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A Gradual Workflow Extension Model based on Activity Decomposition

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Workflow model extension involves the boundary problem of collaborative design. How to determine the boundary of exposure information to ensure internal information secret and the progress of extension smooth is an important problem. It is necessary to study the collaboration model boundary of cross organizational workflow in order to accurately determine the boundaries of collaborative. A gradual workflow extension model based on activity decomposition is proposed combined with fully distributed workflow and homogeneous activity workflow description model which greatly simplifies the complex workflow extension.

1. Introduction

Business processes of large enterprise often contain lots of complex workflow with the characteristic of across organization, cross-regional and cross-industry. It is more and more difficult for workflow definition to accurately describe the practical requirements (van der Aalst and Weske(2013) and Fahland and van der Aalst(2013)). At the same time, processes of large enterprise have obvious administrative characteristic, and each process has its competent parties or coordination (van der Aalst(2013) and de Leoni et al.(2014)). Workflow definition is dominated by one party with others' participating, so process definition is very difficult to accomplish at one stroke.

2. Related work

The existing research methods mainly adopt cross-organizational workflow coordination and workflow continuous improvement methods to solve the above problems.
Workflow is designed and maintained by multiple areas and regional professionals through collaboration in cross-organizational workflow coordination method (Norta(2007) and Xu et al.(2009)). This method can make up for the deficiencies in the knowledge structure and the time and effort. But the disadvantage is increased communication costs -- in order to make the views of the parties fully communicate and agree on the need to spend time and energy, and the information share permissions in the communication of collaborative design is often difficult to control or be active ignored which increased the organization's information security risk. Therefore, one key research in cross organizational workflow lies in the organization boundaries design, namely how to divide the scope of information sharing in cooperative communication of multi parties, the other is to the common communication language of both sides or parties because cross organizational workflow established on the basis of different workflow management systems and the language is required to unify workflow concept of all parties and can accurately express the cooperation needs.
Workflow is designed in continuous improvement methods through elongating workflow design cycle to make the design stage coincide with running stage and adjusting and optimizing workflow model in practice to make it closer to practical and stability(Award et al.(2011), Hompes et al.(2014) and Muthusamy(2012)). The method allows to adjust workflow model according to practice and can make up the gap between theoretical knowledge and practical work. The shortcoming lies in modification risk –– the modification tends to bring lots of uncertain factors. A minor modifications in complex workflow model may make the entire workflow system paralysis and difficult to find reasons. It is difficult for any perfect modification model to ensure the modification can execute correctly under any circumstances and meet the needs of workflow designers. Therefore, the

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research focus in workflow modification field is how to simply the modification operation to make it easier to perform correctly and easier for users to understand and how to limit the range of modification operation to make the risk in a controllable level.
The above two methods have their own advantages in managing large enterprises complex workflow, in this paper a distributed workflow management model based on activity decomposition is put forward to support incremental workflow description combined the two methods.

3. Workflow collaborative design pattern

Cross-organizational workflow collaborative design pattern is mainly used to show the responsibility and authority of multiple organizations which is the foundation of workflow collaborative design. In order to design suitable workflow extension model, it is need to streamline and improve the various schemas in cross-organizational workflow research field(Award et al.(2011), Norta(2007) and Hompes et al.(2014)) and to distinguish organization boundary according to workflow management practices and system architecture characteristics so as to provide theoretical guarantee for the framework of collaborative design.

3.1 Outsourcing pattern

Outsourcing pattern is a kind of workflow pattern conducted by employer organization and contract organization. An activity in workflow pattern is outsourced to contract organization(C-ORG) with input/output data description and basic business functions sample. Appropriate personnel will be selected and reasonable sub-workflow will be designed to meet the requirements of employer organization(E-ORG) according to the condition of C-ORG.E-ORG doesn't need to care about the details of personnel arrangement and process design in C-ORG, also C-ORG doesn't need to care about the upper workflow model, organization, the source and destination of activity data in E-ORG.

3.2 Cooperative pattern

Relative to outsourcing pattern cooperative pattern is a more complex one in which collaboration needs and corresponding responsibilities are determined and shared by both cooperative organizations (O-ORG). The main workflow model including activities, transfer conditions, actor, activity task, data flow and so on, is identified through the communication of both organizations according to their respective situations. Both organizations are able to understand the design principle of the main workflow, the arrangement of activity heads, data flow and business functions, but they can't know the internal staff arrangement and the specific activity process in the other organization.

