



**Research and Practical Issues of
Enterprise Information Systems II,
Volume 2**

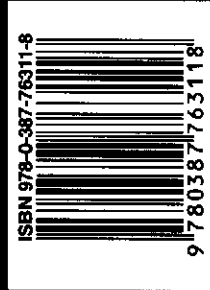
*Edited by Li Xu, A. Min Tjoa
and Sobhail Chaudhry*

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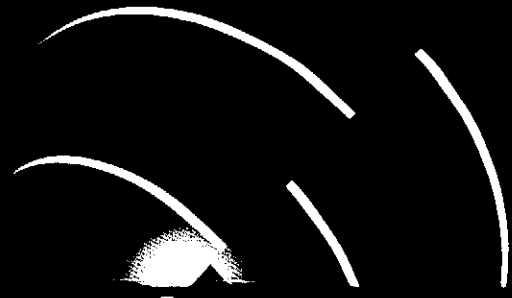
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*Xu
Tjoa
Chaudhry*



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A. Min Tjoa
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IFIP – The International Federation for Information Processing

IFIP was founded in 1960 under the auspices of UNESCO, following the First World Computer Congress held in Paris the previous year. An umbrella organization for societies working in information processing, IFIP's aim is two-fold: to support information processing within its member countries and to encourage technology transfer to developing nations. As its mission statement clearly states,

IFIP's mission is to be the leading, truly international, apolitical organization which encourages and assists in the development, exploitation and application of information technology for the benefit of all people.

IFIP is a non-profitmaking organization, run almost solely by 2500 volunteers. It operates through a number of technical committees, which organize events and publications. IFIP's events range from an international congress to local seminars, but the most important are:

- The IFIP World Computer Congress, held every second year;
- Open conferences;
- Working conferences.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is small and by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is less rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

Any national society whose primary activity is in information may apply to become a full member of IFIP, although full membership is restricted to one society per country. Full members are entitled to vote at the annual General Assembly. National societies preferring a less committed involvement may apply for associate or corresponding membership. Associate members enjoy the same benefits as full members, but without voting rights. Corresponding members are not represented in IFIP bodies. Affiliated membership is open to non-national societies, and individual and honorary membership schemes are also offered.

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Preface

Enterprise information systems (EIS) have become increasingly popular over the last 15 years [1-2]. EIS integrate and support business processes across functional boundaries in a supply chain environment [3-5]. In recent years, more and more enterprises world-wide have adopted EIS such as Enterprise Resource Planning (ERP) for running their businesses. Previously, information systems such as CAD, CAM, MRP/II and CRM were widely used for partial functional integration within a business organization. With global operation, global supply chain, and fierce competition in place, there is a need for suitable EIS such as ERP, E-Business or E-Commerce systems to integrate extended enterprises in a supply chain environment with the objective of achieving efficiency, competency, and competitiveness. As an example, the global economy has forced business enterprises such as Dell and Microsoft to adopt ERP in order to take the advantage of strategic alliances within a global supply chain environment. Today, not only the large companies, but also the medium companies are quickly learning that a highly integrated EIS is more and more a required element of doing business. Businesses all over the world are investing billions of dollars in acquiring and implementing EIS in particular ERP systems by SAP and Oracle. As a result, there is a growing demand for researching EIS to provide insights into challenges, issues, and solutions related to the design, implementation and management of EIS.

There is no doubt that the topic of EIS is new, popular and having important long-term strategic impact on global business and world economy. Due to the importance of the subject, there is a significant amount of ongoing research in the area. To respond the market needs from both academic researchers and practitioners for communicating their research outcomes, and contribute to, and often lead, progresses in the state-of-knowledge and state-of-the-art in EIS, the First IFIP TC8 International Conference on Research and Practical Issues of Enterprise Information Systems (CONFENIS 2006) was held at Vienna, Austria, April 2006 (<http://www.confenis.org/?q=node>). Two months after, the International Forum of Information Systems Frontiers (IFISF)—Xian International Symposium, was held in June 29-30, Xian, China. This is the first international symposium on information systems frontiers that is sponsored by a major Chinese research institution and held in China. One of the main themes of this conference is Enterprise Information Systems. Due to the success of these two premier international conferences, the Second IFIP TC8.9 International Conference on Research and Practical Issues of Enterprise Information Systems (CONFENIS 2007) is to be held in Beijing, China, October 2007 (<http://www.keylab-imie.org/confenis2007/general/index.aspx>).

