

Trustworthy Construction Approach of BPR Software System Based on Semantic Model Verification

Qiang Han¹, Guozhao Yang², Jie Han³ and Wenxing Bao^{4*}

¹*School of Computer Science and Engineering, Beifang University of Nationalities, Yinchuan, Ningxia 750021, China*

¹*Key Laboratory of Trustworthy Distributed Computing and Service (Beijing University of Posts and Telecommunications), Ministry of Education Beijing, 100876, China*

²*School of Computer Science and Engineering, Beifang University of Nationalities, Yinchuan, Ningxia 750021, China*

³*School of Computer Science and Engineering, Beifang University of Nationalities, Yinchuan, Ningxia 750021, China*

⁴*School of Computer Science and Engineering, Beifang University of Nationalities, Yinchuan, Ningxia 750021, China*

¹*hanqiang9@126.com, ²oloroso@vip.qq.com, ³bfmzdxys@163.com*
⁴*bwx71@163.com*

Abstract

Addressing to improve the trustworthiness of Business Process Re-engineering (BPR) system, this paper proposes a trustworthy construction approach to solve the problem mentioned above. Firstly, we analyze related literatures about the topic, we realize that main reason causing to reduce trustworthiness of BPR system is due to break of trustworthy connectivity between front configuration tools and business processes operating server. Secondly, as the primary methods composing of the construction approach, a semantic verification method is illustrated in detail based on Petri net. Finally, a case study is introduced to explain how to use the above construction approach of BPR system.

Keywords: *BPR, Construction Approach, Trustworthiness, Semantic Verification, Petri net, Quality traceability system*

1. Introduction

With the relative theories and technologies of Business Process Re-engineering (BPR) become more mature, and they are applied in agricultures, manufacture industries and service industries comprehensively, although the long-term success of those theories and technologies as a time-effective alternative to executing static business processes without higher flexibility and maintainability, customers are still comprised by the uncertainty of trustworthiness of BPR systems. Therefore, the researchers put forward higher requirements and started to find the approaches in order to improve their trustworthiness through various methods.

The result after trustworthy software always is the same as the user expected results. However, at present, researchers and industries practitioners launched numerous studies,

* Corresponding Author

using different methods for related theories of trustworthy software in different angles, they have not reach at a unified understanding on software trustworthiness. That means the concept of software trustworthiness can be derived from trustworthiness of domain software [1, 2] at first. Then we can summarize the unified standard definition of software trustworthiness in the future. From this view, many references on BPR software have published a lot of achievement in BPR software trustworthiness. According to the fundamental steps of BPR [3, 4], the authors presented approaches to model the current processes (the as-is) at first, the defining the goals of the re-engineering activity (e.g., increase and reduce main process or sub-process) (the to-be), and after acute them, secondly put them into running engine for BPR (the run-operate) and receive the computing data sets.

Undoubtedly, artificial intelligence theory and technology play an important role in business intelligence research and industry. Ref. [5] introduced the first AI tool designed specifically for BPM (Business Process Modeling, one of research aspects in BPR). BPR can be applied to a variety of specific areas in modern society. In order to make information processing more fluently and efficiently, Ref. [6] redesigned the information system process of the logistics system. To analyze the competence and impact of tools for BPR, Ref. [7] shows that BPR tools are related to effectiveness rather than efficiency of the projects. Addressing to the inherent conflict for BPR leaders on choosing the appropriate style, Ref. [8] found that successful BPR leaders use leadership styles that fit the type of task that needs to be done and the needs of the people that will perform the task. On the aspect of process modeling and redesign method for BPR, Ref. [9] introduces the EPRE method provides with guidance for process redesign then to create the current process model. Also Ref. [10] presented methodology that based on the complementary adoption of different modeling techniques and guidelines about the use of process modeling languages to support BPR activities in relation with product development processes. From the view of SOA, Ref. [11] proposed a SOA-based ARIS model for BPR. SOA can improve the deficiency of the ARIS. To change the business process dynamically in the execution stage, Ref. [12] proposed a dynamical BPR model and a micro-kernel structure for the adaptive workflow management system model, to avoid the defect of the traditional BPM model.

2. Trustworthy Construction Approach Based on Semantic Verification

In this section, we focus on the verification function, present coverability analysis algorithm.

