An approach to improve quality of business process management systems

Imen Chaouachi Allani[#1], Belhassen Zouari[#2]

[#]*Université de Tunis El Manar, Faculté des Sciences de Tunis, Laboratoire LIP2, 2092.*

Tunis, Tunisie.

[1]`imen.allani@gmail.com`
[2]`belhassen.zouari@fst.rnu.tn`

Abstract— **Being widely adopted by industry, business process management systems faced new challenges and opportunities. Among different concepts of business process management systems, improving quality of business models is an important issue. Modelling data flow driven processes such as e-commerce order processing workflow should ensure a secure access to data in order to avoid conflicts and anomalies at the execution time. This paper presents a CP-Net modelling of the e-commerce order processing workflow and proposes an approach to secure access to the data of the workflow.**

Keywords— **Business Process Management, e-commerce, quality, security, modelling.**

I. INTRODUCTION

The past 20 years have brought an increasing interest in the domain of business process management (BPM) by an ever growing community of managers, end users, analysts, consultant vendors and academics. In fact, business process management approach can be defined as a process centered approach that leads to substantial improvements in both performance and compliance of a system. A part from productivity gains, BPM has the power to innovate and continuously transform business processes in an organization. That's why, business companies' managers are nowadays trying to use and integrate the various business process change technologies.

While managing business processes has become a necessity for every organization, challenging concepts around BPM are growing. According to a recent study by Paul Harmon [2], nowadays there are three major business process challenging concepts or traditions as he called: business management, quality management and information technology.

With the first concept, managers aim to make workers more productive. While the quality management is about different methodologies proposed to simplify processes and to control the quality of outputs. The Information technology concept focuses on work process automation of all kinds involving the use of computers and software applications. In fact, process modeling is a central element of the business process automation. However, what hinders both practitioners and academics is the lack of support for assessing the quality of process models.

In [5] business process quality can be evaluated through quality factors which are grouped into quality dimensions, each dimension representing a facet of business process quality. Those quality dimensions are the following: performance, efficiency, reliability, security and availability.

When the use on business process systems is increasing today, the demand in security of such systems is increasing as well. To achieve this aim, many methods and tools have been proposed in order to get a secure modeling of BPM Systems. [6] Discusses two task based authorization models for workflows: the Workflow Authorization Model (WAM) and the Task Based Authorization Controls (TBAC). [14] Presents a method to express security policies of a business process using BPMN models. Some recent researches focus on business process security in the cloud as [7] which propose a new environment to model business processes considering security requirements and deploy them automatically in the cloud. To the best of our knowledge, almost researches in the field of security of business processes are dedicated to control flow driven processes, few of them focus on secure data flow modeling.

In this context our contribution is improve security and quality control of data flow business process management systems. We focus on one business process application, the e-commerce order processing workflow [12]. In fact, ensuring secure and compliant data flow modeling is one of the fundamental requirements for such workflows. In e-commerce order processing workflow, several tasks may access simultaneously to the same document which leads to conflicts and errors. In order to avoid anomalies, this paper proposes an approach to secure access to data while modeling the data flow process.

The paper is structured as follows. In the next section we study some aims and challenging concepts of BPM systems. The third section presentes our use case: the e-commerce order processing workflow and presents the modeling of the use case with Colored Petri nets and the result of the verification of the new model. In section 4, we propose the specification of security properties. Section 5 concludes the paper and points to future works.

II. BPM : AIMS AND CHALLENGING CONCEPTS

BPM is a system for managing and transforming organizational operations in an organization.

Thousands of organizations, large and small, private and public, are reaping extraordinary benefits by managing their end-to-end business processes. [1] Gives recent examples of such organizations. At the one hand, through process management, an enterprise can create high-performance processes, which operate with much lower costs, faster speeds, greater accuracy, reduced assets, and enhanced flexibility. By focusing on and designing end-to-end processes that transcend organizational boundaries, companies can drive out the non value adding overhead that accumulates at these boundaries. Through process management, an enterprise can assure that its processes deliver on their promise and operate consistently at the level of which they are capable. Through process management, an enterprise can determine when a process no longer meets its needs and those of its customers and so needs to be replaced.

