

Transforming a formal business process model into a service interaction model

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Abstract: The business process model and service interaction model represent the behaviour model on business view and system view respectively. The automatic transformation from the business process model to the service interaction model can effectively narrow the gap between the business view and the system view. Thus, in this paper, a model transformation approach that can transform the business process model described by extended Petri net into service interaction model in system view is proposed. This approach by extending the UML sequence diagram meta model represents service interaction model, and by using model-driven development designs the transformation from extended Petri net to service interaction model. Especially, each situation of the behaviour transition linked to the different types of places in extended Petri net model are detailed analyzed. According with the these situation, the transformation rules from each situation to different types of message in the service interaction model are designed. In order to carry out the automatic executing of the formalization transformation, the transformation rules are described by the ATL model transformation language, and the ATL codes are implemented by Eclipse platform. Finally, the executing result of the model transformation plug is demonstrated by the Travel Agency system. The experimental results show that the approach in this paper can realize the automatic transformation from business process model to service interaction model, and improve the efficiency of software development.

Keywords: business process model; extended Petri net; service interaction model; model transformation

1. Introduction

The business process model can describe the service process of the business system. Modeling the business process is one key stages in the development process of the business system. There are many ways to describe the business process, such as the business process modelling notation (BPMN) [1], Activity diagram model [2], Petri net model [3], etc. The business process model is the computation independent model (CIM) level model in the model driven architecture (MDA). Currently, many researches are based on model transformation to map business process model into related models at the PIM level, such as bpmn2usecase [4-5], valuemodel2usecase[6], bpmn2statediragram [5] and bpmn2classmodel [7], etc. However, these transformations are difficult to verify the correctness and completeness of the model without formalization. It is well known that the formal process modeling can solve problems such as deadlocks and conflicts of business process models [8]. At the same time, in order to verify the correctness, completeness, and effectiveness of business process models, the formal description of business process model has become an important way of model verification. Among many formal methods, Petri net, as a general formalization method, use "flow" to analyze the behavior of the system [9]. Furthermore, in order to describe more process details, many researchers extend Petri net to study more process details from exception handling [10], context awareness [3], and complex time processes [11], etc.

The service interaction model (SIM) is based on the UML sequence diagram model. Using sequence diagram grammar and symbols, SIM model describes the execution sequence of a series of activities between service objects in order to complete a certain business service, and describes the time order of the message transmission between service objects. The execution sequence of activities in the SIM model is consistent with the business execution process in the business process model, and the message transfer between the service objects is also related to the object flow in the business process. However, there are few researches focused on the transformation from business process model into service interaction model in the current

researches. Therefore, an approach that transforms formal business process model into a service interaction model from is proposed in this paper.

This work makes the following main contributions: (a) focused on a business process perspective, we analyze the extend Petri nets model (EPN) elements and SIM model elements, and discriminate different business flow details; (b) the transformation rules from EPN model to SIM model are designed, and the automatic transformation have been implemented in the Eclipse framework by integrating ATL language.

The remainder of this paper is organized as follows: Section 2 analyses the main related work that involves the transformation of the formal business process model. Section 3 describes the architecture of the EPN model to SIM model. The metamodel definitions of the EPN model and the SIM model are described in Section 4. Section 5 demonstrates the mapping using a case study. Finally, we discuss the primary contributions, conclusions, and future work in Section 6.

2. Related Work

The Petri net model can formally describe control flow, object flow and information flow effectively, and has complete semantic description. Therefore, many researches use Petri net to formalize the BPMN model and UML activity diagram. For the BPMN formal transformation, some researches [8,12-13] use object Petri net model and colored Petri net model to describe the BPMN model elements. While Dijkman et al.[14-15] focused on the semantic analysis, transform the BPMN model to the Petri net model, and verify the effectiveness of the business process. In addition, using Petri nets can also perform reliability verification [16-17], attribute verification [18], security verification [19] and semantic specification [20] for BPMN models. For the UML activity diagram formal transformation, Trickvoic [21] proposes a complete process of mapping UML activity diagram into Petri net model to verify the dynamic model of the real business system. However, since the Condition Event Net (CEN), as a basic Petri net, cannot accurately model workflows, Eshuis et al. [22] discusses the execution semantic design choices of the Petri net model and UML activity diagram. In view of the importance of the object dynamic semantics, Bouabana-Tebibel et al. [23] use object Petri nets to verify the correctness of object dynamic semantics in UML activity diagram. In order to simplify the formalization of the UML activities, Staines [24] proposed a solution, which transform UML activity diagram into colored Petri nets, so that it has a graphical visual verification function. For the Petri net modelling tools, such as ePNK, PNML Framework, Coloane, Tina, etc., can allow intuitive and visual modelling Petri net, so it is easy for system analysts and software developers to understand. Thus, the Petri net model has become the most common formal tool for business process model.

SIM model is mainly used for interactive modeling in the system view, and the execution results can be analyzed using Petri net [25-26]. For the formal research of UML sequence diagrams, Faria et al. [27] propose a method of formalizing UML sequence diagrams using colored Petri nets. They define the mapping rules of UML sequence diagrams to colored Petri net models, and analyze the execution results of this colored Petri net. For the real-time and embedded (MARTE) systems, Yang et al. [26] formalize the MARTE-type timing diagram as a time-colored Petri net model with suppressed arcs. The advantages of Yang's method are the concentration on verification of the time property.

Although the current researches formalize the business process model and service interaction model respectively to verify their correctness and effectiveness, there is still a large gap between the business analysis stage and the system modeling stage. In order to narrow the gap, some researches have proposed transformation methods from business view model to system view model based on MDA (Model Driven Architecture) technology. These transformations include from BPMN model to use case model [5], BPMN model to class model [4], value model to use case model [21], BPMN model to service composition process [28], etc. However, since the SIM model needs to design the message details between business entities, there is few researches on automatically transforming the business process model on the business view into the SIM model on the system view. Although the UML sequence model in the system view is mentioned by Bousetta et al. [4], the sequence model is completely manually designed and refined by software designers on the basis of use case model.

In order to transform the formalized business process model to the SIM model, in this paper, we propose a approach that can support the automatic transformation from formal business process models to SIM model, compared with previous studies, our approach focused on the automatic generation of SIM model, design the transformation rules to realized the automatic transformation from formal business process model to SIM