2.1. Definition of BPR Net

Definition7. BPR Net. $\overline{BPR_net} = (\overline{No}, \overline{Nn}, \overline{Nd}; \overline{P}, \overline{T}; \overline{F}, \overline{M})$; **where:**
 Original BPR Net $No = (Po, To; Fo, Mo)$;
 New BPR Net $Nn = (Pn, Tn; Fn, Mn)$;
 Deleted BPR Net $Nd = (Pd, Td; Fd, Md)$;
 $\overline{P} / \overline{T} / \overline{F} = \otimes[(Po, Pn, Pd) / (To, Tn, Td) / (Fo, Fn, Fd)]$; where:
 \otimes is the construct operator of $\overline{BPR_net}$, for example:
 $\overline{P} = \otimes(Po, Pn, Pd) = (Po - Pd) \cup Pn$. $\overline{M} : \overline{P} \rightarrow Z^+$ is label function, and
 \overline{M} is the initial label of $\overline{BPR_net}$.

2.2. Coverability Computational Algorithm

Input: BPR_net

Output: Coverability Tree: $CT(BPR_net)$

Step1. If $BPR_net = (N; P, T; F, M)$. Label the initial marking \overline{M} as the root of $CT(BPR_net)$ and tag it “new”.

Step2. While “new” markings exist, do:

Step2.1 Select a new marking M .

Step2.2 If M is identical to a marking on the path from M_{BPR} , then mark M as “old” and return to Step2.1.

Step2.3 If $\forall t \in \overline{T} : \neg \exists (M[t >])$ then marking M as “END-NODE” and return to Step2.1.

Step2.4 For $\exists t, t \in \overline{T} \mid M[t >$ do:

Step2.4.1 Obtain the marking $\overline{M'}$ when $\exists t, t \in \overline{T} \mid M[t > M'$.

Step2.4.2 On the path from \overline{M} to M' , if $\exists M'' \mid M'' < M'$, then for each place $p \mid M''(p) < M'(p)$, update $M'(p)$ with w .

Step2.4.3 Introduce M' as a new node of $CT(BPR_net)$, draw an Arc with label t from M to M' , and mark M' as “new”. Return to Step2.

2.3. Coverability Analysis Algorithm

Input: $CT(BPR_net), CT(No), CT(Nn)$

Output: $CT(No), CT(Nn), R(CT(No), CT(Nn))$

Step1. Expanding every marking M_i^{BPR} of $CT(BPR_net)$, M_j^{No} of $CT(No)$ and M_k^{Nn} of $CT(Nn)$ into an unified format in order to compare and analyze them to generate Coverability Analyze Tree of No and Nn as $CT(No)$ and $CT(Nn)$, and generate Relation Map between No and Nn as $R(CT(No), CT(Nn))$.

$$M_i^{BPR} = (m_1^{bpr}, m_2^{bpr}, \dots, m_B^{bpr}),$$

$$M_j^{No} = (m_1^o, m_2^o, \dots, m_B^o),$$

$$M_k^{Nn} = (m_1^n, m_2^n, \dots, m_B^n), \text{ where :}$$

Suppose that unified format is

$$B = Card(Po) + Card(Pn),$$

$$\forall i \mid i \in SeriesNoOf(Pd) \rightarrow m_i^{bpr} = 0;$$

$$\forall i \mid i \in SeriesNoOf(Po) \rightarrow m_i^{bpr} \leq m_i^o;$$

$$\forall i \mid i \in SeriesNoOf(Pn) \rightarrow m_i^{bpr} \leq m_i^n;$$

$$\forall j \mid j \notin SeriesNoOf(Po) \rightarrow m_j^o = 0;$$

$$\forall k \mid k \notin SeriesNoOf(Pn) \rightarrow m_k^n = 0;$$

Step2.

While get M_i^{BPR} by traverse $CT(BPR_net)$, do:

$\exists j, \exists k \mid \forall x, m_x^{bpr} \leq (m_x^o + m_x^n)$, where :

If $m_x^{bpr} \in M_i^{BPR}, m_x^o \in M_j^{No}, m_x^n \in M_k^{Nn}$ Then delete M_i^{BPR} and its arcs, continue;

Else If
 $x \in SeriesNoOf(Po) \wedge (m_x^{bpr} > m_x^o)$, Put M_x^o into $\overline{CT(No)}$;
 If $x \in SeriesNoOf(Pn) \wedge (m_x^{bpr} > m_x^n)$, Put M_x^n into $\overline{CT(Nn)}$;
 Else
 Put M_x^o, M_x^n into $\overline{CT(No)}, \overline{CT(Nn)}$; ;
 Else
 Put M_x^o, M_x^n into $CT(No), CT(Nn)$;
 Insert relation record $(M_i^{BPR}, M_x^o, M_x^n)$ into $\overline{R(CT(No), CT(Nn))}$,
 Delete M_i^{BPR} and its Arcs, continue;

End do.