The most known methodologies of process quality improvement are TQM [4], Lean and six sigma [13]

According to [3] a process model should satisfy three main quality goals: syntactic quality, semantic quality and pragmatic quality.

III. USE CASE : E-COMMERCE ORDER PROCESSING WORKFLOW

Nowadays electronic commerce (e-commerce) services have risen to become more and more popular on Internet and Web environment. It has improved the international competitiveness of commercial enterprises and expended the market in an effective way. E-commerce applications are developed to allow companies to communicate with consumers with an automated process. The most fundamental requirement for success of applications in the domain of e-commence begins with the modeling of the workflow process.

A. Presentation of the workflow

The order processing workflow is a classical use case in organizations which deals with the process of validating or cancelling orders. In this process, as shown in Fig. 1, the workflow begins when an order is received and then the customer's credit is checked based on the result of the credit check. Either the order is cancelled or the steps of warehouse pickup invoice and ship are performed.

Table 1 shows the data flow analysis of the e-commerce order processing workflow

Task	Input Data	Output Data
Receive order	Order Information: – Payment information(i.e. Customer ID, credit card.) – Order items(i.e. SKUs, unit price, quantity.) – Shipping Advice(i.e. UPS ground.)	The order information in the input document is split into three documents: – Payment information – Order items – Shipping Advice
Check credit	Payment	Approved or rejected
Warehouse pickup	Order items	Pickup List
Invoice	Payment, Package List, and Shipping Advice	Invoice
Ship	Pickup List and Shipping Advice	Proof of Shipment

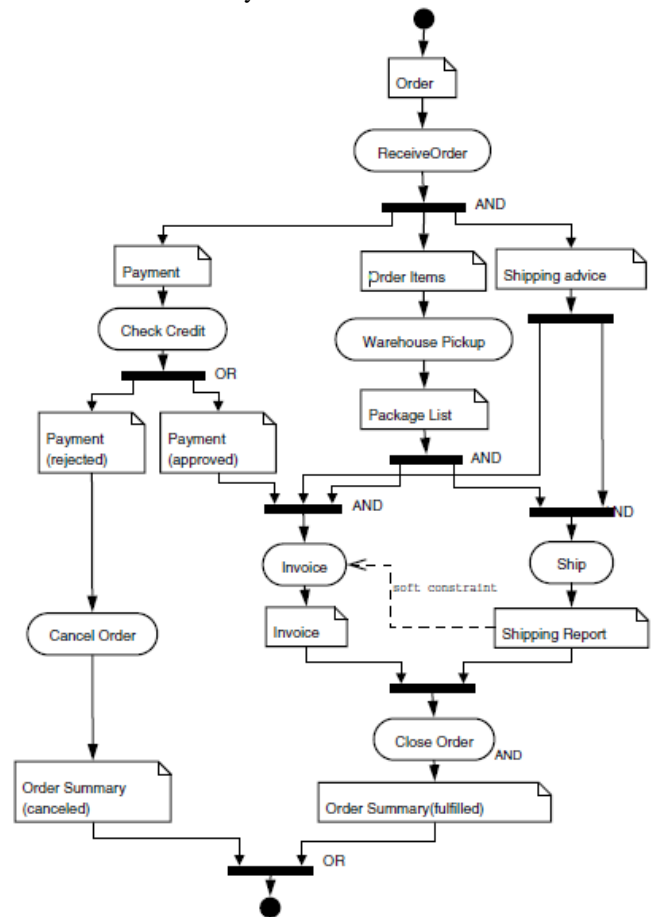Table 1 Data flow analysis of the workflow

Fig. 1 E-Commerce order processing workflow

B. CP-Net modelling of the workflow

The order processing workflow is a document-driven workflow which is an approach that fundamentally deals with data. What is specific in such workflows is the existence of data objects fulfilling specific requirements. This criteria influences process execution.