CONFENIS 2007 is a primary international event which provides an opportunity for EIS academicians and practitioners in the world to gather, exchange ideas, and present original research in their fields. The purpose of the conference is to report on the state-of-the-art of, and emerging trends in, research and practice in EIS. The conference called for original contributions on significant research findings, reflecting advanced technological

research and applications in the field, and state-of-the-art survey papers and reviews on future directions of enterprise information systems.

CONFENIS 2007 received about five hundred submissions with selected ones included in these two volumes of proceedings. CONFENIS 2007 is to establish an international forum on the increasingly important area of Enterprise Information Systems. Distinguished scholars invited as keynote speakers include: John Warfield (George Mason University, USA), Shoubu Xu (Chinese Academy of Engineering and Beijing Jiaotong University), Xiaohong Guan (Tsinghua University, China), William McCarthy (Michigan State University, USA), G. Swanson (International Federation for Systems Research) and Yushun Fan (Tsinghua University, China).

We hope that this proceedings will serve our authors as an avenue to contribute to the progresses in the state-of-knowledge and state-of-the-art in EIS and its applications; meanwhile, we hope it will serve information systems professionals worldwide as an avenue to gain a new perspective on how the global business and world economy are impacted by EIS. We are very grateful to have the sponsorship of Beijing University of Posts and Telecommunications and Beijing University of Aeronautics and Astronautics for this conference. We would specially like to thank Dean Tingjie Lu, Professor Huaying Shu, Associate Dean Zhanhong Xin and Dr. Jiayin Qi of the School of Economics and Management of Beijing University of Posts and Telecommunications, Professor Lu Lin and Professor Guoping Xia of Beijing University of Aeronautics and Astronautics, former Chair of IFIP TC8, Professor J. Derald Roodé (South Africa), former Vice-Chair of IFIP TC8, Professor David Avison (France), Secretary of IFIP TC8, Professor Isabel Ramos (Portugal), and Vice-Chair of IFIP TC8, Professor Jan Pries-Heje (Denmark), for their encouragement and guidance throughout this endeavor. We are also deeply grateful to many individual reviewers who worked with us so diligently.

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CIM to PIM Transformation: A Reality

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Abstract. Within the scope of MDA, the model transformation is orientated towards solving the problems of time, cost and quality associated with software creation. Moreover, business process modeling, through the use of industrial standards such as UML or BPMN, offers us a good opportunity to incorporate requirements at high levels of abstraction. We consider Secure Business Process models such as the Computation Independent Model (CIM). In this paper we show that it is possible to define CIM to PIM (Platform Independent Model) transformations, using QVT rules. Through our rules, we obtain certain UML analysis-level classes and use cases which will be part of the PIM of an information system. We illustrate our approach with a case study concerned with payment for the consumption of electrical energy.

Keywords: Business process, MDA, Requirement specifications, Security

1. INTRODUCTION

Software engineering is currently greatly influenced by MDA, a new paradigm which claims to work both at a model and at a metamodel level. The MDA approach is not based on one single idea. Among the objectives pursued, are the separation of business-neutral descriptions and platform dependent implementations, the expression of specific aspects of a system under development with specialized domain-specific languages, the establishment of precise relations between these different languages within a global framework and, in particular, the capability of expressing operational transformations between them [1]. The MDA approach is composed of: the Computation Independent Model (CIM), the Platform Independent Model (PIM), and the Platform Specific Model (PSM) [2].

Because these models represent a different abstraction of the same system, an integration/transformation mechanism is required to establish how to go from one level (e.g. CIM) to another (e.g. PIM). Thus, transformations are a core element in the MDA. In the last few years, the most ambitious bet is QVT (Query/View/Transformation) [3], the transformation language proposed by the OMG. QVT plays an important role in the OMG metamodel family, because it includes special features which can be used to perform transformations within these frameworks.

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On the other hand, enterprise performance has been linked to the capacity which each of these enterprises has to adapt itself to the changes that arise in the market. In this context, Business Processes (BP), defined as a set of procedures or activities which collectively pursue a business objective or policy goal [4], have become valuable resources that have been used to maintain competitiveness.

Although the importance of business process security is widely accepted, until now the business analyst perspective in relation to security has hardly been dealt with. In [5, 6] we introduced security representation into business processes. To do so, we extended the UML 2.0 Activity Diagram (UML 2.0-AD) [7] and the Business Process Modeling Notation - Business Process Diagram (BPMN-BPD) [8]. A BPSSec profile was created which allows us to capture security requirements expressed by the business analyst. Such a specification gives origin to a Secure Business Process.

A business process built by a business analyst is not only useful in the specific business field but is also very useful in a process of software construction, and can be used to obtain system requirements, a stage taken into account by all modern development processes.

