Workflow-Based Dynamic Enterprise Modeling*

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Abstract: Traditional systems for enterprise modeling and business process control are often static and cannot adapt to a changing environment. This article presents a workflow-based method to dynamically execute the enterprise model. This approach gives an explicit representation of the business process logic and the relationships between the elements involved in the process. An execution-oriented integrated enterprise modeling system is proposed in combination with other enterprise views. The enterprise model can be established and executed dynamically in the actual environment due to the dynamic properties of the workflow model.

Key words: Enterprise modeling; Business process; Workflow

Introduction

In an enterprise, management decisions must be based on accurate, reliable information, and must be supported by reliable modeling methodology. However traditional modeling systems use static enterprise models which run in a pre-defined order with pre-allocated resources and personnel which is a static description of the enterprise information. As conditions change, the modeling system cannot automatically redesign itself. This paper proposes a dynamic workflow-based integrated enterprise modeling method which gives an explicit representation of the business process. An integrated enterprise modeling system is presented in combination with other enterprise views. The dynamic workflow model allows re-allocation of enterprise resources and re-routing of work in the actual environment.

1 Definition of Enterprise Business Process Based on Workflow

Every company's day-to-day operations involve business processes. A business process can be defined as a sequence of steps that accomplish a business goal.

Workflow relates to the business process by representing the:

- Specific tasks or activities performed by people or programs (work),
- Interactions required between them (flow).

A complete workflow specification consists of a description of the elements that make up the business process[2]. These elements are described in the following table:

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Table 1 Business process elements

Elements	Description
Activity	A task performed by a person or an application
Role	Participants in workflow
Route	Referring to the starting, intermediary, and ending points through the workflow process
Rule	Referring to any rule or condition that affects the workflow object
Information	Content which is passed from the activities
Resource	Resources needed by the execution of activities.

For the elements described in table 1, the generalized structure of the business process model can be depicted by the directional network-topology mode shown in Fig. 1. The enterprise business process can be described with nodes and connections between nodes.

In fig. 1, the nodes are categorized as the following types:

- Activity: The basic unit of a business process, embodying a manual or automatic enterprise operation over a period of time.
- Sub-process: Nodes that can be further decomposed
- Starting nodes: the initial step in the process.
- Ending nodes: the final step in the process.
- Synchronization nodes: Harmonize and synchronize different activities.

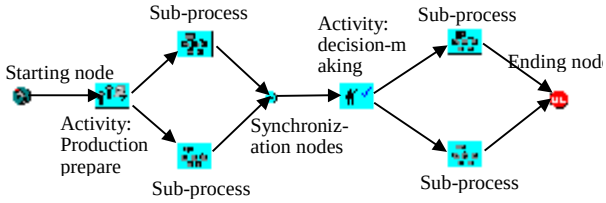

Fig. 1 The network-topology graph of a business process

An activity can be considered as an object containing the following attributes:

- Input: The prerequisite to begin an activity including materials and relevant information.
- Output: Finished products, semi finished products and output information.
- Role: The aggregation of enterprise personnel that can accomplish some professional job, which is close related to the enterprise organizational structure.
- Resource: Physical equipment, such as machine tools, not consumed in an activity[3].
- Constraint: Limits resulting from competition in markets and pressure from customers. A major constraint is time, which demands activities be finished in a certain period.

By defining specific types of nodes, users can not only clarify the specific meanings of the nodes, but

can also intensify model semantics. Models based on the directional chart can be easily modeled using extended Petri nets. User can simulate the process models and evaluate their performance using the Petri net tools. The evaluation results can then be used to improve their practicability.

2 DYNAMICAL WORKFLOW MODELLING FOR ENTERPRISE PROCESS

Traditional workflow systems support task integration with pre-defined flow control. Although a process can be modified by executing event-driven rules, by enforcing inter-activity dependencies, or by failure recovery, those changes are also pre-defined. Therefore the execution of traditional workflow models is static and pre-defined. But practical business processes operate in a dynamic and distributed environment with dynamic relationships among a large number of activities. New techniques should be combined with the workflow system to model the automatic and dynamic response[4].

This paper provides an infrastructure for dynamic business process modeling and execution using a meta-workflow model and agent technique.