The access to documents may occur concurrently. The framework allows this via three locking mechanisms (shared, exclusive, append) and via the opportunity to split and duplicate documents. In this section we represent the

workflow with Colored Petri net model Fig. 2 .The reason we choose a variant of Petri nets is at least twofold [9]:

- Petri nets are graphical and yet practice
- Petri nets offer several analysis techniques

The ordinary Petri nets formalism as presented by Carl Adam Petri [10] has no types and no modules, it has only one kind of tokens and the net is flat. Colored Petri Nets (CP-nets) [11] is one of the extensions of Petri nets. CP-nets preserve useful properties of Petri nets and at the same time extend initial formalism to allow the distinction between tokens. With CP-nets it is possible to use data types and complex data manipulation. Each token has attached a data value called the token color. The token colors can be investigated and modified by the occurring transitions.

In [15], a variant of Petri net model is used to specify and verify secure process workflows including document resource description and related security requirements.

Data Driven WorkFlow (DDWF) approach uses data objects to visualise how data is processed. The existence of data objects fulfilling specific requirements is the criteria which influences process execution. Following, each task needs to get assigned at least one document to work with. This assignment is a directed relation.

In DDWF modelling, each data object has an input- output representation. First of all, we consider a single copy of the data object that is handled within the process. Different data object shapes with the same label are considered to refer to the same data object. In our example, all shapes labelled order refer to the same data object. Furthermore, each data object is in a certain state at any time during the execution of the process. This state changes through the execution of activities. To begin our specification, we must extract which state a data object must be in before an activity can start (Here, the data object will be considered as a precondition) and which state a data object must be in after having completed the activity (considered as effect).

In order to get a mapping of the model DDWF, we provide a separate data flow mapping for each data object. Each of these mappings represents preconditions and effects of tasks regarding the corresponding data object. Fig.3 illustrates mapping rules from a DDWF model to the corresponding Petri Net representation: Each data object is mapped to a set of places. Each place represents one of the states the data

object can be in. Activities with preconditions or effects are modelled as transitions. Depending on the kind of preconditions and effects we present an activity by one or a set of transitions in the data flow model. Depending also on the preconditions and effects, arcs connect the places with transitions.
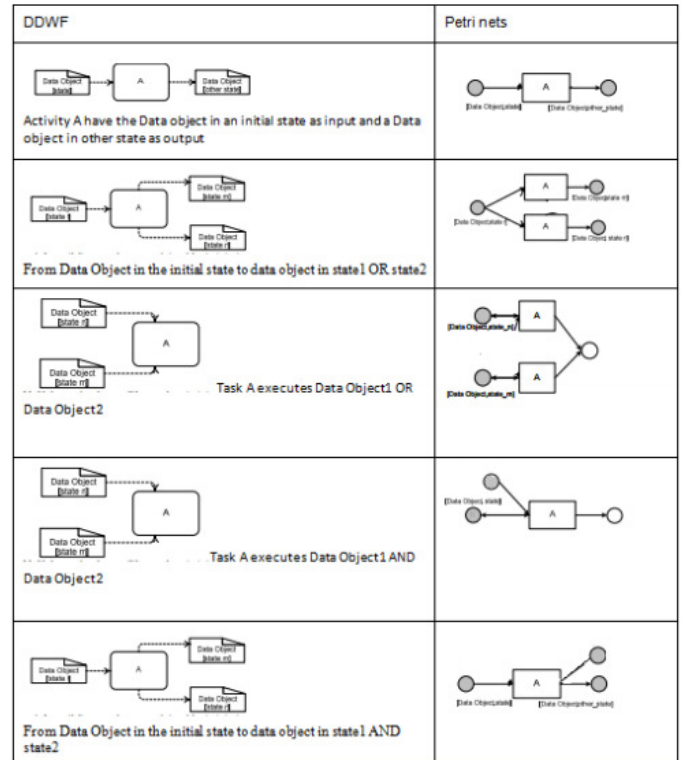

