Interorganizational Workflow Collaboration Based on Local Process Views

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Abstract

Globalization and advanced information technologies cause the increasing development of collaborative business. This paper proposes an interorganizational workflow modeling approach for collaborative business based on local process views. In the proposed model, instead of sharing a pre-defined global workflow view among organizations, each organization has its own understanding and preference of the whole collaboration and can manage its local workflow process distributively and autonomously. Further, we provide a methodology for interorganizational workflow collaboration by two phases: the bottom-up coordination phase and the top-down implementation phase. We illustrate the effectiveness of the proposed model and collaboration approach by a case of collaborative software development process.

1. Introduction

With the global expansion of Internet and distributed computing environments, computer mediated collaboration has experienced tremendous increases among different organizations. Interorganizational workflow is modeled for the collaboration and cooperation across organizational boundaries in previous research [1, 2, 3, 12].

In the service-oriented environment, different organizations always have workflow processes (services) based on their own cultural and knowledge backgrounds. Therefore, in the collaborative business, organizations might have different considerations about the collaboration. Moreover, it is important to design interorganizational workflow collaboration models that take into consideration the flexibility, privacy preservation, workflow reuse and the issue of how to implement such models by using or extending common business process management framework. To address above issues, we consider the following three issues in this paper.

(1) Modeling interorganizational workflow: When modeling interorganizational workflow, it is important to take different views of different organizations into consideration. In the real world, organizations always do not share a pre-defined global interorganizational workflow process, but have their own understandings of how to model the whole workflow process with their unique backgrounds and knowledge, which we call local process views of organizations. Moreover, the local workflows are not expected to be shared among organizations. Therefore we propose a model, where each organization has a local process view.

(2) Interorganizational workflow collaboration approach: In the proposed model, since each organization has its own local process view, it is necessary to develop the approach of interorganizational workflow collaboration from coordinating local process views of different organizations to implement the whole model. To realize this process, we divide the collaboration process into two phases: bottom-up coordination and top-down implementation.

(3) Validating the approach by case study: To validate the proposed interorganizational workflow model and the collaboration approach, it is necessary to apply in real-world case with implementation. In this paper, we take collaborative software development workflow for instance.

This paper is organized as follows: Section 2 introduces related work. Section 3 provides overview of interorganizational workflow model that supports local process views for different organizations. In Sect.4, interorganizational workflow collaboration approach is proposed. A case study of collaborative software development and discussion is given in Sect.5, followed by the conclusion in Sect.6.

2. Related Work

Previous approaches of interorganizational workflow mainly include organization contracts, workflow inheritance, workflow cooperation and composition, and so on.

A typical example of the contract approach is CrossFlow [3], where cooperation between organizations is based on dynamic service outsourcing specified in electronic contracts. The lifecycle of a service outsourcing by contracts consists of: (1) contract establishment; (2) dynamic infras-

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tructure configuration; (3) contract enactment; and (4) dynamic infrastructure disposal.

The workflow inheritance proposed by van der Aalst [13] describes interorganizational workflow using following steps: (1) public workflow process design; (2) public workflow process assignment among organizations; (3) distributive private workflow creation in each organization; and (4) private workflow modification using inheritance-preserving transformation.

In the approach of workflow cooperation and composition, each organization always has its own local workflow process. Chebbi $et\ al.$ [1] presents an approach of interorganizational workflow cooperation to provide support for organizations which are involved in a shared but not pre-modeled cooperative workflow across organizational boundaries. Such kind of approaches usually consist of following steps: (1) workflow advertisement; (2) workflow interconnections; and (3) workflow cooperation.

Above attempts belong to either top-down (from global process to local parts) [3, 13] or bottom-up (from local parts to global process) [1] design approach. However, the top-down approach cannot support modern business environment well especially the service-oriented architecture, where each organization always has its own business process (services) and has its own consideration about a potential interorganizational collaboration. Moreover, current bottom-up approach does not address the important issue of how to implement the interorganizational workflow model. Therefore, to consider the support of service-oriented environment and the implementation issues, we will propose an interorganizational workflow model and collaboration approach by combining the bottom-up and top-down methods.

In this paper, we apply the ARIS business process management platform to illustrate the collaboration approach, which is a well-known approach to enterprise modeling of IDS Scheer AG [9]. In designing business process, ARIS has an elaborated decomposition of an enterprise in several views: data view, function view, organization view, product/service view and, to realize the connection between these views, the process view (also known as control view) [9]. We use the ARIS design platform to implement the model, however it cannot support the coordination of organizations.

