A New Business Process Verification Approach for E-Commerce Using Petri Nets

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ABSTRACT

The design, modeling, optimization, reengineering, and coupling of business processes in e-commerce environment have gradually become a hot research topic. Business processes must be strictly described and validated by formal methods to ensure their reliability and efficiency. This paper systematically studies the introduction of new business process characteristics into behavioral temporal logic and extend TLA to obtain a new logic system PTLA, which enriches the theoretical system of formal method of business process under the environment of e-commerce. The paper also discusses Petri nets and show how to convert Petri nets into TLA. A parallel Petri net model was built to represent the dynamic, concurrency and flexibility, and cross-organizational e-commerce business process. Finally, the use of simulation to extend the business process execution language BPEL to TLA.

KEYWORDS

Business, Business Process, E-Commerce, Formal Analysis and Verification, Petri Net, Process Execution Language

INTRODUCTION

E-commerce is quietly changing people's way of life, the success of Amazon, e-Bay, Dangdang and Taobao, showing its broad prospects of development. Business process (Yubo, 2019; Feiyi, 2018) is more efficient and has a great effect on the development of enterprises under the e-commerce environment. Although it has had a series of analysis and modeling methods (Yu et al., 2018) to assist the design of business processes, after the reengineering of business process may still exist a logical flaw and up to less than the enterprise expected target. So it is an inevitable trend to analyze and verify the business process with the aid of formal analysis method. Currently, it is lack of business process which can be more complex and dynamic in the e-commerce environment and a lack of formal method system for the formal analysis and verification.

In the near future, the research on the business process of e-commerce is mainly concerned with the specification and verification of business processes. Such as the use of Petri network, automaton, process algebra specification and verification business service process BPEL (Business Process Execution Language) model (Jahan, 2017; Chhabra, Aishwarya et al., 2018); Chen Ying Firstly put

forward a set of rules, realizing the transformation from BPEL under death path elimination semantic to ordinary if-then-else form. Then, this method establishes the formal model of BPEL process using Colored Petri Net (CPN). Finally, the automatic analysis and verification of BPEL process model is accomplished with CPN-Tools.(Chen Ying et al, 2017); Qiang Hu proposed a logic Petri net–based path detecting method for compatibility analysis of interactive service processes, the service process described by WS-BPEL is modeled as a service net based on logic Petri nets (Qiang Hu et al., 2018). In the literature (Sun Changai et al., 2019), the author mentioned business process execution language for Web service (WS-BPEL) is an executable XML based and process-oriented service composition language. Due to unique features of Web services, such as dynamics, loose coupling, and open deployment and execution environment, it is an important issue how to assure the quality of WS-BPEL programs. The researchers (Zhang Man et al., 2016; Hansen Dominik et al., 2016) also proposed how to transform the UML model into TLA, and using the model checking tool TLC detected the formal description. Hansen Dominik (Hansen Dominik et al., 2016) explores the model checking tool TLC based on TLA+ to speed up the verification of multiple threads and use the disk technology to alleviate the state explosion problem. ZHANG Jun-ming (ZHANG Jun-ming et al., 2015) given the temporal specification model of PCS s by the TLA language and then made use of model checking tool TLC to detect PCS, and finally the property of liveness and mutex were checked.

Roa J. (Roa J. et al., 2016) try to provide a semi-automated framework based on TLA to describe and analyze business processes. In this paper, we analyze the research status of the formal analysis of business process, and point out that the formal analysis of the business process using temporal logic of actions TLA is innovative and feasible. After an overview of the TLA, the behavior of temporal logic TLA is extended and improved, and a new logic system PTLA (Process Temporal logic of actions) is designed. We increased tissue arc based on the Petri net, to achieve the basic Petri net, and use it to connect to the places and transitions, and lead into different organizational processes to extend it by the places and changes, a parallel Petri net model is established to describe the dynamic changes and adaptive ability, which can be used to model the dynamic, concurrent, flexible and cross organizational e-business processes. Through the study of existing BPEL language, we use the extension mechanisms of inter organization and flexible as activity added to the BPEL process, which can be described enterprise business process characteristics under the e-commerce environment.

TEMPORAL LOGIC OF ACTIONS TLA AND ITS EXTENSION

Summary of TLA

Temporal logic of actions (TLA) is a combination of temporal logic and behavioral logic and it's to describe and verify the logic of concurrent systems, it is a new logical method based on linear temporal logic and behavior logic proposed by Kapus (Kapus, 2015) in 2015. Temporal logic TLA is a new research direction in the current model checking technology, which can express the model program and logic rule in a language. Model checking is a method to verify the system properties, and the model checking technique is a kind of formal method. As a logical language that describes the behavior and properties of dynamic systems, TLA (Liu Zhaoyang, 2015) has been widely used in real-time systems, such as the representation and verification of real-time systems, the analysis of network protocols and artificial intelligence.

TLA is a kind of logic that describes and verifies the concurrent system, and the performance of the system is described by the same logic. Thus, a system can achieve its specifications and determine the assertion that a system is achieved, all of which is expressed in a logical meaning. TLA is relatively simple, its syntax and semantics can be summed up as a paragraph of words.

Through the Kapus and some scholars' research, combined with testing tools developed by Microsoft and Compaq company, TLA and its description language TLA+ and automatic test tools TLC can be perfected improved gradually.

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