Management of Workflow over the Web Supporting Distributed Process Evolution

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Abstract. With the emergence of the Internet, the Web became a widely-used collaboration environment for business process activity. Business process itself is a very evolable entity. In this paper, we introduce a workflow management system called SoftPM/W^2 for the business processes over the Web. For efficient workflow management, SoftPM/W^2 provides integrated formal representation of business process elements, generation of business data model from business process model, a view-based mechanism for distributed evolution, and unique evolution control mechanism.

1 Introduction

Workflow evolution means the dynamic changes on the instance of initial business process model. In transaction-oriented business domain such as banking process, evolutions may hardly occur. However, evolutions often occur in the domains of long term business process such as the Web-based business activity collaboration. Human involvement usually exists. Refinement on exsiting business process is often required. These evolutions are unavoidable[10].

For such distributed workflow evolution, it is more reasonable to let the evolution be made in distributed manners because business process activities are mostly carried out by distributed participants. In this sense, workflow management mechanism must provide some means to allow each participant to make changes on business process instance. Then, the changes made by each participant should be reflected into the overall business process in consistent manners. In workflow evolution management, some of the major technical issues are business process modeling, process modification, and change control techniques.

The business process modeling technique is the most fundamantal mechanism to manage the process changes. For the systematic and consistent management of process change, the overall business process must be defined in unambiguous way. SoftPM/W^2 uses a high-level Petri-net called *MAM net*[7, 8] as the process modeling formalism. MAM net supports an integrated activity-oriented modeling of business process activities, business data, and participants. SoftPM/W^2 also automatically generates business-data oriented model to observe business process in data-oriented perspective.

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Each participant needs an effective means to make changes on process. Participants usually have knowledges only on the portion of the process of their own interest. They usually have vague idea on how the entire business process looks like. Participants want to see only the portions of the process of their own interest. We call this *views* of each participant. SoftPM/W^2 extracts views from the both business process model and business data model for each participant.

Simply allowing each participant to freely modify the business process possess high risks because a modification on a critical portion of the business process can raise unexpected consecutive modifications. SoftPM/W^2 supports the control of modification by analyzing the degree of the impact caused by modifications.

In architectural perspective, SoftPM/W^2 is implemented with pure Java in a thin client/server architecture. SoftPM/W^2 supports the execution of business process over the Web. Participants can evolve the business process through a Java Applet in any web browser.

In this paper, we propose a process-oriented approach to the workflow management over the Web environment. Its prototype implementation is called SoftPM/W^2. SoftPM/W^2 is a retailored version of a process management system, SoftPM[8], which we had previously developed for software process domain.

This paper is organized as follows: In Section 2, the business process modeling mechanism is described. In Section 3, we explain the view-based mechanism for workflow evolution. In Section 5, we give conclusion and future work.

2 Business Process Modeling

In our approach, business process is modeled in the activity-oriented perspective which we call business process model. Then, the corresponding data-oriented model is automatically generated. We call this business data model.

To demonstrate our approach throughout this paper, we use the ISPW-6 process example[6] which desribes the requirement change management activities during software system development. The ISPW-6 example consists of five collaborating activites: *modify design, modify code, modify test plan, modify unit test package*, and *test unit*. There are five involving participants: two design engineers, two software engineers, and one quality assurance engineers.

SoftPM/W^2 provides a easy-to-use graphical modeling layer above underlying MAM net formalism for designing business process model. The modeling mechanism is similar to drawing a PERT chart. Fig.1 shows the process model of the ISPW-6 example.

The goal of the business data model is to provide an data-oriented perspective of software process. In SoftPM/W^2, a business data model is represented as a directed graph with nodes representing the business data and arcs representing the usage dependencies among business data. The business data model is generated from corresponding business process model. Fig.2 shows the business data model generated from the business process model shown in Fig.1.

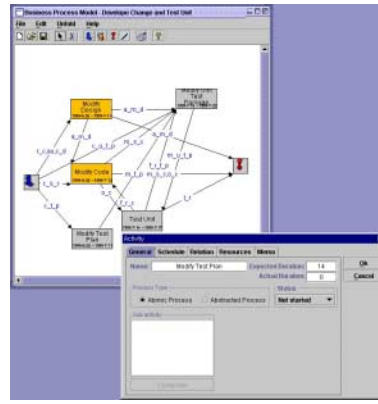


Fig. 1. Business Process Model of ISPW-6 Example

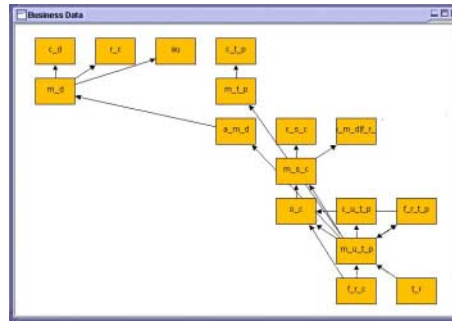


Fig. 2. Business Data Model of ISPW-6 Example

3 Workflow Evolution

In our approach, we define views for each corresponding participant, in both business process model and business data model. Each participant manipulates business process through their views. Then, such distributed modifications are reflected into the global business process model.

