
Summary: A key requirement in the system development efforts of today is to achieve integration between business and ICT. For many enterprises business models are changing, as new cross-enterprise cooperation emerges. At the ICT level, Web services are used as the cornerstones for modelling the interactions of the cooperating enterprises. Such large systems require techniques and tools that allow monitoring and analyzing service-oriented systems in use. Process mining is a technique that enables automatic extraction of process schemas from the event-log data of underlying systems. One problem is that the process mining techniques enable discovering only of abstract process specifications, without providing knowledge on the business-oriented aspects of a cooperation, such as the values and resources being exchanged, or the achieved business goals. This proposal aims to provide a systematic method for verifying business-oriented aspects by discovering business process and business models by mining information on execution of underlying, Web service-based systems.

Keywords: Business alignment, Process mining, Service-oriented systems, Service interactions, Business process models, Business models

1 Introduction

Software services are the building block of future systems that integrate existing IT assets and thereby provide the basis for building complex cross-enterprise systems. Large scale service-oriented systems rely on complex interactions between individual software services composed in the form of processes [1]. Such large systems require techniques and tools that allow monitoring and analyzing of service-oriented systems in use.
Process mining has become a widely accepted technique for extracting process specification from system executions [2]. This technique is commonly applied using a set of tools that enable automatic mining of process schemas from event-log data. In the environment of service-oriented systems, service interactions are used as a basis for fulfilling the system execution logs.

One aspect of use of process mining is measuring business alignment, i.e., comparing the real behavior of an information system with its intended or expected business behavior. In the context of service-oriented systems, this first means extracting the knowledge needed to verify fit with business process aspects at a lower level, such as who invoked a service, what information has been exchanged in an interaction, and in what order service interactions are coordinated. This knowledge can be further used to analyze business aspects on a higher level, such as what business parties have been engaged in a service interaction context, what resources and values that have been exchanged, and what goals have been achieved by the interactions.

2 Problem Statement

For many enterprises new business models and processes are emerging or existing models are changing, as new cross-enterprise cooperation emerges. In such changing environments, there is a continuous requirement for measuring the alignment between business and information systems. Thus, in a Web service-oriented system constellation, it is important to have the ability to monitor execution of the services in order to discover business-oriented aspects. One problem is that current literature on process mining mostly focuses on discovering process specifications without providing knowledge on business-oriented aspects such as the values and resources being exchanged or the achieved goals.

Within this proposal we aim to research methods for verifying business-oriented aspects by discovering business process and business models by mining information on execution of underlying Web service-based systems.
3 Related Research

Discovery and verification of process models using mining-based techniques has become an extensively researched topic in the last few years. Van Der Aalst et al. [2] proposes a framework that enables discovering of models describing processes and organizations by extracting the control-flow information (that is, the ordering of the executing operations) using the audit trails of a workflow management system or the transaction logs of an enterprise resource planning system. The framework might also be used for examining the alignment between business processes and the supporting information systems, by measuring the fit between a discovered process and a predefined process model, or directly matching a system audit log and a predefined process model [3]. ENSIAS in collaboration with LORIA-INRIA [4, 5] has proposed a technique for mining the transactional behaviour of information systems, in order to analyze and improve process recovery procedures.

Lately, several studies have set focus on the mining of Web service-oriented systems [6] and [7]. These works examine several aspects of Web service executions, such as the internal behaviour (that is, interfaces and messages), the interaction behaviour for discovering the critical dependencies among a set of services, and the workflow behaviour meaning an entire control-flow of a set of service interactions. The outlined studies enable discovering abstract process models, that is, models that cover partial orderings of a set of activities, but where the semantics of those activities are not visible.

Recently, researchers have started to extensively study the business-oriented perspective as a foundation for deriving executable business processes [8]. A business model is used to define the what in a business environment, identifying actors and exchanges of values between actors. A business process model, coordinating underlying Web services, elaborates the how in the given business context, specifying a procedure for executing low-level operational activities. The KTH/SYSLAB research group has proposed methods for deriving business process models from business models [9,10]. The concepts and methods proposed by this group can be used as a basis for a reengineering procedure, that is, for discovering a business model from a business process in order to verify the alignment between the operational and higher level business aspects of an enterprise.
4 Research Objectives and Expected Outcomes

The objective of this research is to propose a method for discovering business process models and business models by mining the interactions of Web services.

The method consists of three major steps (see Figure 1):

- Step 1: Discovering an abstract process model from a Web service event log
- Step 2: Producing a business process model from an abstract process model
- Step 3: Producing a business model from a business process model

![Figure 1. Mining Web service interaction to obtain process and business models](image.png)

The current architecture of WorkflowMiner [11] is, as shown in the lower parts of Figure 2, builds upon four main components: Event-based Log Collectors/Adapters, Events Analyser, Workflow Patterns Analyser, and Performance Analyser.