2.1 The meta- workflow model

As opposed to the conventional process model, the base units of a meta-workflow model are the tasks not the activities and the roles and resources used by the workflow are not assigned to actual objects. The meta-workflow model is simply a task flow model which can be viewed as an object. The model can be executed in different ways according to the actual situation by different people supported by different resources.

There are three basic elements in the meta-workflow model: task, resource class, and role. A task corresponds to a generic piece of work. A task is not defined for a specific case, but for a type of cases. Compared with activities defined in business processes, the activity can be seen as the actual execution of a task. An activity combines a task, a case, a trigger and an optional resource.

Resource classes and roles are used to define the requirements for the resource type or person’s ability in the business process. The resources and people should not be explicitly linked to tasks. If a task is linked to a specific user, then the task will be blocked if the user is absent. The use of links to specific resources also reduces flexibility. Moreover, the workflow process definition needs to be modified each time a new employee is hired (or an existing employee is discharged).

To avoid links to specific resources, resources are grouped into classes which are a group of resources with similar characteristics. A resource may be a member of multiple resource classes.

The roles can also be viewed as a kind of resource class. If a resource class is based on the capabilities

(i.e. functional requirements) of its members, it is called a role. If the classification is based on the structure of the organization, such a resource class is called an organizational unit (e.g. team, branch or department), which can also be treated as a role.

The meta-workflow model associates roles and resource classes with each task. During executing, the meta-workflow model will be initiated, and the roles and the resource classes will be associated with actual objects according to the dynamical situation (Fig. 2).

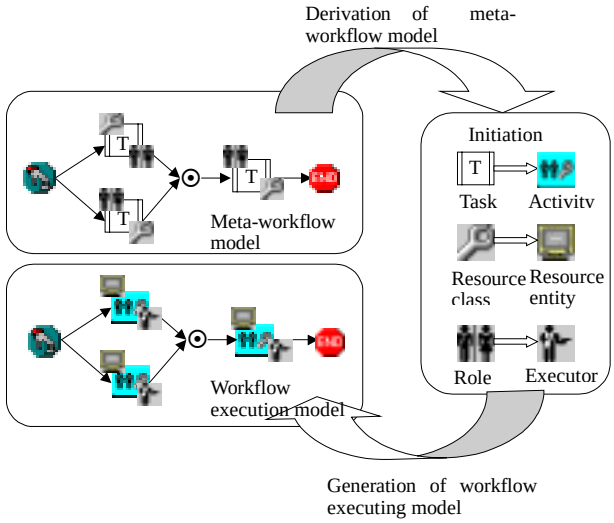

Fig. 2 Initiation of the meta-workflow model

2.2 Dynamic execution of workflow model supported by agent

The meta-workflow model defines a business process template which can be dynamically executed according to the actual requirements and conditions. But the meta-workflow model can only satisfy the dynamic generation of the workflow model. Once the meta-workflow model is initiated, the workflow model will be executed in static mode because the resources, executors and the process logic of the workflow model have already been established which will result in the failure of the workflow execution when some of the conditions change, such as a shortage of resources or the absence of an executor. This paper presents an agent-based workflow execution method to provide dynamic execution of the workflow model. The software agents are personalized, run continuously and are semi-autonomous, as they are driven by a set of beliefs, desires and intentions. The most promising feature of using an agent in the workflow model is not the launching of a process to be executed by a stand-by workflow server, but the performing of activities by the software agent on the fly. A software agent can be used as the workflow engine to dynamically perform the activities in a workflow, and the workflow will orchestrate or control the interactions between agents rather than directly control the actual execution of the activity (Fig. 3).