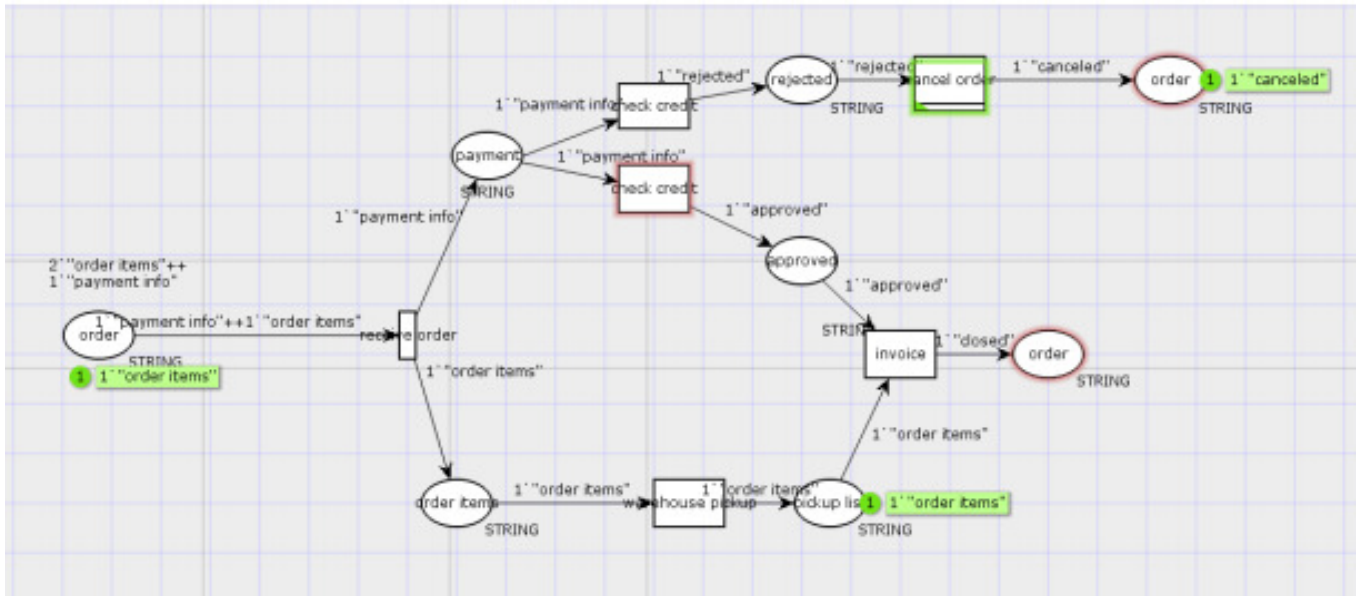Fig.3 mapping rules from a DDWF model to the corresponding Petri Net representation

Fig. 2 CP-Net modelling of e-commerce order process

IV. SPECIFICATION OF SECURITY PROPERTIES

The approach of securing access to data in the order processing model relies on two properties. The first is locking the document "DocLockState" and the second is copying the document "DocCopyState"

Those two properties help us to model concurrent access to a document and also to determine the control flow. In our paper, these two properties together will play key role in securing access to documents in a document driven workflow.

DocLockState assigned to a document indicates which tasks having the permission to access to this document. While DocCopyState helps the system to identify different copies or parts of the document. DocLockState is needed in addition to DocCopyState to secure the access of the tasks to documents. To illustrate this relation between the two properties, we give a simple example from an order processing workflow. The workflow receives initially a document called order information which contains informations about payment and order items. The access to payment informations should not be allowed to any task for security reasons surely. That's why we need firstly to split the original document to two documents payment information and order items, and then assign an exclusive lock mode to the document payment information.

Fig. 4 shows the state diagram of DocLockState.

In our document driven workflow, for each document is assigned a DocLockstate value, one of the four values see table 2.

The DocLockState of the document may change during the execution of the workflow according to permissible transitions between the values. We give a Petri Net modeling of the permissible transitions.
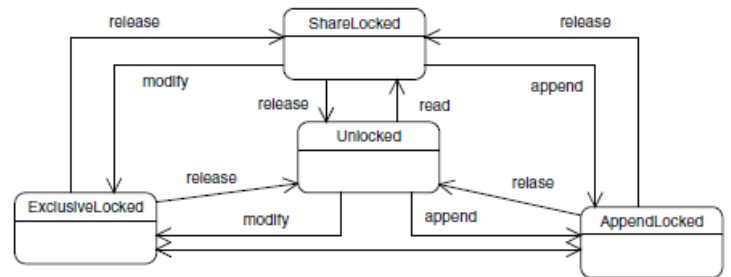

