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# Workflow Modeling Method Based on Coordination Theory

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## ABSTRACT

Workflow is an abstract model for discrete event system and business process. In order to solve the problems of low description ability and flexibility existed in current workflow management systems, in this paper, a new workflow modeling method based on coordination theory and feedback mechanism is put forward. The proposed method extends the traditional activity network model and introduces new modeling mechanisms. Several new modeling elements, such as request node, service node, coordination node, and multiple instances node, are added to the modeling method. An example workflow model regarding bid and evaluation process is given. Research results show that compared with traditional activity network model, the proposed method has significant advantages in enhancing description ability, reducing model complexity, and improving system flexibility and adaptability. The proposed method has important value in designing and developing workflow management systems with high reliable, flexibility, and adaptability.

**KEY WORDS:** Discrete event system, Information modeling, Workflow modeling, Coordination theory.

## 1. INTRODUCTION

Business Process Reengineering (BPR) requires the companies to transfer their organization structure and the operation mechanism. The transition from traditional function oriented hierarchical structure to process oriented network structure. During this transition process, the core business processes of the company are redesigned and implemented, so as to dramatically improve the company's competitive ability. The workflow technology provides key support to the modeling, analysis and implementation of the BPR, so the workflow software product is fast evolving. There are hundreds of products developed by different companies.

Workflow model is a typical method for modeling discrete event system. It is an abstract model of the business processes. Because the workflow model is to be interpreted and executed by computer software, i.e. workflow management system, so, the workflow model should have good semantic property. Compared with the evolving speed of the workflow products, the research on workflow modeling methods is slow. Until now, there does not have a systematic theory framework. The existing modeling methods are: activity network modeling method[2], Petri net based mothod[3], speech-act theory based method[4], activity and state chart based method[5], and extended transaction model based method[6].

The problems existed for current workflow modeling methods are: 1) the lack of abundance in model semantics, the inability to describe complex problems; 2) the lack of flexibility, it is difficulty to deal with the uncertainty happened during the instance execution processes. 3) the lack of feedback and coordination mechanism, the current modeling methods are all based on the hierarchy relationship, which means that the ending of preceding activity is the instruction of the following activity, while in the practical application, it is not always suitable; 4) lack of multiple activity instances execution during one process instance; 5) lack of good reusability, even a very small adjust of the business process, the associated workflow model should be redefined, it is time costing and increasing the management complexity.

In this paper, a new workflow modeling method based on coordination theory and feedback mechanism is put forward. The proposed method extends the traditional activity network model and introduces new modeling mechanisms, such as feedback mechanism, market mechanism, and coordination mechanism. Several new modeling elements, such as request node, service node, coordination node, and multiple instances node, are added to the modeling method. An example is given also to show the advantages of the proposed method.

## 2. MODELING MECHANISM

The proposed modeling method introduces the coordination mechanism of the coordination theory and feedback mechanism of the control theory. Coordination theory is used to solve the problems in the management of cooperative work, it is science about cooperative activities and their interdependence. Malone[7] has proposed 4 kinds

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of coordination strategies: hierarchy, market, equal partnership, and broker.

The above mentioned 4 kinds of coordination strategies can best suit practical company's business operation process as well as the relationship between different business unit or activity. Based on the above observation, in this paper, a new workflow modeling method is proposed. In the proposed method, besides the hierarchy mechanism used in traditional activity network modeling methods, the following mechanisms based on coordination and feedback theory are added to the modeling method：

1) **Request-service mechanism**： By introducing request and service nodes, the activity can request multiple services according to the dynamic execution conditions. In the meantime, according to request-service primitives of the object-oriented technology, based on the request activity and service activity working sequence, such as whether the requester should wait for the response from the service node, the request node is further divided into 4 different nodes. The 4 nodes are simple request, request-continue, request-wait, and request-wait-continue node.
2) **Multiple instances mechanism**： By introducing multiple instances activity, the concurrent execution of multiple instances of one activity is allowed.
3) **Condition setup mechanism**： By introducing condition setup node and condition setup arc, thus the dynamic setup of activity execution condition is enabled.
4) **Negotiation mechanism**： By introducing negotiation node, the user is allowed to define specific coordination logic or to start other groupware to support group work.

The introduction of above mentioned coordination and feedback mechanisms can better support the interaction, negotiation, feedback between different activities and support the dynamic condition setup, as well as multiple instances execution. They all contribute to increase the description power of the modeling method and improve the workflow system's flexibility significantly.

## 3. MODEL CONSTRUCTS

The proposed workflow model consists of activity node and connection arc.