3. Interorganizational Workflow Based on Local Process Views

The interorganizational workflow model in this paper is based on the loosely coupled workflow interoperability, where the whole workflow is made up of several pieces, which may be active in parallel over different organizations [11, 12]. In traditional loosely coupled interorganizational workflow, although each organization has a local workflow that can be executed independently, there is always a global view of interorganizational workflow. Without considering the potential conflicts caused by different cultural backgrounds and understandings about the collaboration of different organizations, there is an assumption that organizations accept pre-defined global workflow. However, this assumption is not reasonable because it is impossible for all organizations to have the same opinions on creating a global workflow view at the beginning, which is extremely important in service-oriented environment.

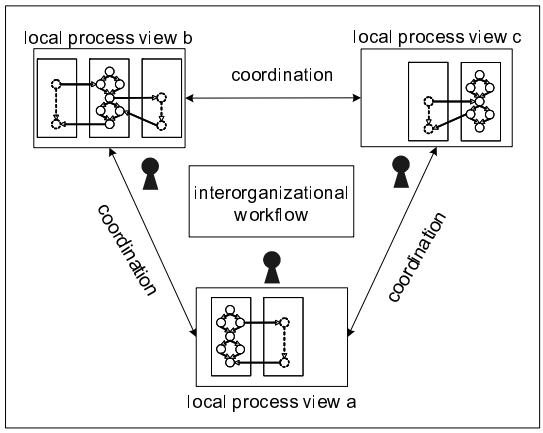

Figure 1. Interorganizational workflow model based on local process views.

Therefore, in our model, organizations do not create a global view for interorganizational workflow collaboration. Instead, each organization has a local process view, which consists of local workflow, interaction between organizations, and limited information of workflows of other organizations. Figure 1 outlines the architecture for the interorganizational workflow model based on local process views. Organizations can collaborate with each other by coordination of local process views and the interorganizational workflow can be derived from the local process views of business partners.

Definition 1 (Local Process View) If an organization has n partners in the collaboration environment, then its local process view can be expressed as a tuple $LPV = (I, WF_0, VWF_1, VWF_2, \ldots, VWF_n, ISC)$, where

(1) I is a finite set of organizations, including the local organization and its n partners;

(2) WF_0 is the workflow process of the local organization, which is private to other organizations, and for each $k \in \{1, 2, \ldots, n\}$:$VWF_k$ is the virtual workflow process of its partner k, which is modeled with its own consideration and open to public; and

(3) ISC is the Interaction Sequence Chart which speci-

fies the interaction between partners with the consideration of the local organization and is also open to public.

A virtual workflow has the similar form of a common local workflow process. However, the tasks and flow relations are virtual. Tasks in a virtual workflow always have the abstraction form of tasks in a common local workflow, and the flow relations describe the flow of virtual tasks.

Definition 2 (Interaction Sequence Chart) An interaction sequence chart is defined as a tuple $ISC = (I, P, from, to, \{\preceq_i\}_{i \in I})$ where

(1) I is a finite set of organizations;

(2) P is a finite set of interaction points that present interactions between organization;

(3) $from$ and to are functions from P to I; and

(4) For each $i \in I$:$\preceq_i$ is a partial order on $\{?p \mid p \in P \; and \; to(p) = i\} \cup \{!p \mid p \in P \; and \; from(p) = i\}$ where $?p$ represents a receiving interaction point and $!p$ represents a sending interaction point.

Interaction Sequence Chart is defined based on the concept of Message Sequence Charts, which is a widespread graphical language to visualize communications between systems/processes [8]. Similar approach is used in previous research of interorganizational workflow [11].

If we implement the interorganizational workflow model using the ARIS platform [9], in the definition of local process view, for any partner i, WF_i and other virtual workflows can be modeled as standard process models in ARIS design platform, such as EPC (event-driven process chain) diagram [10], value-added chain diagram [4] and so on. A local process view of an organization can be represented as an e-business scenario diagram [4], which is also a standard type of model in ARIS design platform.