![Figure 2. From WorkflowMiner to BusinessAligner](image.png)
The expected result of the project is the design of the BusinessAligner Framework through extending WorkflowMiner with the following components:

**Business process patterns discoverer.** This component will extract business process patterns based on workflow patterns discovered by WorkflowMiner [11] on web service interaction.

**Business model discoverer.** This component will identify business models based on discovered business process patterns.

**Business / IT Service Aligner.** This component will enable checking how well Web service interactions conform (i.e. align) to business processes and business models of the collaborating enterprises [3]. This will enable discovering potential discrepancies between actual and expected business behaviour.

## 5 Work plan

The work in the project is divided into three main phases. Each of these phases addresses one of the steps in the method.

### Phase 1

*Discovering an abstract process model from a Web service event log*

In this phase, we will refine an existing method for discovering abstract process models from a Web service event log. The method to be used as a basis is the Web Service Interaction Mining (WSIM [6]) method jointly developed by the research groups of ENSIAS and the Vienna University of Technology, and WorkflowMiner [11] jointly developed by the research groups of ENSIAS and LORIA-INRIA. The method will be refined in order to facilitate semantic enrichment as well as process pattern application needed for the second and third steps of the method. One part of this phase consists of a case study where the refined method will be applied to a sizable case.

### Phase 2

*Producing a business process model from an abstract process model*
In this phase, we will develop a method for producing a business process model from an abstract process model. As a business process model is semantically richer than an abstract process model, this method will require that additional information about the business domain is captured from business experts. It is envisaged that this information capture can be supported by means of process patterns, [12], that embody generic knowledge on typical process structures. Furthermore, the intentions of the messages identified in the abstract process model need to be identified and made explicit. This will be done according to principles developed within the Language Action approach, [13]. This phase will include an evaluation of the proposed method by applying it to the case study introduced in Phase 1.

**Phase 3**

*Producing a business model from a business process model*

In this phase, we will develop a method for producing a business model from a business process model. Such a method can be viewed as a reverse engineering approach, where the forward engineering would move from a business model to a business process model. In previous work, we have developed such a method, [10, 14], which will form the basis for constructing a corresponding reverse engineering method. This method will also make heavy use of workflow patterns, [12], to govern the transformation process. This phase will include a case study continuing the case studies from the previous phases.

**6 Research Benefits**

As the result of the project we expect to achieve

- Discovery of business and process models. By using the Workflow Miner, the service interaction patterns and the workflow patterns, the method will enable creation of a business process model and furthermore a business model.
- Verification of existing business and process models. The method will enable checking how well Web service interactions conform to business processes and business models of the collaborating enterprises. This will enable discovering potential discrepancies between actual and expected business behaviour.
• Traceability. Using our approach it will become possible to align business concepts with service-oriented systems.

The research will provide the knowledge on how to utilize service interactions for identifying and verifying process and business models. Results of the research will be useful also to practitioners, who currently lack both tools and mechanisms for a business-oriented verification of executable, service-based systems.

7 Cooperation
To achieve both short term operational results and long term successful MENA-Sweden collaboration, many actions need to be scheduled;

(a) Electronic exchanges of research drafts and recent papers;
(b) Common research visits in Sweden and Mena region;
(c) Scheduling collaboration meetings to insure face-to-face agreements;
(d) Co-supervision of Engineering projects, Masters by research and PhD thesis in both Sweden and Mena Region;
(e) Common R&D project achievement;
(f) Common publications in selected conferences and workshops;
(g) Common applications to funding programs;

8 Budget Motivation
On the basis of the cooperation-volume and characteristics, we ask for a three years support. The cooperation will be realised through a number of scheduled visits and work sessions. The results from the project will be documented in joint papers.

9 References

4. W. Gaaloul, K. Baïna et C. Godart. A Bottom-up Workflow Mining Approach for Workflow Applications Analysis. 2nd IEEE Int. Workshop on Data Engineering Issues in E-Commerce and Services (DEECS’06), In Conjunction with CEC’06 and EEE’06, San Francisco, California, 2006


11. K. Baïna, W. Gaaloul, R. El Khattabi, and A. Mouhou WorkflowMiner : a New Workflow Patterns and Performance Analysis tool. 18th Int. Conf. on Advanced Information Systems Engineering (CAiSE’06) Forum, Luxembourg, June 5-9, 2006


14. Andersson B., Bergholtz M., Grégoire B., Johannesson P., Schmitt M., Zdravkovic J.: From Business to Process Models – a Chaining Methodology. Accepted for the INTEROP BUSITAL’06 Workshop, in conjunction with the 18th Int. Conf. on the Advanced Information Systems Engineering (CAiSE’06), Luxembourg, June 5-9, 2006