In this paper, we demonstrate how a set of analysis-level classes and use cases, both considered as being a PIM, can be obtained from the specification of a Secure Business Process, which is considered to be a CIM. The transformations have been described as a set of QVT rules and refinement rules. All of the artifacts, the Secure Business Process, the Analysis-level class, and the Use case, can be used in the software development process.

The structure of the remainder of the paper is as follows: in Section 2, we shall summarize the main backgrounds which explain the method that we have designed in order to incorporate security into business processes, the various steps of which they are made up and the tool which supports the realization of these stages. Finally, in Section 3, we will describe a case study and in Section 4 our conclusions will be drawn.

2. BACKGROUND

The main works related to security requirements specification in business processes [9-13] all coincide in the idea that it is necessary to capture the point of view of the business expert with regard to security, and to include these specifications within the software development process.

At present, security requirements which are easily identifiable by those who model business processes can be captured at a high level because: (i) business process representation has improved in UML 2.0-AD and BPMN-BPD, (ii) the security requirement tends to have the same basic kinds of valuable and potentially vulnerable assets [14], and (iii) empirical studies show that it is common at the business process level for customers and end users to be able to express their security needs [15].

Consequently, we have approached the problem of including security in business processes by extending the BPMN-BPD [6] and UML 2.0-AD [5] which allows business analysts to specify security requirements. The proposed extension, which we

have called BPSSec-Profile, considers the graphical representation of security requirements; a non-limited list, taken from the taxonomy proposed in [14].

In our proposal we have used a padlock, standard *de facto*, to represent security requirements. The same symbol, the padlock, but with a twisted corner is used to represent a Security Requirement with Audit Register (see Figure 1).

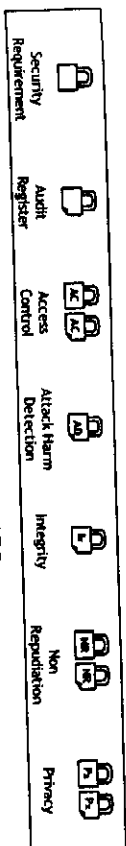


Figure 1. Icons used in BPSSec

As a result of the application of the BPSSec-Profile, a Secure Business Process (SBP) is obtained. This description is used to obtain the analysis-level classes and use case in which security forms a part of the diagrams obtained.

In this paper, CIM to PIM transformations are aimed at obtaining useful artifacts in software development. The basic aspects of our proposal are shown in Figure 1. The first column (on the left) shows two types of models which conform to the MDA. In the last column we can see the Unified Process [16] disciplines. The central part shows our proposal and the artifacts which are derived from its application. The business process specification is made by using UML 2.0-AD and BPSSec-Profile. We applied a set of QVT rules, refinement rules and checklists to obtain a subset of analysis-level classes and use cases that facilitate the understanding of the problem. SBP is used in "Business Modeling" and use cases are used in the "Requirement" and "Analysis & Design" disciplines of the Unified Process.

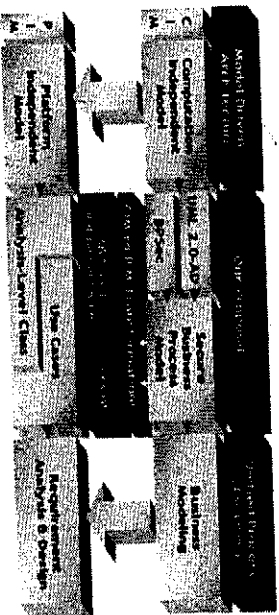


Figure 2. An Overview of Our Proposal

In order to apply the BPSSec-profile and to obtain artifacts which will be useful in a software development process, we have designed a method called M-BPSSec [17] (see Figure 3). This method permits the ordered and systematic carrying out of the elicitation of security requests and the attainment of analysis cases and use cases. M-BPSSec considers stages, workers, tools, models and artifacts which, if grouped together, permit (i) the design of an SBP (ii) the attainment of analysis-level classes and use cases which include security aspects and (iii) the storage of information related to the specification of the business process.

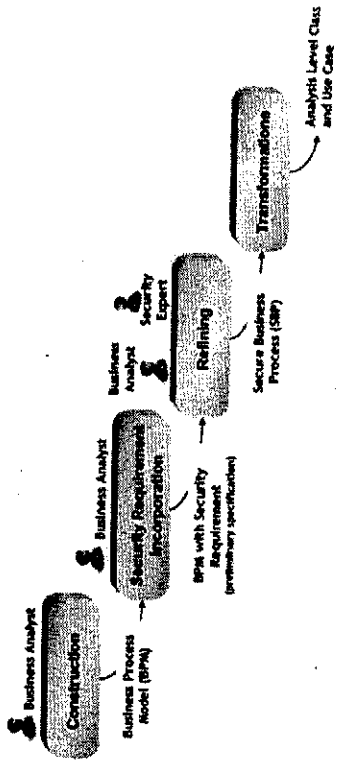


Figure 3. M-BPsec Overview

Each of the stages of M-BPsec is technologically supported by the BPsec-Tool (see Figure 4). This tool is used to design the SBP, to automatically transform models and to update the data contained in the secure business process repository. The BPsec-Tool was built by using a 3-tiered architecture to separate the presentation, application, and storage components, using MS-Visio, C#, and MS-Access technology respectively.