3.1 Views

The view of a participant in business process model is a subset of process activities, which are related to the participant. Intuitively, the activities carried out by the participant are the main constituent activities of the participant's view. In addition, other activities having data-depedency on those main constituent activites should be considered. The data dependency between two activities exists when business data is passed from one to the other, or when the activities

use the same business data. Before giving the definition of a view in SoftPM/W^2 approach, we define the following attributes of business process.

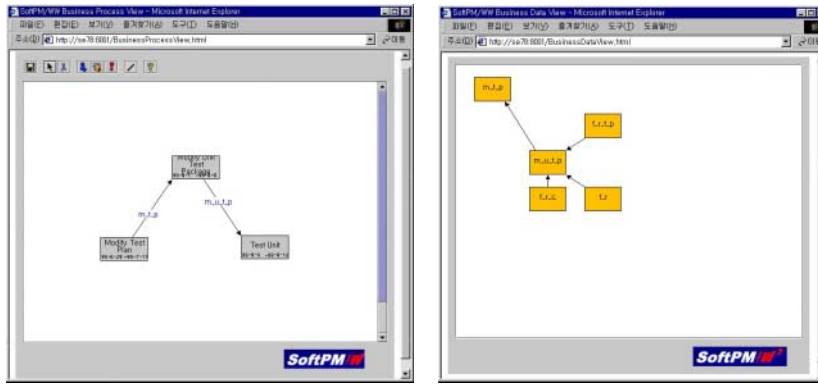
- *Require*(p): the set of business activities which require the participant p for its execution
- *Dependent*(a): the set of business activities which are data-dependent on the activity a.

Then, the view of participant p can be defined as follows:

$$V_p = Require(p) \cup \{p_i \mid p_i \in Dependent(a_i) \ for\ all\ a_i \in Require(p)\}$$

The view extraction can be automated. Fig.3(a) shows the the client Web-browser showing the business process view of the quality assurance engineer in the ISPW-6 example.

The view of a participant in the business data model is a subset of the business data model. The view consists of the business data manipulateted by the activities carried out by the participants, and other business data which has usage dependency to the business data manipulated by the participant. Fig.3(b) shows the client Web-browser showing the business data view of the quality assurance engineer in the ISPW-6 example.



(a) Business Process View (b) Business Data View

Fig. 3. Views of the Quality Assurance Engineer

3.2 Controlling Evolution

Controlling of evolution are achieved by limiting the permission on process modification. The permission is determined by the degree of impact caused by the

modification. The degree of impact can be determined by several factors according to the specific characteristics of process and organization. In our approach, we consider usage-dependency relations between business data since workflow has very data-dependent behavior in general.

Using the dependency relationships represented in the business data model, we can perform the change impact analysis on business data. Change impact value(CIV) of an artifact node r_i is computed by counting the number of data nodes that have dependency on r_i, and dividing the number by the total number of data node in his/her view. Thus, change impact value(CIV) is defined as follows:

$$CIV(r_i) = \frac{\#\{r_j \in Data\ nodes\ in\ the\ view | \exists\ a\ path(r_j, r_i)\}}{\#(Data\ nodes\ in\ the\ view)}$$

If a participant are trying to modify an activity, each business data produced by the activity are analyzed by calculating their CIVs. If the sum of the CIVs is less than the control value specified by manager, the modification can proceed. Otherwise, it is not allowed.

4 Conclusion and Future Work

With efforts primarily from industry, workflow management has emerged as a widely-accepted techinique to integrate and automate the execution steps of business process. Various prototypes and commerical products have been introduced[2–5, 9–11].

Comparing to the existing approaches, there are several characteristics of SoftPM/W^2 which distinguishes itself from them. Those characteristics are the integrated formal representation of business process elements(i.e. business process activity, business data, participants), the generation of data-oriented model from activity-oriented model, the support of distributed workflow evolution over the Web through a view-based approach, unique evolution control, and with the change impact analysis.

Most of the existing approach from industry do not fully support the formal modeling of business process. Some approaches[1, 2, 4, 11] from research community support the formal modeling using Petri nets or Statechart. However, they do support integrated modeling of business process elements including all business process activity, business data, and participants. None of the existing approach provides a mechanism for generating business-data model from their business process model. In their approaches, they build different perspecitive models independently that may cause inconsistency between models and require extra modeling effort. In business process modeling domain, a few approaches[1, 10] address the workflow evolution. The OPSIS approach[1] emplyeed a view-based process change. However, they do not provide specific means for the distributed evolution.

We have some future works for more advanced research. We plan to port SoftPM/W^2 into CORBA environment as a distributed object system over the

Web environment. Along with the adoption of CORBA, we are trying to objectifying actual business data entities to support the migration data objects over the Internet.

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