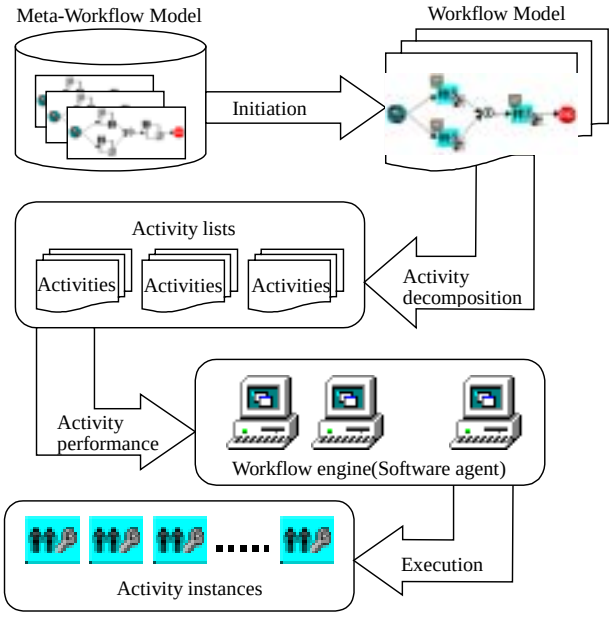

Fig. 3 Agent-based execution of a workflow model

In statically structured distributed systems, service is provided by stationary servers. The introduction of an agent can free the services from such a static configuration. Given the underlying support for communication, program-flow, action-initiation, and persistent object storage, dynamic agents can be used as the "nuts and bolts" to integrate system components on the fly, and thus dynamically provide services.

Agent cooperation is more dynamic and flexible. The tasks performed by agents may be dynamically selected as they focus on a general goal, depending on the current situation such as the results of previous tasks.

By using multi-agent cooperation in the workflow, the execution of an activity is handled by autonomous agents rather than by centralized workflow control. The dynamic agent infrastructure is suitable for the use of agent cooperation in the workflow because a dynamic agent is not simply a task, but a carrier of tasks that represents steps in a business process. Compared with a normal task, a dynamic agent is a continuous running object with a persistent communication channel and knowledge across tasks and processes. In these aspects the behavior of a dynamic agent is more similar to a human user than to a normal program task. This allows, for example, an auction agent to use the above capabilities to combine requests from multiple buyers and to make intelligent decisions by cooperating with other agents.

3 Execution Oriented Integrated Enterprise Modeling Based on Workflow

The execution oriented integrated enterprise modeling method described here uses the workflow model as its core model with other model view (function view, information view, organization view and resource view) models as accessories, and with association and quotation relationships between the different view

models. The workflow model can be considered to be an execution-oriented process model which represents the enterprise business process view. The integrated enterprise modeling method is used to establish each view model and to execute it step by step, which the workflow model as the key control to secure consistency between models. The dynamic properties of the workflow model can re-configure the enterprise model according to the actual execution environment.

3.1 Integrated enterprise modeling method

The definition, simulation and execution of the enterprise model need the participation of all the view models. The relationships between the workflow and the other views are the most important parts of the integrated modeling method[5]. This section discusses the relationships among the multiple views and shows how to establish an integrated enterprise model. All these relationships are combined with the workflow model.

The organization model provides role types to the process model during the meta-workflow model definition period and provides role assignment scenarios during the execution period. During the model execution period, relative organization model data will be modified and the personnel state will be locked. After the activity is finished, the organization model data will be modified again and the personnel will be released.

The resource model provides resource classes to the process model during the meta-workflow model definition period and provides specific resource ID assignment scenarios during the execution period. During this period, relative resource pool data will be modified and the resource state will be locked. After the activity is finished, the resource will be released for another activity. The associations and quotations from the organization model and the resource model to the process model use concrete organization and resource elements in each activity during the modeling process.

The relationships between the function model, the information model and the workflow model are constructed as follows. In the definition of the process view model, the defined model structure is mapped to the function view model. The input and output information is used in the definition of the information flow or control flow between different functional modules. The function view model can re-organize the information flow from the process model according to the requirements of the function view modeling. Some information might be organized as input and output information, with other information organized as control information. Similarly, the information view model extracts information from the process view model and establishes the information view model according to the organizational mode of the information view model.

3.2 Integrated modeling, simulation and execution

Enterprise modeling focuses on process description and iteratively builds each view.

The simplified function, organization and resource views are built first as parts of the workflow model. The obtained workflow model will then be used to guide the production of more detailed function, organization and resource models. The function model can be rearranged with supplementary statements added to the resource model if necessary. The information model is then built through a mapping mechanism.

The result of the integrated modelling will serve as the input to the simulation tools[6]. In our system, the workflow model was initiated first. The tasks, roles and the resource classes were then assigned to actual objects. The workflow instance was then transformed to the Petri net model[7]. A Petri net simulation tool then started running the Petri net model in the background. The simulation process was then mapped to the workflow interface with animated results. The simulation results could be exported directly to guide the enterprise model execution.

4 Conclusions

An integrated workflow based modeling method was used to dynamically represent a business process and other aspects of an enterprise. The model results can then be analyzed and optimized to minimize the time and cost for an enterprise's processes.

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