3.3 Multi-cooperative pattern

Multi-cooperative pattern is a kind of workflow pattern supporting multi patterns, multi co operations and homogeneous activity model based on outsourcing pattern and cooperative pattern. There are various participants in multi-cooperative pattern which can be divided into process cooperative organization and activity outsourcing organization. The former is responsible for the consultation of the whole workflow view while the latter is responsible for the activity cooperation. The cooperative organization can understand the workflow design principle, the arrangement of activity heads, data flow and business functions, but can't know the internal staff arrangement and the specific activity process in the other organizations. The outsourcing organization can't know more information besides activity input/output data description and business functions sample. Multi-cooperative pattern can support cooperative pattern and outsourcing pattern at the same time, still can use homogeneous activity description ability to strengthen the scalability of cooperation model.

4. Activity decomposition model

Workflow management model based on activity decomposition is on the basis of distributed workflow architecture which takes a single activity as collaborative boundary and takes individual activity as workflow change means to limit the impact of process change area to a smaller range, so as to realize the progressively collaborative workflow design.
Activity decomposition activity decomposition is a collaborative workflow design method which uses a single activity as collaborative boundary. The superior partner is responsible for each activity definition and process deployment, while the junior partner is responsible for decomposing the activity deployed to local into more complex sub-workflow and redeploying the sub-workflow, by analogy to realize collaborative workflow design, as shown in Figure 1.
A new sub-workflow will be generated after activity decomposition by the junior partner. Once the activity is processed after the sub-workflow being deployed, whether the upper and lower workflow exist at the same time will be detected, if it is, the lower workflow will be executed while the upper will be skipped. Only after all activities of the lower workflow are executed, the decomposed activity of the upper can execute the backward

transfer instruction. The operation of junior partner can't directly modify the deployment result of the upper workflow which can improve the stability and controllability of the system.

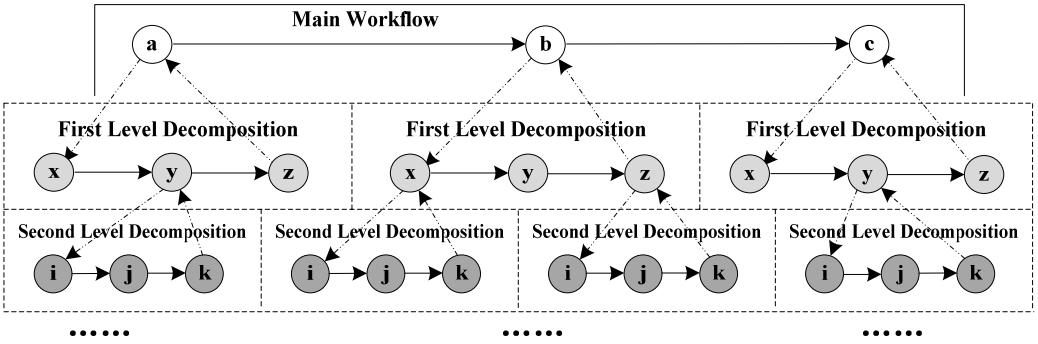

Figure 1: Activity decomposition diagram

5. Activity decomposition permission control

The activity decomposition permission must be controlled in order to ensure the safety of process management. Two levels of constraint need to be provided in order to control activity decomposition based on the two types of permission: the operation constraint to perform activity decomposition for users and the mapping constraints between user and permission. More detailed execution permission control can be provided through the dual constraints of activity decomposition.

The access control collection of activity decomposition is a two-tuples defined as $EAC = \{COAC, OSAC\}$, in which the collaborative access control collection $COAC \subset AUS \times SWF$ represents the visual permission collection to workflow, $AUS \in US$ are business personnel being installed workflow definition platform in their business node, US represents a collection of all users. SWF is workflow model collection containing ordinal activity AN and homogeneous activity SAN. The outsourcing access control collection $OSAC \subset AUS \times (AN \cup SAN)$ represents the collection of decomposition permission to all activities.