4. Interorganizational Workflow Collaboration Steps

In the collaborative business environment, each organization has its own consideration, understanding and preference about the whole collaboration work, which can be represented using the model based on local process views we propose in Sect.3. Therefore, there are two phases for interorganizational workflow collaboration. In the first phase, organizations coordinate with each other about their different local process views, which is a bottom-up process. In the second phase, organizations implement the interorganizational workflow model based on the agreement they reach in the first phase, which is a top-down process.

4.1. Phase 1: Bottom-up Coordination

In the process of coordination of different local process views of different organizations, to make them compatible with each other, it is necessary for each organization to coordinate with other organizations by conducting compatibility analysis to eliminate potential conflicts about local process views. The coordination process of organizations is described as following steps.

(1) *Design local process views*: each organization designs its local workflow, interaction protocols and virtual workflows of its partners based on their own requirement and consideration. Organizations make the parts of interaction protocols and virtual workflows of its partners public, while keeping the local workflow processes as privacy;

(2) *Coordinate interaction protocols*: organizations exchange and compare the interaction protocols (Interaction Sequence Charts) designed by partners with their own interaction protocols. If there are conflicts, they negotiate and coordinate to reach an agreement on the interaction protocols between organizations. Then, they modify interaction protocols and the related parts of their local workflow processes in the local process views;

(3) *Coordinate local workflow processes*: organizations compare the workflow part with their partners by (a) exchanging public virtual workflow processes with each other and compare the local workflow and its related virtual workflow of the local organization designed by its partners; (b) exchanging comparison results of workflow processes and negotiate to reach an agreement on the workflow processes;

(4) *Modify local process views*: organizations revise their local process views according to the coordination results and save as new workflow for reuse in further collaboration.

4.2. Phase 2: Top-down Implementation

After coordination and negotiation of different local process views, it can be assumed that organizations have reached agreement of interaction protocols and mutual understandings of local workflows. Therefore, the interorganizational workflow model based on local process views should be further implemented. The implementation of the model includes the following three steps.

(1) *Establish overall organizational structures*: in the collaborative business environment, there are always different roles from multiple organizations involved. Thus, it is necessary to model the organizations and the organizational units that are related to the interorganizational workflow. Roles for members and groups in each organization can also be defined in this step;

(2) *Form common interaction part among organizations*: in this step, the collaboration among organizations can be derived from the compatible interaction protocols (Interaction Sequence Charts) and virtual workflow processes after coordination and negotiation in phase 1. Organizations cooperate to design the interaction scenario of the whole collaborative business. To ensure the flexibility of workflow

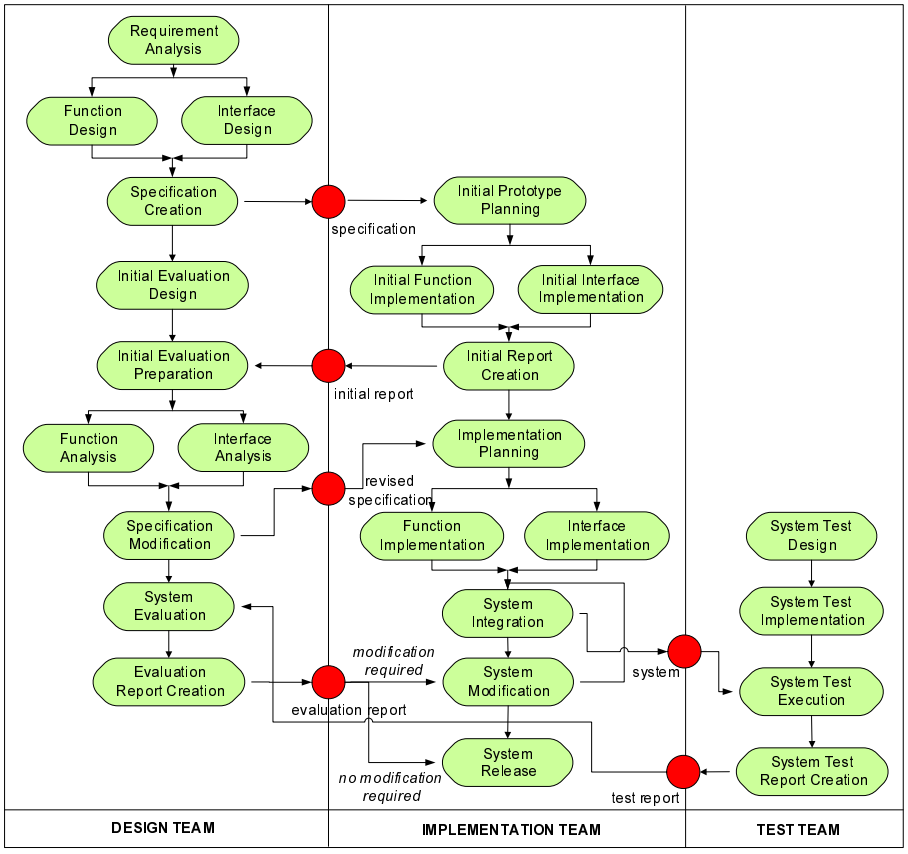

Figure 2. A global function view for collaborative software development in traditional approach.