Step3.

If $\overline{CT(No)} = \overline{CT(Nn)} = \overline{CT(BPR_net)} = \emptyset$ Then Return True. Else Return False.

3. Case Study

Agricultural product quality traceability system can protection safety of agricultural production, from the source of production to final consumption. In order to achieve the quality of agricultural products traceability, the main task of this system is that the traceability code can be generated according to the corresponding information and this system can trace corresponding information according to the traceability code.

The system consists of four modules: Module production, processing module, warehousing module and logistics modules, the main processes of the system as shown in Figure 1.

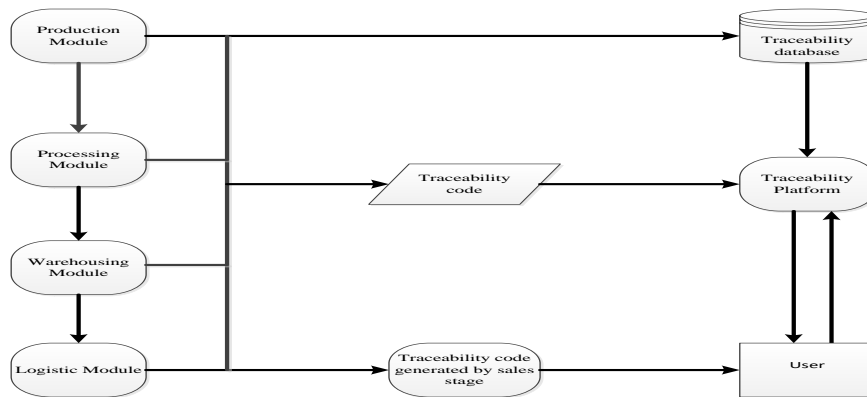


Figure 1. The Main Flow of Agricultural Products Traceability System

The system formed the corresponding traceability code by above four modules, users can be traceability according the appropriate traceability code. Production module generates the corresponding production file, the file contains data related to the production process. Processing module generates the corresponding processing file, this file contains the data of processing and the corresponding process information. Warehousing module generates the corresponding warehousing file, this file contains warehousing information and the data of out warehousing, *etc.* Logistics module is responsible for recording a series data of products in the logistics, this file contains company information, vehicle information, *etc.* Above four modules will submit these data to the traceability database. This system will integrate the data of generated by these four modules to generate sales stage traceability code for consumer inquiries. Furthermore, each module can generate corresponding traceability code for corporate users inquiries. Also, each module provides an interface to extract traceability information from the traceability system within the enterprise.

These are introduction which the main modules and process of the traceability system. The next will be modeled using Petri net for its processes. Through analysis of its model to validate the system design process is reasonable.

Information flow control Internal operation rules of system, to analyze by tracking information in the flow process during different states of the system, place in Petri net indicates that the system is currently in state, token indicates that information flow and control flow between nodes. In this paper, Petri net as an analytical tool to construct a model for the main flow chart of agricultural products traceability system and related analysis as shown in Figure 2 and Figure 3.