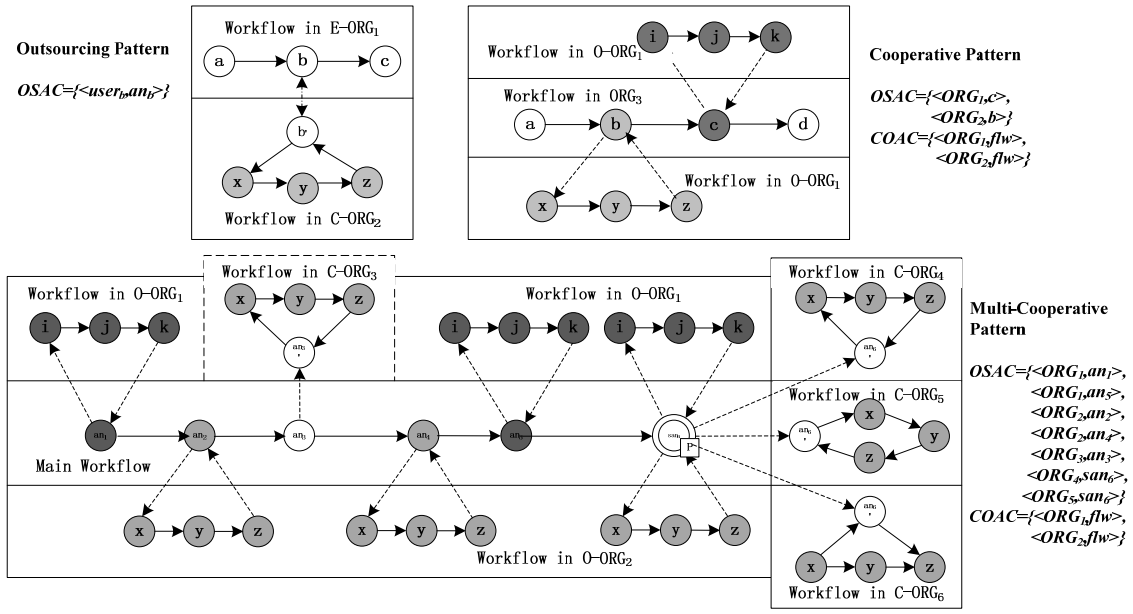

Figure 2: Description example of activity decomposition pattern

Constraint If there exist businessman $user$ and workflow model swf, AN and SAN is activity collection and homogeneous activity collection respectively and the decomposition privilege of $user$ to swf $\Re(user, swf\} \in COAC$. $\forall an \in AN$, if $\delta(an)$ represents the actor of activity an, if $\delta(an) = user$, then $\Re(user, an) \in OSAC$; $\forall san \in SAN$, if Z is the collection of the all actors of activity san, then $\Re(Z, san) \in OSAC$.

The access control of activity decomposition model is shown in Figure 2. In outsourcing mode, only the outsourcing access control collection needs to be set, while in collaboration mode both outsourcing and collaborative access control collection need to be set to satisfy the above constraints.

6. Activity decomposition algorithm

Activity decomposition algorithm is called to distribute workflow, activity or sub-workflow model in accordance with decomposition permissions to the activity node allowed to be decomposition at workflow deployment time. It doesn't realize runtime deployment, but distribute the calculated model to workflow definition platform on business node. The algorithm contains the following three steps:

First, get the set of business users with the cooperation access privilege to workflow and distribute the read-only workflow model to definition platform of business users.

Second, if there is business user with the outsourcing access privilege for ordinary activity nodes, then an empty sub-workflow model related to the activity can be generated and distributed to the users' definition platform.

Third, get the set of business users with outsourcing access privilege for homogeneous activity node, if there is sub-workflow on the node, it will be distributed to the users' definition platform, otherwise an empty sub-workflow model related to the activity will be generated and distributed to the users' definition platform.