integration and dynamic changes, each organization only includes part of the necessary high level processes of its local workflow that have interaction with other organizations;

(3) *Build local process models of organizations*: after designing the organization structure and common parts among organizations, the local process models are defined in this step. Each organization designs its local process model distributively in details based on the coordination results in phase 1. Business processes are normally modeled using a multi-level procedure. Starting with the top process hierarchy, processes are detailed consecutively. This detailing is usually carried out over several hierarchy levels using subprocesses for different levels of members within organizations. The interaction parts with other organizations are also designed in details in the local model based on the high level parts designed in the former step.

5. Case Study and Discussion

To describe the proposed approach, we introduce an example of collaborative software development which has also been discussed in previous work [5, 6, 7]. In the example, three teams (organizations) are involved: Alpha Team mainly conducts the design and evaluation, Beta Team does the coding job and implementation, and Gamma Team focuses on the testing process. Figure 2 shows a global function view for the case in traditional approach, where organizations share a global view.

In our interorganizational workflow approach based on local process views, there is no pre-defined global view as shown in Fig.2. Instead, each organization has a local process view at the beginning. The local process views designed by three organizations might be different. For example, the following conflicts are always reported in the software development between companies in real world. In the design team, software specifications are modified in parallel with development. However, the understanding of implementation team is that specifications are fully designed before development. To detect those conflicts, compatibility analysis of different local process views is required as we describe in phase 1 of Sect.4. The detailed compatibility analysis mechanism has been discussed in our previous

work [6]. Three teams are expected to reach an agreement of interaction protocols and local workflows by compatibility analysis and negotiation. After coordination of local process views of different organizations in phase 1, we can apply the top-down implementation steps described in Sect.4 using the ARIS design platform in phase 2 as follows.

First, we design the organization structure of the collaborative software development. Since there are three organizations involved, a main business house and three sub business houses are designed for this purpose. The main house means the common business model (interaction parts) which involves all the three teams. In the main house, the five views (organization, data, process, function and product/service) include the business models that are related to the common part of all the organizations.

Then, the common part of the three organizations as the process view in the main business house designed in step 1 of phase 2 is formed using the e-Business Scenario Diagram, which is derived from the coordinated Interaction Sequence Charts and public virtual workflow processes in phase 1. Figure 3 shows the screenshot of designing the common part of three organizations. The interaction process starts from the Alpha Team by sending the *specification* of the software to Beta Team after finishing *Development Analysis* subprocess. Beta Team then conducts the *initial Implementation* and interacts with Alpha Team with *initial report* after finishing the subprocess. The three organizations interact with each other in this way until reaching the *Software Release* subprocess in the Beta Team. The diagram is designed by the involved organizations and expresses how the organizations interact with each other. All the elements here (the subprocesses, data, organizations) have links with the business model in the local organizations. Comparing the common part in Fig.3 with the process of Design Team in Fig.2, we can see that the *Development Analysis* of Alpha Team in Fig.3 is a high level subprocess which includes four lower level subprocesses in Fig.2, namely *Requirement Analysis*, *Function Design*, *Interface Design* and *Specification Creation*. Also, not all the subprocesses of Design Team in Fig.2 is open to the public in the common part in Fig.3. This is simply because only public interaction subprocesses of all the organizations are designed the common processes in phase 2.