In Figure 1, three types of connection arcs are given. The conditional arc is used to define conditional connection between activities, the conditional setup arc is used to dynamic setup execution condition for activity, the setup conditions are enable condition, complete time, and finish condition, etc.

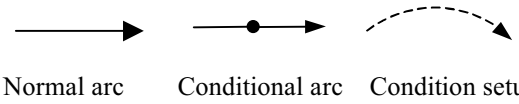



Figure 1. Connection arcs

Figure 2 presents 15 types of activity nodes.

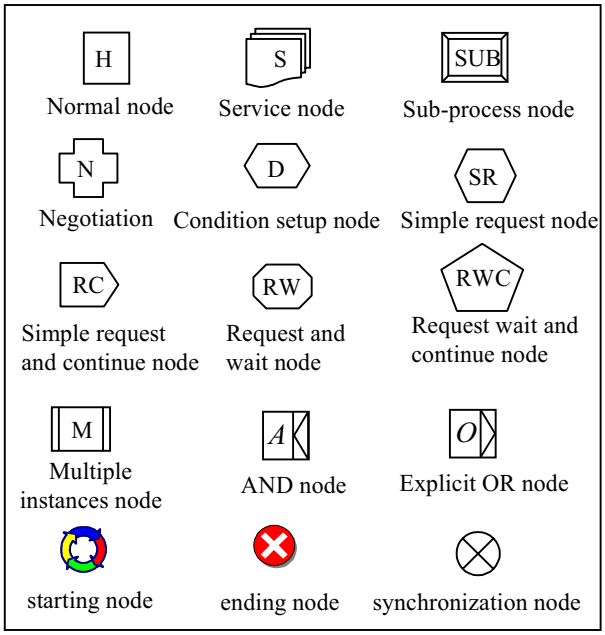
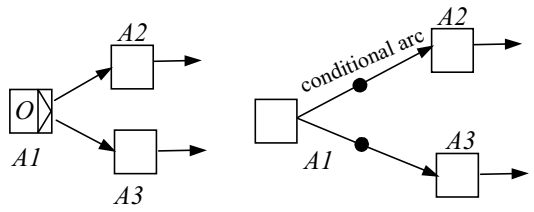



Figure 2. Graphical symbols for activity node

1) **Normal node**： The same meaning as traditional activity network modeling method.
2) **Subprocess node**： The subprocess node represents a low level workflow model, it is used to form hierarchical workflow model.
3) **Starting node**： It is used to represent the start of a workflow process. It is also used in service node as the entry of a service process.
4) **Ending node**： It is used to represent the end of a workflow process. It is also used in service node as the output of a service process.
5) **Negotiation node**： This node represents the user defined negotiation logic, or the start of other groupware software to support group work.
6) **Multiple instances node**： For this type of node, multiple instances for one activity can be executed concurrently.
7) **Explicit OR node**： Explicit OR node is different from implicit OR node. The difference is that the explicit OR node selects the following up activity according to the conditions defined on the OR node, while the implicit node selects the following up activity according to the conditions defined on connection arcs.




（a) explicit OR node (b) implicit OR node

Figure 3. Explicit and implicit OR node

8) **AND node：** AND node is used to concurrently fire multiple following up activities.
9) **Synchronization node：** It is used to synchronize multiple concurrent execution subprocesses, thus to enable the join operation of multiple activities.
10) **Service node：** One service node can provide several services. Each service is defined by a subprocess. Every service node provides a service interface that includes service list, its function, input data, xpected execution time, cost, and output data.
11) **Request node：** Request node sends request to service node. According to execution requirements, one request node may ask several services. Based on the request-service primitives of object-oriented technology, the request node is further divide into following 4 types: simple request node, simple request and continue node, request and wait node, and request wait and continue node:

- **Simple request node：** Simple request node completes its task after sending out the service request, it does not wait the service node's response. The simple request node is the simplest type in the request/service relationship.