The process of activity decomposition algorithm can be described as following:

Input: the set of activity decomposition privilege $EAC = (COAC, OSAC)$; Workflow model swf

Output: null

Begin Decomposition

//get the collections of business units with visual access to *swf*

$unitList \leftarrow GetUnitList(swf, COAC)$;

//publish a read-only workflow to the business unit list

For ($\forall unit \in unitList$) do

$techUser \leftarrow unit.techUser$; //get technology node of business units

$DeployReadOnlyModel(techUser.addr,\ techUser.username,\ Package(swf))$;

End for

//publish the sub workflow to the business unit with activity decomposition

For ($\forall an \in swf.AN$) do

$unit \leftarrow GetUnit(an, OSAC)$; //get business units with decomposition to *an*

If ($Exists(unit)$)

$techUser \leftarrow unit.techUser$;

$subSWF = createBasicSubSWF(swf.id, an)$; //build sub workflow with three basic nodes

$DeployModel(techUser.addr, techUser.username, Package(subSWF))$;

End if

End for

For ($\forall san \in swf.SAN$) do

$unitList \leftarrow GetUnitList(san, OSAC)$;

If ($HasSubSWF(san)$) //if the activity has sub workflow

$subSWF = GetSubSWF(san)$;// select the workflow to be published

Else

$subSWF = createBasicSubSWF(swf.id, san)$;//generate a new sub workflow

End if

For ($\forall unit \in unitList$) do

$techUser \leftarrow unit.techUser$; //get technology node of business units

$DeployModel(techUser.addr, techUser.username, Package(subSWF))$;

End for

End for

End Decomposition

7. Case study

The initial purchasing process of a large enterprise is shown in the solid line box in Figure 3 which is started by the director of business units, and the purchasing instructions are forwarded to each project team in his organization. After all material requirement forms are received by the directors they can be collected to generate purchase requisitions and submit headquarter. The requisitions will be distributed to the corresponding procurement center according to its material type once reviewed. After bargaining the result will be handed over to headquarter for contact. Only material has been received, financial department can pay in accordance with the contract. The organization includes purchasing office, financial department, three business units, and two purchasing centers, two project teams, shown as the solid line box in Figure 4.

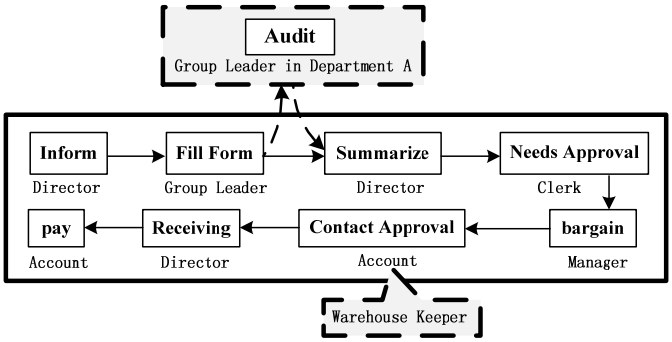

Figure 3: Purchasing process

Now Warehouse A4 is added in Business Unit A and granted *COAC* permission to the purchasing process. At the same time, purchasing centre Z has granted *OSAC* permission to the purchasing process. After changing the corresponding organizational structure, purchasing process is shown in the dashed box of Figure 3 and Figure 4.

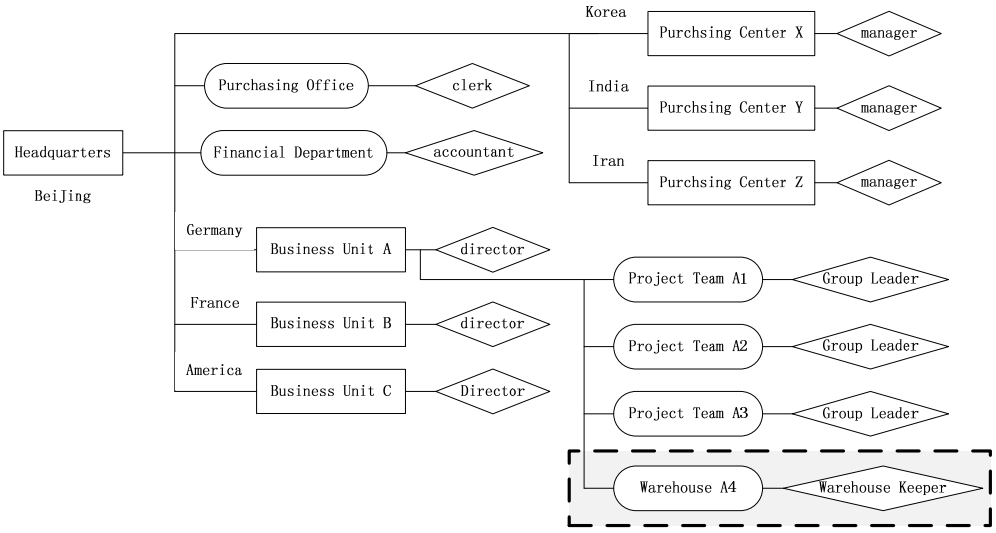

Figure 4: Organization structure

Business unit A granted *COAC* permission can see the whole view of the main workflow and be able to improve its own purchasing applying activities and receiving activities. The improvement result is audit activities executed by director are added to purchasing applying activities and the actual consignee is changed in receiving activities.