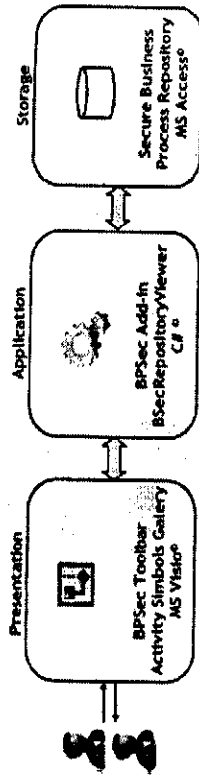


Figure 4. The Components of the BPsec-Tool

The transformations from the secure business process to the analysis classes are carried out by using a set of QVT rules and Refinement rules, a detailed description of which can be found in [18]. Basically, an equivalence relationship is established between the elements in both metamodels. A subset of the QVT rules is shown in Table.

The transformations from the secure business process to the use case are carried out by using a set of QVT rules, Refinement rules and a Checklist a detailed description of which are given in [19]. As with the analysis classes, the QVT rules permit the unidirectional transformation of the elements in both metamodels. A subset of the QVT rules is shown in Table. The checklists are used to obtain use cases related to the security specifications.

In both cases, the Refinement rules are applied after the QVT rules. The objective of this is to enrich both the analysis classes and the use cases by incorporating significant names, identifying relationships between classes and establishing dependencies between actors.

Table 1. Mapping from UML 2.0-AD/BPsec-Profile to Analysis-level Classes and Use Cases

Transformation	UML 2.0-AD/BPsec-Profile	Analysis-level Class and Use Case
Transformation ActivityDiagram2UseCaseDiagram	<pre> // From Activity Partition to Analysis-Level Class checkonly domain uml_ActivityDiagram as:ActivityPartition (name = n) enforce domain uml_ClassDiagram as:Class (name = n) where { ap:containsNode -> forall(chn:ActionIR4(chn)) } top relation R2 // From Interruptible Activity Region to Analysis-Level Class checkonly domain uml_ActivityDiagram as:InterruptibleActivityRegion (name = n) enforce domain uml_ClassDiagram as:Class (name = n) where { ap:containsNode -> forall(chn:ActionIR4(chn)) } // From Data Store Node to Analysis-Level Class checkonly domain uml_ActivityDiagram as:DataStoreNode (name = n) enforce domain uml_ClassDiagram as:Class (name = n) // From Action to Operation in Analysis-Level Class relation R4 // From Action to Operation in Analysis-Level Class checkonly domain uml_ActivityDiagram as:Action (name = n, inPartition=ap) enforce domain uml_ClassDiagram as:Operation (name = n, ownerClass=c:Class{name=ap.name}) </pre>	<pre> // From Action to Use Case checkonly domain uml_ActivityDiagram as:Action (name = n, inPartition=ap) enforce domain uml_UseCaseDiagram as:UseCase (name = n, subject=ACTORS, setOfActors=[]) where { ap:containsNode -> forall(chn:ActionIR4(chn)) } top relation R1 // From Interruptible Activity Region to Actor checkonly domain uml_ActivityDiagram as:InterruptibleActivityRegion (name = n) enforce domain uml_UseCaseDiagram as:Actor (name = n) where { ap:containsNode -> forall(chn:ActionIR4(chn)) } // From Security Requirement to subject top relation R3 // From Security Requirement to subject checkonly domain bpsec_BPsec as:SecurityRequirement (requirementType = n) enforce domain uml_UseCaseDiagram as:Classifier (name=n) </pre>

In the following section, we have developed a case study through which to show the CIM to PIM transformations. This is done by using the M-BPsec method which is supported by the BPsec-Tool.

3. A CASE STUDY

The case study has been developed in a cooperative which is dedicated to the distribution of electricity in rural areas. The Coopelan Ltda. (www.coopelan.cl)

cooperative came into being in 1957, and currently maintains 2,200 kms of electrical lines which are used to supply more than 12,000 clients. Recent years have seen the commercialization of goods and services, both for their clients for electrical energy (who are associates of the cooperative) and for the public in general. From an organizational point of view, the cooperative is made up of a technical area which is related to the distribution of electricity, a commercial area which is in charge of goods and services, and an administrative area. The cooperative has a total of 70 employees.