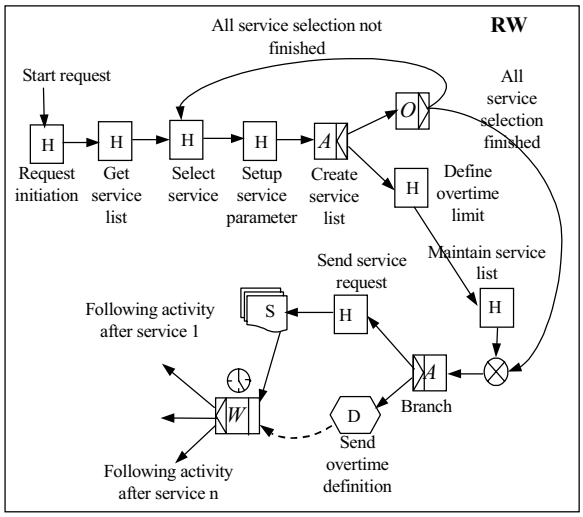



Figure 4. Process logic for request and wait node

- **Simple request and continue node：** Simple request and continue node is very similar to the simple request node, the only difference is that it triggers another activity after sending out the service request, thus creates a concurrent new process.
- **Request and wait node:** Request and wait node waits for the answer from service node after it sends out the request. In order to avoid endless wait, a clock is setup. It is defined by timeout define node. Figure 4 gives out the internal logic of the request and wait node.
- **Request wait and continue node:** The logic of this node is similar to that of request and wait node, the only difference is that it triggers another activity after sending out request.

## 4. MODELING EXAMPLE

Figure 5 presents an example about a bidding process. The main activities for bidding process are given, such as bid preparing, bid release, receive proposal, proposal evaluation, decide winner, etc.

Through comparing our workflow model with traditional activity network model, the advantages of the proposed method are:

1) **Strong model description power and simple structure:** For the example shown in Figure 5, if it is modeled using traditional activity network method, the scale will be much larger than Figure 5.
2) **Good adaptability and generality:** The proposed method can better deal with the uncertainties of the practical applications. For example, the evaluation expert number, deadline, and timeout can be dynamically setup in our model. So it can greatly improve the adaptability of the model.
3) **Simplified modeling process:** The introduction of request, service, negotiation, multiple instance node greatly reduces the modeling process, the user can better understand the model. The feedback, negotiation, request, and service mechanisms are better suit for practical business processes.

## 5. CONCLUSIONS

Although business process reengineering, process management, and workflow management has been much emphasized, there exist also a lot of workflow products, the workflow technology is still no widely used by companies, one of the main reason is the lack of flexibility and reliability for the workflow products. In this paper, a new workflow modeling method based on feedback and coordination mechanisms is put forward.

Some new modeling elements are added. Practical modeling example shows that the proposed method has the significant advantages on flexibility, adaptability, modeling power, and simple structure. But it should be pointed out that the introduction of new modeling elements has also increased the complexity for implementation of workflow engine.

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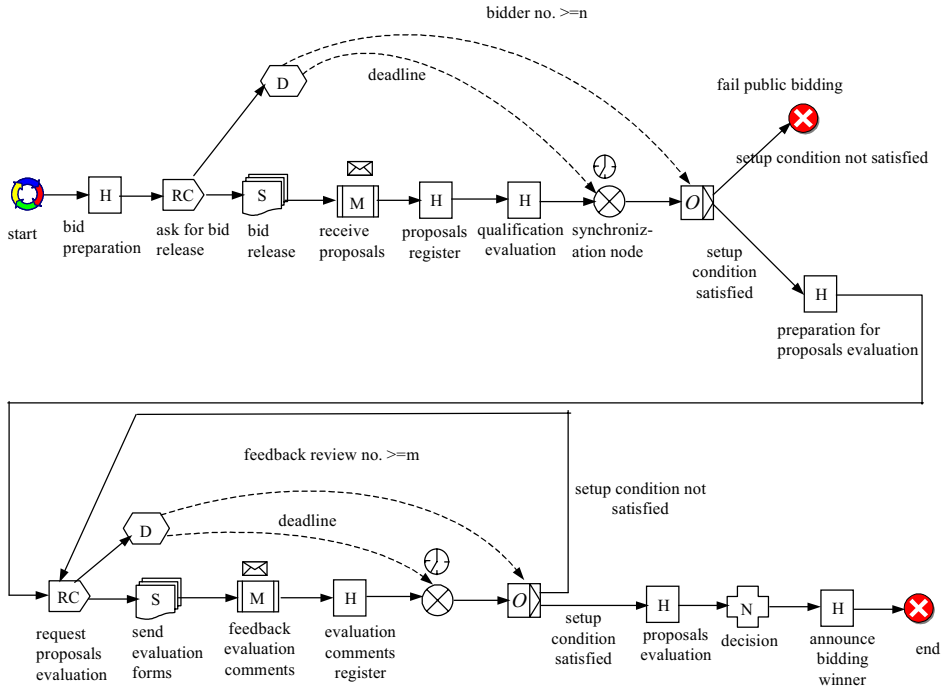


Figure 5. Workflow model for bidding process