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Unified enterprise modeling and integration environment based on Workflow technology

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Abstract

This paper proposed a model-driven approach to support enterprise-lifecycle integration. The contents and relationships involved in EI is identified and specified by enterprise integration modeling. The workflow technology is used to support the execution and control of the model and reflect the model to enterprise operations. A unified environment of modeling, simulation, optimization, and execution is developed in object-oriented method, which can support the full lifecycle integration of enterprise.

Keywords: Enterprise engineering; Enterprise modeling; Enterprise integration; Workflow technology

1. Introduction

Enterprise Engineering (EE) can be seen as the art of identification, design, analyzing, implementation and improvement of enterprise and its operations. Enterprise Modeling (EM) and Enterprise Integration (EI) are the two major tasks of EE[1]. The first one is used to understand the enterprise functions, constructs and status. The second one is for the coordination, communication and cooperation between different parts of enterprise. Although they locate in the different phases of EE, one is in built-time and the other is in run-time, there are tight relationships existed between them. The exercise of integration needs validated enterprise models to provide an invaluable source of information. On the other hand, the execution of enterprise models need an information infrastructure (IIS) to provide a number of Model eXecution Services (MXS), which is the main function of EI.

In the last decades, many results have been achieved in the field of enterprise modeling and integration, such as CIMOSA, GRAI-GIM, PERA, ARIS and DEM. Some important frameworks are put forward and some workbenches are developed to verify these frameworks. But until now, most of these works are conceptual and lack corresponding tools and environment to support their effective use. In this paper, a model-driven approach is introduced which can support enterprise-lifecycle integration. The enterprise integration modelling method is proposed to identify and specify the contents and relationships involved in EI. The workflow technology is used to support the integration and execution of the model and reflect the models to enterprise operations. A unified environment of modeling, simulation, optimization, and execution is developed in object-oriented method, which can support the full lifecycle integration of enterprise.

2. Model driven enterprise integration

Due to the complexity of EI, it should be required to formulate and access the relationships between various interconnected views of the enterprise. This requires knowledge of the related impact of different organiazational structures, engineering and production processes, as well as the computer support systems involved. In order to encapsulate this knowledge and use it to structure and enable design and build integration processes, a model is required to represent different aspects of EI and provide a much clearer understanding of the integration processes[2]. This is the original concept of "model driven integration". Furthermore, the model should also be used to configure, manage and maintain run-time integration of enterprise[3].

In order to realize model driven integration, there are three main problems should be settled down, which are how to create the enterprise integration model, how to map the build-time model to run-time model, and how to control and execute the model in an enterprise engineering environment. In the last of this section, all these questions will be answered.

2.1. Enterprise integration modeling based on workflow

Enterprise integration modeling is the process to generate the model which encapsulate information about how the various components (e.g. people, machines, application programmes, databases) of enterprise should be put together. Unlike enterprise model, the enterprise integration model does not need to establish all the view models of enterprise. But the definition of enterprise integration model needs the participation of all the enterprise models. The relationships between all these models are most important to the enterprise integration modeling.

In this paper, a workflow based enterprise integration modeling method is presented, which takes workflow model as its core model and other view (function view, information view, organization view and resource view) models as accessorial ones. Through the association and quotation between workflow model and other view models, the complex integration relationships between different enterprise entities can be modeled clearly.

In this part, we discuss the relationships among multiple view models and show how to establish an enterprise integration model. All these relationships are cored with workflow model[4](Fig. 1).

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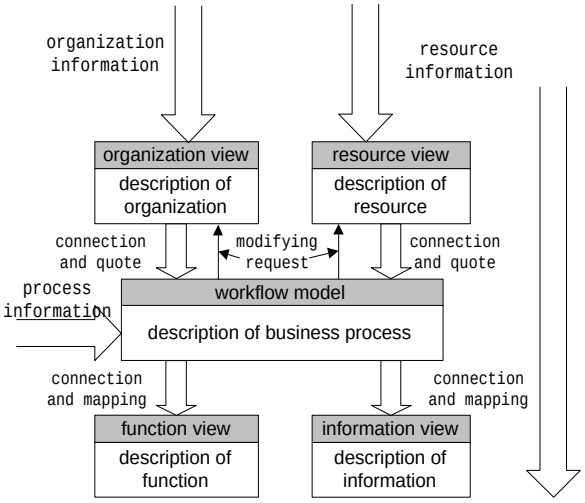

Fig. 1 workflow based enterprise integration modeling

First, organization model provides role types to workflow 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 personnel state will be locked. After the activity is finished, the organization model data will be modified again and personnel will be released.