Fig.4 DocLockState

The DocCopyState (see Fig.5) have three values, Original Duplicate and Split. A document is by default original. It can be split into one or several parts. These parts may be merged if necessary. However in some situations, the split documents require no merge. A document can also be duplicated for security requirements. If the same document has to be used by more than one task separately, copies must be made and each task will have his own secure access to his duplicate copy. Merging copies is possible in some cases.
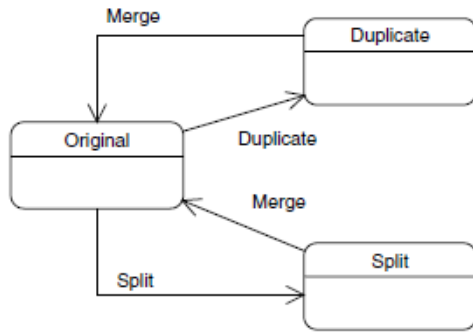
Fig.5 DocCopyState

DocLockState Value	Definition
Unlocked (default value)	the document is by default unlocked
ShareLocked	the document is shared between multiple tasks
AppendLocked	the document can be attached to a task but not changed
ExclusiveLocked	the document can be held by only one task

TABLE 2
DOCLOCKSTATE VALUES

We note that formal verification of security properties is out of the scope of our paper.

V. CONCLUSION AND FUTURE WORKS

For organisations which automate their business processes with workflow models, quality management and security of is critical especially for data flow business process models.

We proposed an approach to secure data flow modelling of the e-commerce order processing workflow based on security properties. We will show further how we will be able to model a secure and compliant data flow driven system.

Security properties defined in this paper may also be scheduled with time. A document can be locked for a period of time then gets unlocked automatically. The extension of security properties with time is one of the ideas to be developed in future.

REFERENCES

[1] Hammer M (2014) What is business process management? In: vom Brocke J, Rosemann M (eds) Handbook on business process management, vol 1, 2nd edn. Springer, Heidelberg, pp 3–16
[2] Paul Harmon" *Business Process Change, Third Edition: A Business Process Management Guide for Managers and Process Professionals"2014*
[3] Reijers HA, Mendling J, Recker J (2010) Business process quality management. In: vom Brocke J, Rosemann M (eds) Handbook on business process management, vol 1. Springer, Heidelberg
[4] Dale, B.G., van der Wiele, D.T., van Iwaarden, J.: Managing Quality. Blackwell Publishing Ltd., Singapore (2007)
[5] A Quality-Oriented Business Process Meta-Model Farideh Heidari1 , Pericles Loucopoulos1 , and Zoubida Kedad2
[6] Simone Fischer-Hübner, "IT-Security and Privacy-Design and Use of Privacy-Enhancing Security Mechanisms", Springer Scientific Publishers, Lecture Notes of Computer Science, LNCS 1958, May 2001
[7] F. Lins, R. Medeiros, B. Silva, A. Souza, D. Aragao, J. Damasceno, P. Maciel, N.Rosa, B. Stephenson, and J. Li. Ssc4cloud tooling: An integrated environment for the development of business processes with security requirements in the cloud. In Services (SERVICES), 2011 IEEE World Congress on, pages 53 –60, july 2011.
[8] Wang, J. and A. Kumar, A Framework for Document-Driven Workflow Systems, in Business Process Management. 2005. p. 285-301.
[9] W.M.P. van der Aalst. Challenges in business process management: Verification of business processes using Petri nets. Bulletin of the EATCS, (80):174–199, 2003.
[10] Petri, Carl A. (1962). "Kommunikation mit Automaten". Ph. D. Thesis. University of Bonn.
[11] Jensen, Kurt (1996). Coloured Petri Nets (2 ed.). Berlin: Heidelberg. p. 234
[12] Dr. V. R. Salkute "study of workflow management systems in E commerce" International Journal of the Computer, the Internet and Management Vol. 19. No.1 (January-April, 2011) pp 25 -31
[13] Paul Harmon "Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professioinals" 2008
[14] Aroua, M. K. & Zouari, B. (2012), Modeling of A-Posteriori Access Control in Business Processes, IEEE Computer Society, pp. 403-408.
[15] [15] M.K.Aroua B.Zouari Secure Document-Driven Business Process Management Systems, technical report- LIP2 Lab, july 2013.