and information of a common product development process concerning all involved partners is quite difficult. Having two companies in a collaboration (e.g. in two different locations), it is very difficult to ensure a consistent database while sharing information. However, process and information management between collaborative companies usually lack sufficient information exchange and sharing. In order to avoid sharing unprotected information representing a company's specific know-how, collaborating companies usually manage their product development processes and product data in a highly inconsistent and inefficient way. Besides these organizational and technical issues, there are additional topics, such as the assurance of intellectual property rights on used and shared information which is vital for companies in virtual market places.

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Y. Luo (Ed.): CDVE 2013, LNCS 8091, pp. 189–196, 2013.

The overall goal of the paper is to realise a common workflow system between dislocated companies based on sharing processes.

2 The State-of-the-Art for Inter-enterprise Processes Collaboration

With the increasing heterogeneity and dynamics of the economy, more and more enterprises are challenged to adapt continuously to the rapid changes, to concentrate on their core competencies as well as to search for competitive advantages and innovations[1].

Rapid technological advances and altered customer demands create a new dynamic and complex business environment, whereas flexibility and mobility are implicitly required from enterprises. For these reasons different enterprises have to cooperate in order to meet effectively customer needs, to encounter the contemporary prevalent high competition and innovation pressure as well as to be permanently successful in largely saturated markets. The innovative moment consists in the cross-enterprise integration of data, functions and processes[2].

Tremendous developments in data storing, processing and communication over the last two decades have made unprecedented impact on how most enterprises operate, develop future business strategies and deal with day to day operations. At present, Businesses are increasingly moving towards extensive automation of their private and public processes. This automation takes the form of complex interactions between heterogeneous and autonomous systems within the enterprise and often cross multiple organizations. Controlling these complex interactions in order to effectively manage collaborative business processes is known to be a critical yet difficult problem using current technology solutions[3]. Process-oriented collaboration are becoming the most advanced inter-enterprise integration form.

Process collaboration provides a sophisticated management system that places an abstract business-oriented layer on top of traditional B2B communication mechanisms such as message brokers and message-oriented middleware (for example IBM MQSeries and Microsoft Message Queue).

The lifecycle of inter-enterprise processes collaboration includes business process modeling and model execution and collaboration.

There are some business process modelling languages being specified today, such as BPML, XPDL and BPEL4WS. BPEL4WS is an industry standard specification for defining the workflow between Web services[4]. It is intended to provide a workflow language to model complex and non-deterministic business processes. The most important feature of BPEL4WS is to support business process coordination among multiple parties. This enables the outcome (success or failure) of units of work at various levels of granularity of the business processes. BPEL4WS enables modeling of long-running interactions between business processes with nested units of work between them and each with its own data requirements.

For the execution and management of process models. Workflow has now been adopted as a way to implement the cross-organizational management needed to carry out businesses[5]. The interoperability is the essence of inter-enterprise workflow used for management of business processes. Considering the execution of workflow, services computing poses significant challenges as developers determine how to leverage emerging technologies to automate individual applications based on cross-organizational, heterogeneous software components. Nowadays, The Web has become the user interface of global business, and Web services now offer a strong foundation for software interoperability through the core open standards of XML, SOAP, WSDL, and UDDI. The interaction models that fully realize the potential agility of Web services computing are just beginning to emerge. At present, web service has become a hot topic in the research field of business process integration[6].

3 Design of Service-Oriented Workflow System

Because of the nature of service such as loosely coupling, coarse granularity, access transparency, platform independency and business orientation, workflow in Service-Oriented Computing also presents many new characteristics:

- Services are implemented by workflow. Workflow technology enables the resilient and dynamic composition of services.
- Workflow is just another kind of services. Business process itself may be distributed among dispersed partners, and the involved applications as well as the whole workflow are delivered as services.
- There are multiple processes running at the same time. They communicate with event/messages (No explicit control link among them) and share the resource or data. New processes/services are dynamically created or invoked.
- The processes change dynamically along with the changes of services. Because of the autonomy of services, it requires ensuring the usability of services and selecting service components in real time during the operation of processes, which also results in the difficulty in evaluating workflow performance.
- Based on the above characteristics, we proposed the definition of SOWF.

Service-oriented workflow (SOWF) is the business process partly or totally executed by the computers automatically in service-oriented environments, partial or entire activities in the business process are completed by services in Network. In other words, SOWF is a composition of web services for the purpose of special tasks.

As shown in Figure 1, the architecture of service-oriented workflow management system is put forward. It is a hierarchical structure which contains three layers, i.e., the user interface layer, the operation logic layer, and the persistent storage layer. The user interface layer includes interfaces for workflow model presentation, execution management and user interaction, while the persistent storage layer comprises databases (DB) for storing the workflow models and relevant data.