Second, resource model provides resource classes to workflow 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 resource state will be locked. After the activity is finished, the resource will be released for another activity. The meanings of association and quotation from organization model, resource model to process model is using concrete organization and resource element in each activity during modeling process.

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

2.2. Mapping of build-time model to run-time model

EM and EI are two major tasks of EE, which locate in the different phases. One is in built-time and the other is in run-time. CIM-OSA identified a requirement for consistent architecture to support both of the two phases. However the architecture is just conceptual. In this paper, the workflow technology is used to provide methods and tools by which a bridge could be formed across the gap between the model world (build time) and the real world (run time)(as showed in Fig. 2). In build-time, using the workflow modeling tools, the enterprise integration model can be built. And in run time, the enterprise integration model is instantiated by workflow engine, which provides workflow enactment service to translate the model to the one that can be understand and operated by the computer. That is to say, the physical link between the original model and the information system is established. Material flow, information flow and capital flow are used to initialize the workflow model.

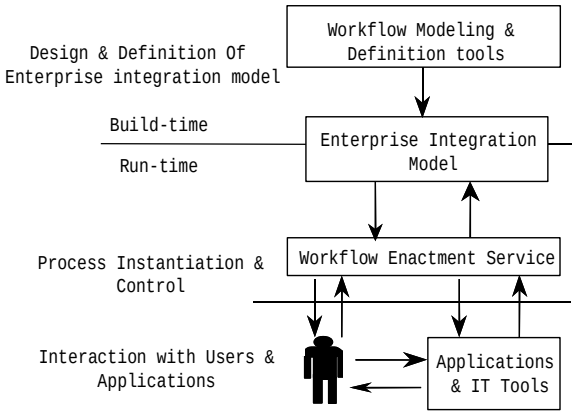

Fig. 2 The structure of workflow management system

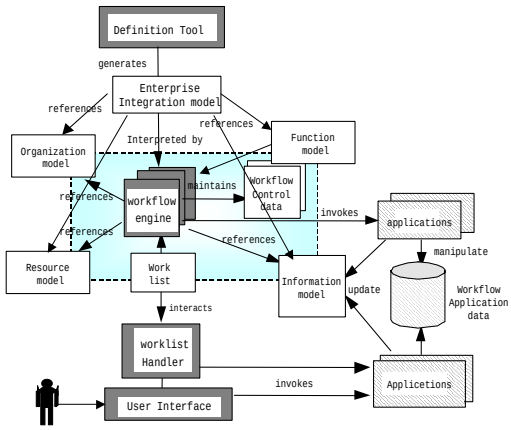

Fig. 3 The scenario of execution of enterprise model

Fig. 3 summarizes the scenario of how workflow technology used to control the integration and execution of the enterprise models[5].

In the build-time, the definition tool establishes enterprise integration model referencing the different view models. Different from the operational model, in build-time, the roles and resources used by the model are not appointed to actual objects. At this time, the integration model can be seen as a meta-model. When executed, it can be instantiated by different ways according to the actual situation. It can be executed by different person and supported by different resource.

In the run time, the model will be instantiated by workflow engine, and the roles and the resource classes will be associated with actual objects according to the situation dynamically.

Workflow engine is the core of the workflow system in run-time. It performs such actions as start model instances, schedule activities, navigate the right route in execution, generate worklist for each participant, and maintain the status of execution, etc.

2.3. The integration infrastructure

The integration infrastructure is used to support model execution for model driven enterprise operation. This infrastructure provides a platform for enterprise model enactment and portability. A number of services support model execution linking the model directly to information sources and sinks. An important structure of integration infrastructure is CIMOSA IIS, which defines five service entities. Most of the entities provide several services for the execution of enterprise models. The business service entity is directly concerned with the execution of the particular enterprise model providing process control, activity control, and resource management functionalities. Three service entities are providing access to databases (information service), manufacturing resources (presentation services—include presentation services for humans) and communication networks (common services). Management services will provide for configuration and management of the integration infrastructure itself[6].