The specific workflow model based on activity decomposition and the workflow model eventually deployed are shown in Figure 5(a) and (b) respectively. It can be seen from the figure that the method based on activity decomposition greatly simplifies workflow management which makes each workflow designer can contribute to complex workflow management only need to master less business knowledge.

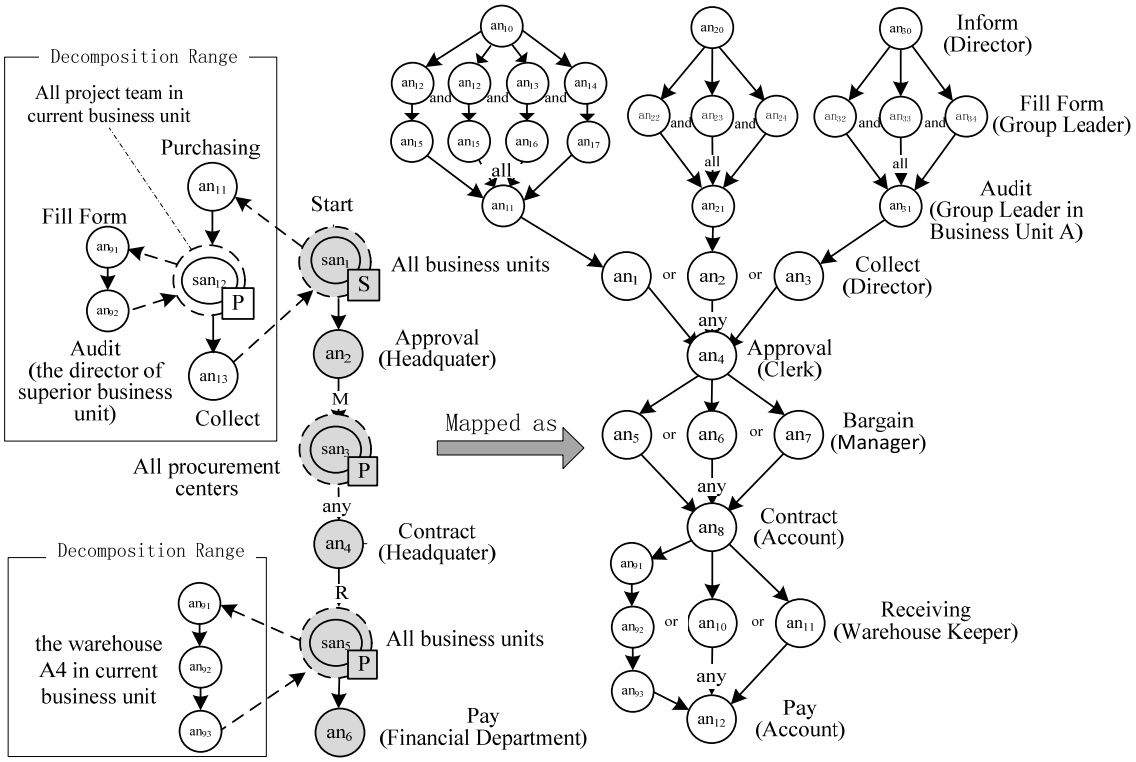

Figure 5: Workflow extension model based on activity decomposition and workflow model after mapping

8. Conclusions

A gradual workflow extension model based on activity decomposition was proposed aiming at the collaborative design of workflow model extension. Three design patterns were studied including outsourcing pattern, cooperative pattern and multi-cooperative pattern based which the model, permission control and core algorithm of activity decomposition were studied. Experimental results show that the method using the hierarchical nature of the organization can limit the impact of process changes to a relatively small rang through gradual activity decomposition and effectively control the risk of workflow improvement.

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