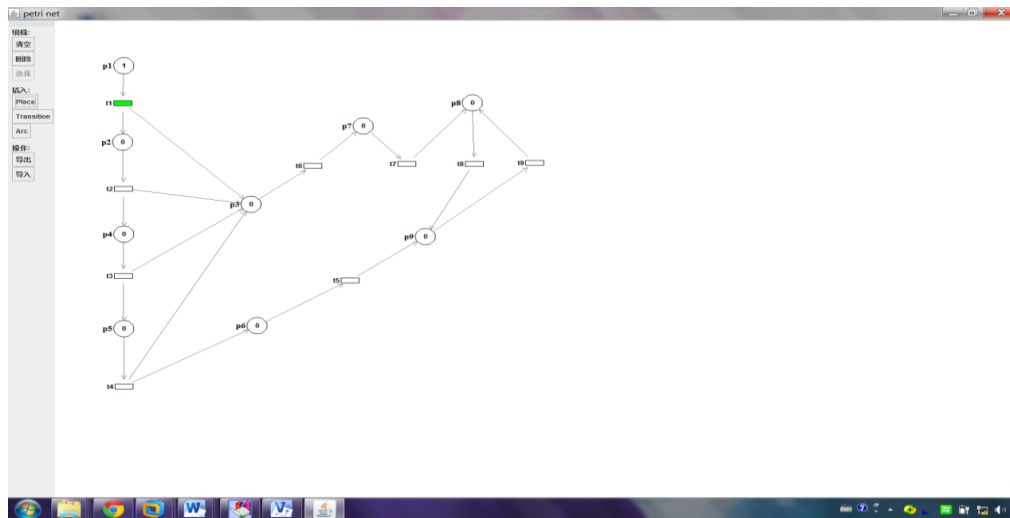


Figure 2. Flow Process of Agricultural Products Traceability System by Petri Net

In Figure 2, the flow process of agricultural products traceability system by Petri net, T1 represents agricultural production stage, the relevant data generated in the production process will be put in the place P2 and P3; T2 represents the processing of agricultural products, put the detection of qualified products and related data were in the place P4 and P3; T3 represents the process of putting the product into the warehouse, and the data generated during storage put into the place P5 and P3; T4 represents logistics, data generated by the logistics process add in the place P6 and P3; T5 represents consumers inquires by traceability code formed during sales stage; T6 represents the information during the various stages stored into the

database; T7 represents traceability platform extracted related information from the database by traceability code; T9 represents the user will pass the traceability code to the traceability platform; T8 represents traceability information will be back to the user by traceability platform query through traceability code.

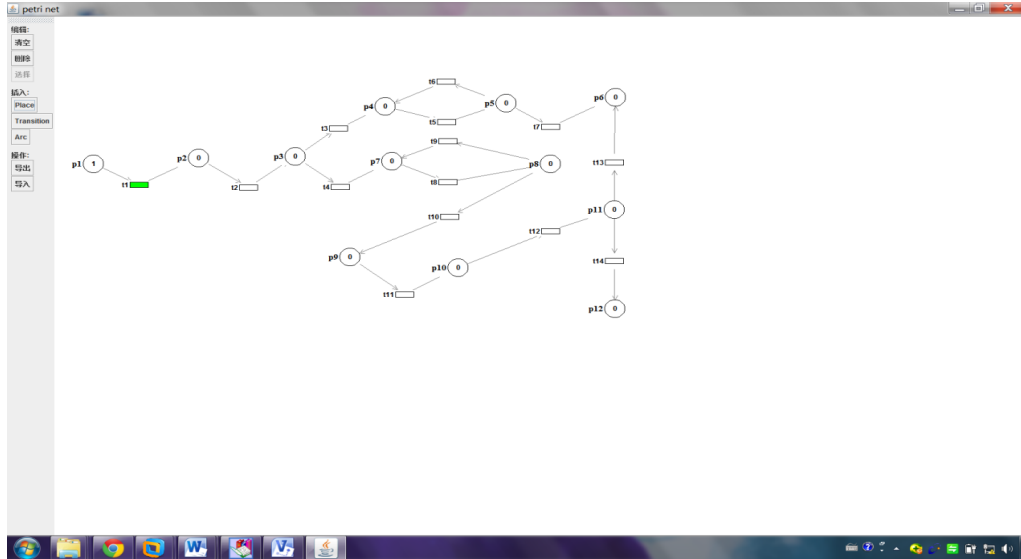


Figure 3. Petri Net Model of Quality Traceability Process for Consumers

In Figure 3 Petri net model of quality traceability process for consumers, T1 represents the login, T2 represents to find camera, T3 represents to find the camera, T5 represents to identify two-dimensional code, T6 represents re-identification, T7 represents that the consumers get products information, T4 represents it not find the camera, T8 represents to manually enter the traceability code, T9 represents traceability code inspection failed and need to re-enter, T10 represents a successful test, T11 means that sent traceability code to traceability system, T12 represents query, T13 represents the existence of traceability codes and obtain product information, T14 represents the query fails.

Using Petri net modeling for the above two processes, analysis the activity, reachability, boundedness, and its effective verification, consistent related properties of Petri net. According to the definition and nature of Petri net, verify that the two Petri net are reachable, activity and bounded, so they are valid Petri net. Petri net is used in the system modeling, providing a good basis for subsequent design and development of the system.