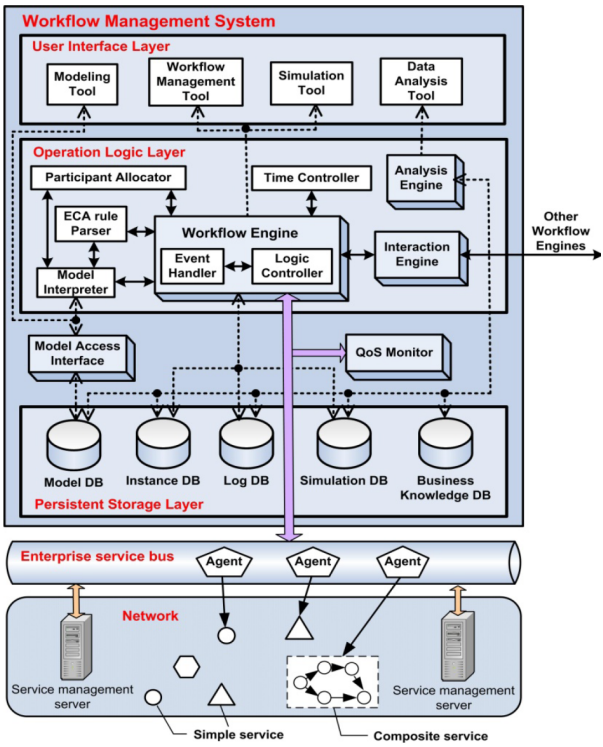

Fig. 1. The architecture of service-oriented workflow

The core element of the operation logic layer is the workflow engine, with the participant allocator, the model interpreter, the ECA (Event- Condition-Action) rule parser and the time controller as supportive components. The engine is basically composed of a logic controller and an event handler, with the former dealing with the navigation of control flows as well as data flows in a workflow model, and the latter handling particular events in service computing. The analysis engine deals with the data from persistent storage layer and supports the data analysis tools, the result of the analysis is fed back to business knowledge DB as rules or knowledge for future use. The interaction engine is a bridge between this workflow engine and other workflow engines by event communication and data correlation.

In service-oriented environments, there are two kinds of activities in business processes, one is normal task executed like traditional activity, and the other is service which needs special mechanism.

When the workflow engine encounters a service to handle, it turns to the enterprise service bus, in which the agent is responsible for the execution of the service through querying the service management server who stores the directory of all the service. Finally a simple service or composite service (constructed by composing several simple services according to certain regulation) in Network is selected to match the requirement of specific service. The quality of service is guaranteed by the QoS monitor modular.

4 Implementation and Application

Based on Service-oriented workflow, we developed a engineering collaborative portal, which can provide workflow management Functionality for collaborative product development.

The portal provides process-modelling services for collaboration partners to build a common product development process so as to integrate the local engineering process of each partner, as illustrated in the following picture (Figure 2). The basic functionalities include: create a process model, edit a process model, add an activity, edit an activity, save the process model, etc.

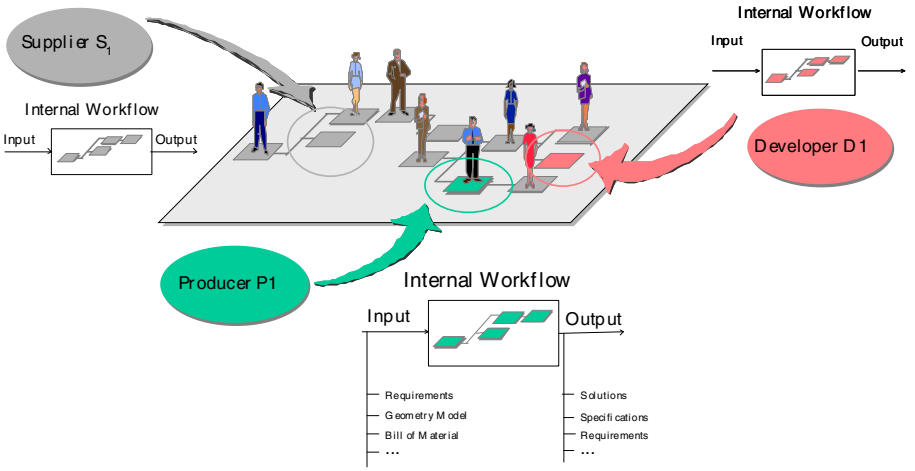

Fig. 2. Modeling for collaborative product development processes

Within the portal, the process-modelling services will have direct interaction with the workflow engine. Workflow engine executes the process model and manage the interaction between processes.