Finally, local process models of the organizations are designed distributively in details in the three sub business houses in step 1 of phase 2. In each sub house, five views are designed. Here we give an example of designing the business model in Alpha Team and focus on the process view. In the business process modeling system, processes are designed by multi-level structures. The modeling system ARIS Business Architect provides various types of models for designing process view. To design the top level main process of Alpha Team, we use the value-added chain dia-

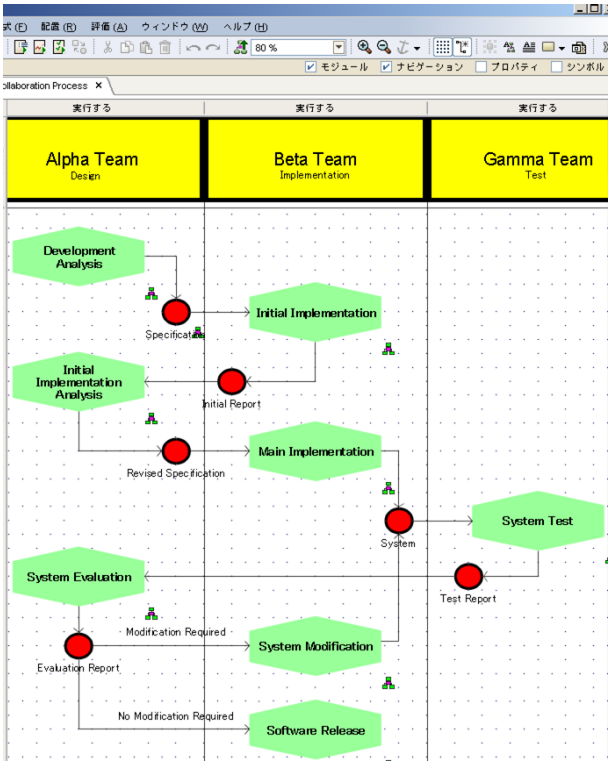

Figure 3. Common parts derived from local process views after coordination.

gram. The main process of Alpha Team includes four subprocesses, namely *Development Analysis*, *Prototype Analysis*, *Initial Implementation Analysis* and *System Evaluation*. After the main process is designed, we further design each subprocess in more details. For example, the subprocess *Development Analysis* of Alpha team can be further designed using event-driven process chain (EPC) diagram. Therefore, the process view of Alpha Team can be designed until the bottom processes. By this means, we can also design the process views of Beta Team and Gamma Team.

Flexibility support is an important issue in interorganizational workflow and covers many aspects. In our approach, we concentrate on flexibility of local workflow design. Since each organization has its own local process view, it is flexible for organizations to design the whole collaboration based on its understanding. Moreover, when designing the common parts, very little information of the organizations is required. Therefore, when there are dynamic changes in the collaboration process, the local workflow will be less affected than in the situation that all information of local workflows are shared with other organizations as in some traditional models.

Privacy preservation is another essential requirement for

interorganizational workflow. In our approach, organizations design virtual workflows for other organizations based on their own understandings that are open to other partners for detecting conflicts. In the implementation phase, the access of process groups (subprocesses) can be controlled by designing access administration mechanisms. For each process group, users in the whole system can be controlled by managing the *read*, *write* and *delete* permissions. When organizations access the process server, they can only access the parts that they have the access right. Therefore, using this property, we can manage interorganizational workflow while preserving the privacies of organizations.

Besides, our approach support workflow reuse since each organization has a local process view including not only local workflows but also interaction information that can be preserved as a workflow service.

Although the proposed model and collaboration approach provides flexibility support, privacy preservation and workflow reuse for organizations in the business design stage, it is still insufficient for current business process management systems to support interorganizational workflow collaboration. For example, the coordination of organizations to reach an agreement on the common interaction cannot be well supported in current concept. Also, the integration of different business process management systems of different organizations is an important challenge. Moreover, in a global business environment, the issue of how to support and analyze the different cultural influences in controlling stage is still to be worked out.

6. Conclusion

In this paper, we propose an interorganizational workflow model and collaboration approach for collaborative business. We first present an interorganizational workflow model, taking different process modeling views of different organizations into consideration. In this model based on local process views, organizations do not share a pre-defined global interorganizational workflow process, but have their own understandings of how to model the whole workflow process with their unique backgrounds and knowledge. The local workflows are shared among organizations. The proposed interorganizational workflow model for collaboration has the following features: consideration of different workflow modeling views of different organizations, privacy preservation of organizations and flexibility of local workflows. Then we provide a methodology for interorganizational workflow collaboration by two phases: the bottom-up coordination phase and the top-down implementation phase. The proposed interorganizational workflow model and collaboration approach is demonstrated by a case study of collaborative software development. We also discuss some limitations of applying current business process management systems for interorganizational workflow collaboration, which can be our future focus.

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