4. Conclusion

BPR-based application software development to improve the efficiency and effectiveness of agriculture, manufacturing and services has a significant meaning. In this paper, first, we propose a credible method of construction BPR software system, which is based on semantic validation. Secondly, we have to verify its credibility by analyzing the process algebraic models. In detail, semantic verification algorithm can check the attributes of BPR PA *e.g.*, coverability by translating PA with Petri Net labeled BPR Net. In addition, process algebraic model support the probability of analyzing the trustworthiness level of application software based on BPRAS in order to validate whether the design of application software meet the requirement of users. Finally, we give a case study. In the future, we plan to research the application trustworthiness model based on process algebraic model of BPRAS.

Acknowledgments

This work was supported by National Natural Science Foundation of China (61363001, 61162013 and 91118002); The State Ethnic Affairs Commission Research Project (12BFZ010). The Science Foundation of Beifang University of Nationalities (2013XYZ030). Thank the students who participate in the seventh China (Chengdu) International Software Design & Application Competition, they are Shen Wang, Aihong Yang, Haibo Gao.

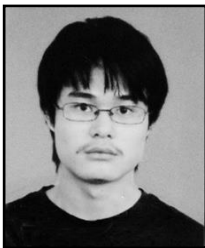
References

- [1] T. Bao, S. Liu and X. Wang, "Research on Trustworthiness Evaluation Method for Domain Software Based on Actual Evidence", Chinese Journal of Electronics, vol. 20, no.2, (2011), pp.195-199.
- [2] X. Fang, C. Jiang and X. Fan, "Behavior-Aware Trustworthiness Study of Networked Software", International Journal of Computational Intelligence Systems, vol. 3, no. 5, (2010), pp. 542-552.
- [3] A. Ciaghi, A. Villafiorita and A. Mattioli, "VLPM: A Tool to Support BPR in Public Administration", Third International Conference on Digital Society, (2009); pp.289-293.
- [4] Q. Han, Y. Qian, "VIMPM: A Tool to Support BPR in Integrated Manufacturing", Chang Chun, TMEE, (2011); China, pp. 910-913.
- [5] S. R. Hedberg, "AI Tools for Business-Process Modeling", IEEE EXPERT, vol. 11, no. 4, (1996), pp. 13-15.
- [6] L. Ming, F. Jingchun and Z. Fujie, "Research on Information Process Reengineering of Logistics System Based on BPR", Proceedings of the International Conference on Logistics Engineering and Intelligent Transportation Systems, pp.1-4.
- [7] I I Im, A. Omar, El Sawy, A. Hars, "Competence and Impact of Tools for BPR", Information & Management, vol. 36, no. 6, (1999), pp. 301-311.
- [8] N. Sutcliffe, "Leadership Behavior and Business Process Reengineering (BPR) Outcomes - An Empirical Analysis of 30 BPR Projects", Information & Management, vol. 36, no. 5, (1999), pp. 273-286.
- [9] K.-H. Kim and Y.-G. Kim, "Process Reverse Engineering for BPR: A Form-based Approach", Information & Management, vol. 33, no. 4, (1998), pp. 187-200.
- [10] M. Bertoni, U. Cugini, D. Regazzoni, C. Rizzi and M. Ugolotti, "A BPR Methodology for Product Development Processes", IFIP, vol. 207, (2006), pp. 370-378.
- [11] C. Li, J. Qi and H. Shu, "A SOA-based ARIS Model for BPR", Proceedings of the IEEE International Conference on e-Business Engineering, (2008); pp. 590-595.
- [12] C. Lei and L. Bin, "A Workflow Model Supporting Dynamic BPR", Proceedings of the 6th International Conference on Grid and Cooperative Computing, (2007); pp. 721-724.

Authors



Qiang Han, is a systems analyst and CCF senior member. He graduated from Beijing University of Post and Telecommunications with Ph.D in computer science and technology. Now he is a master tutor in the School of Computer Science and Engineering, Beifang University of Nationalities. His research interests include business process reengineering and trustworthy software.



Guozhao Yang, he graduated from Xiamen University of Technology majoring in computer science and technology. Now he is a master candidate in the School of Computer Science and Engineering, Beifang University of Nationalities. His research interests include electronics farm platform traceability system.



Jie Han, she graduated from Hebei University of Technology majoring in computer science and technology. Now she is a master candidate in the School of Computer Science and Engineering, Beifang University of Nationalities. Her research interests include trustworthy workflow management system.

Wenxing Bao, he is CCF senior member, a full professor and tutor master in the School of Computer Science and Engineering, Beifang University of Nationalities. He graduated from Xi'an Jiao Tong University with Ph.D in electronic science and technology. His research interests include digital agriculture and information systems, image processing and computer vision.