We built up a workflow scenario of electromechanical product design process on BPEL workflow engine (Shown in Figure 3).

In this workflow, we set one Receive-Reply Activity, six Invoke Activities and two Assign Activities. Different Partner Links were designed to meet different needs in operations. MechanicalDesign and MechanicalDetailedDesign share the same Partner Link Mechanic-alDesigner. So do ElectronicDesign and DetailedElectronicDesign. Mechanical(Detailed)Design and Electronic(Detailed)Design are put into Flow Containers so that the process could proceed until both of the Activities in Container are completed.

The detailed views of activities in this Process are listed from Tab. 1. to Tab. 3.

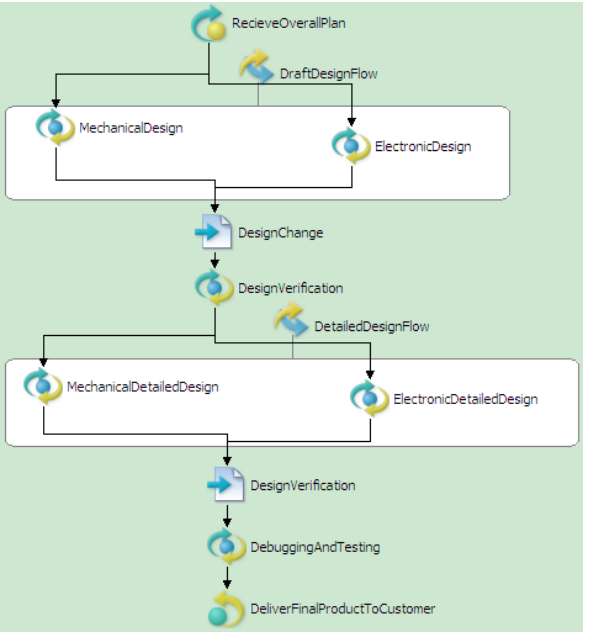

Fig. 3. Electromechanical Product Design Process

Table 1. Receive-Reply Activities

Activity Name	**ReceiveOverallPlan**	**DeliverFinalProductToCustomer**
Activity Type	Receive	Reply
Operation	GetOverallPlan	GetOverallPlan
Partner Link	GetRequestLT	GetRequestLT
Port Type	OverallPlanPT	OverallPlanPT
Variable	OverallPlan	FinalDesign

Table 2. Assign Activity

Activity Name	DesignVerification
Copy Operations	Copy Variable(TwoDimCADDesign) Part(TwoDimDesign) TO Variable(FinalDesign) Part(TwoDimDesign); Copy Variable(ThreeDimCADDesign) Part(ThreeDimDesign) TO Variable(FinalDesign) Part(ThreeDimDesign);

Table 3. Invoke Activities

Activity Name	**Electron-ic(Detailed) Design**	**Mechani-cal(Detailed) Design**	**Design Verifica-tion**	**Debug-gingAnd Testing**
Input Variable	OverallPlan	OverallPlan	Modifi-cation	FinalDe-sign
Operation	Electronic-Design	Mechanical-Design	change-design	debugtest
Output Variable	TwoDim-CADDesign	ThreeDim-CADDesign		
Partner Link	Electronic-Designer	Mechanical-Designer	chagede-sign	tester
Port Type	Electronic-DesignerPT	Mechanical-DesignerPT	Change-De-signPT	Debug-TestPT

The Variables in process are defined by Message as shown in Tab. 4. These Variables help ThreeDimCADDesign and TwoDimCADDesign be changed throughout the process. By assigning value, the design are copied to the FinalDesign. Overall Plan is the Input of the workflow that guides the execution process. We need to write the initial value of OverallPlan Message to launch the process. FinalDesign is the output of this workflow, delivering final products to customers. Modification is used in DesignVerification Activity to record detailed changes in design.

Table 4. Variables Defined in BPEL Process

Variable Name	1		2	
	Part Name	Type	Part Name	Type
OverallPlan	Process Description	String	OverallPlan-Drawing	anyURI
FinalDesign	TwoDim Design	anyURI	ThreeDim Design	anyURI
TwoDim CADDesign	TwoDim Design	anyURI		
ThreeDim CADDesign	ThreeDim Design	anyURI		
Modification	Modifica-tionDoc	String		

5 Conclusions

This paper implements a service-oriented workflow system that could be deployed in cross-domain platforms. Currently, we have finished the definition and execution of

collaborative product development processes on the system. Based on the system, internal business processes of an enterprise and external business processes between the enterprise and its partners can be integrated and coordinated.

Acknowledgments. This work is supported by National Key Technology R&D Program under Grant No. 2012BAH25F07 and Postdoctoral Science Foundation of China.

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