Because the cooperative's main clients live in rural areas, the way in which they presently receive payment for the consumption of electricity presents two problems: (i) delivery of the invoice upon which the consumption of electrical energy is detailed and (ii) receipt of payment of said debt. Business analysts have used a traditional method to modify the business process associated with the recovery of energy consumption debts, and have incorporated an electronic debt advisor and electronic payment. This complementary method has increased the index of debt recovery. The cooperative has neither the technical nor the operative capacity through which to receive electronic payments (via the Internet) and for this reason it has decided to employ an external collector to carry out this task.

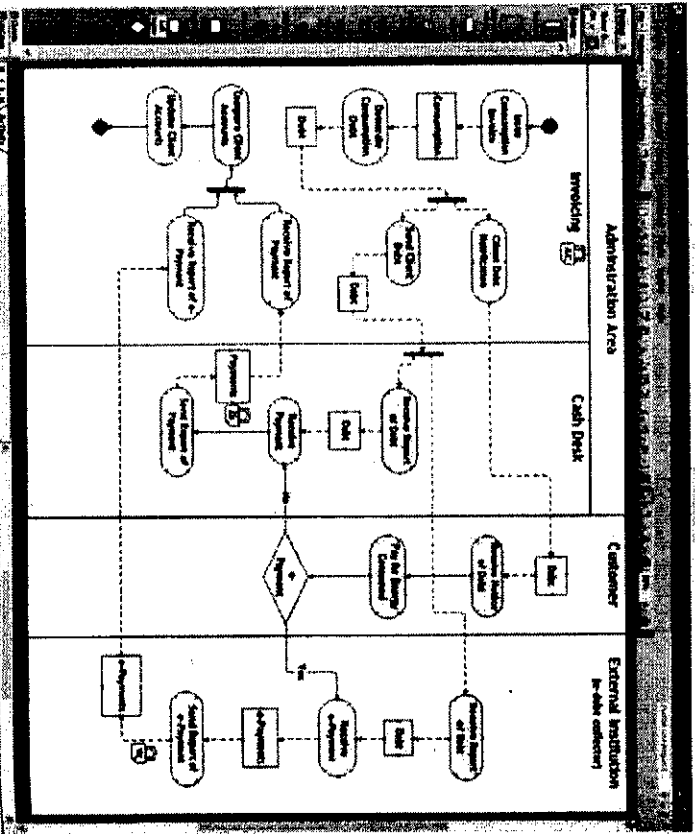


Figure 5. Secure Business Process: Payment for Consumption of Electrical Energy

The business process which we shall describe as a part of our case study is about payment for consumption of electrical energy. The case study was carried out with the

assistance of the cooperative's business analysts. M-BPSSec was used in the development of this case study. The result of the first three stages is a Secure Business Process called "Payment for consumption of Electrical Energy", which is shown in Figure 5.

Details of the application of the stages of M-BPSSec are:

The Construction stage basically consists of producing a business process, and this is done by the business analyst. In this case, the business process was described by using the UML 2.0-AD. The areas which were identified were Activity Partitions "External Institution", "Customer", and "Administration Area", which was divided into two central Activity Partitions called "Invoicing" and "Cash Desk". This business process is initiated when the "Issue Consumption Invoicing" activity is carried out, and it terminates with receipt of payments and an updating of clients' debts.

In the Security Requirement Incorporation stage, the business analyst identifies which, from his/her point of view, are the vulnerable areas in the business process. A meeting has previously taken place in which the significance of the security requirements considered in the BPSSec-Profile is explained. The business analyst identifies vulnerable areas in: (i) the information which is sent from "External collector" to "Invoicing", for which Non-reputation is specified, (ii) the information related to the payments received in the "Cash Desk", for which a high level of Integrity is specified, and (iii) the activities and information related to the Invoicing Activity Partition for which Access Control is specified.

The Refinement stage was carried out by the business analyst in conjunction with the security expert. These people analyzed and agreed upon the security requirement specifications and added Audit Register to the Non-Reputation and Access Control specifications.

Finally, the Transformations stage was applied to the secure business process. This stage was carried out automatically by using the BPSSec-Tool. The results obtained were the analysis class diagram shown in Figure 6 and the Integrity in payments and Non reputation for message use cases (see Figure 7), general use case for payments for consumption of electrical energy and access control in invoicing (see Figure 8).

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