Based on CIMOSA IIS, we developed an object-oriented integration infrastructure, as illustrated in Figure 4[7]. Here, ORB is the supporting layer of the whole architecture. It provides the basic object interoperability. Object Service and Common Facility are general system services similar as in OMA architecture. They can be accessed through object request. On the ground of ORB Core and general service, we define the model execution framework, which provides such general execution services as management service, business service, information service, and presentation service, etc. execution framework acts as the supporting architecture for model integration and running. On the top is workflow management system, which utilizes the services provided by infrastructure to control and execute the enterprise integration model.

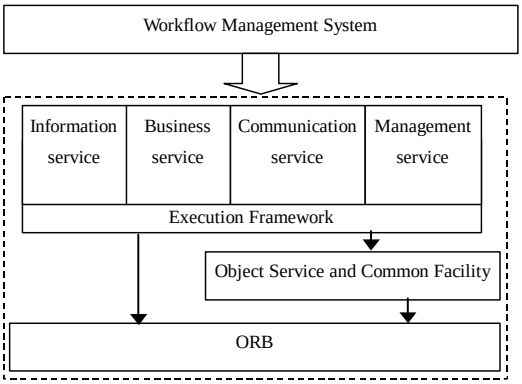

Fig. 4 Architecture of object based Integration infrastructure

3. A unified environment for enterprise modeling and integration[8]

In the preceding sections, model driven integration based on workflow is introduced, and on the basis of this, a unified environment of modeling, simulation, optimization and execution will be put forward in this section, which realize the full lifecycle integration of enterprise. The architecture of the environment is presented in Fig. 5. The environment is established on software bus and its services and the application system is mainly composed of modeling tool, modeling optimization tool and model implementation tool.

In the modeling environment, the associations between different view models are designed using object-orientated method, and the dynamic connections between different view models are realized using request/service method.

Simulation environment is also supported by ORB service. Integrated simulation adopts the strategy of using workflow model as its core, Petri net technology as its background support and ORB service as its bottom support technology. It simulates the running of workflow model by running Petri net model. On this basis, it completes the simulation of enterprise model, and provides reliable results to analyze and evaluate enterprise system.

After modeling, simulation, and optimization, appropriate enterprise model is achieved, then the transition from enterprise model to implementation model comes to be the next emphases. The implementation model can be generated through the instantiation of workflow models. The execution of the implementation model is based on the execution service provided by workflow engine. The key support technology in this distributed implementation environment is ORB bus and its common object services. With the support of ORB bus and relative distributed object service, transparent object services in distributed environment can be favorably realized.

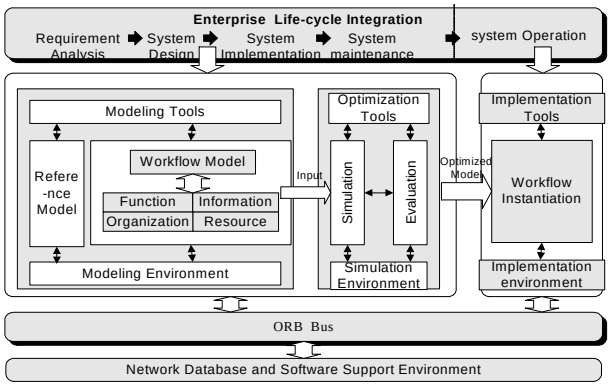

Fig. 5 Unified modeling and integration environment

4. Conclusion

In this paper, the main problems existed in model driven integration method are pointed out. The workflow technology is used to solve these problems. The workflow based enterprise integration modeling method is presented. The complex relationships between different models can be modeled through the workflow modeling. The transition of build-time model to run-time model is performed by workflow engine. The engine also control the execution of run-time model through an integration infrastructure which provides a number of services to support model execution. On this basis, a unified environment for enterprise integration modeling, simulation, optimization, and execution is developed in object-oriented method, which can support the full lifecycle integration of enterprise.

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