# ICSTE 2010

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# PROCEEDINGS

# 2010 2nd International Conference on Software Technology and Engineering (ICSTE)



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# PREFACE

Dear Distinguished Delegates and Guests,

The Organizing Committee warmly welcomes our distinguished delegates and guests to the 2010 2nd International Conference on Software Technology and Engineering (ICSTE 2010) held during October 3-5, 2010 in San Juan, Puerto Rico, USA.

ICSTE 2010 is sponsored by International Association of Computer Science and Information Technology (IACSIT), co-sponsored by Polytechnic University of Puerto Rico, supported by IACSIT Members and scholars from universities all round the world. If you have attended a conference sponsored by IACSIT before, you are aware that the conferences together report the results of research efforts in a broad range of computer science and Information Technology. These conferences are aimed at discussing with all of you the wide range of problems encountered in present and future high technologies. The ICSTE is organized to gather members of our international community scientists so that researchers from around the world can present their leading-edge work, expanding our community's knowledge and insight into the significant challenges currently being addressed in that research. The conference Program Committee is itself quite diverse and truly international, with membership from the Americas, Europe, Asia, Africa and Oceania.

This proceeding records the fully refereed papers presented at the conference. The main conference themes and tracks are Software Technology and Engineering. The main goal of these events is to provide international scientific forums for exchange of new ideas in a number of fields that interact in-depth through discussions with their peers from around the world. Both inward research; core areas of Software Technology and Engineering and outward research; multi-disciplinary, inter-disciplinary, and applications will be covered during these events.

The conference has solicited and gathered technical research submissions related to all aspects of major conference themes and tracks. All the submitted papers in the proceeding have been peer reviewed by the reviewers drawn from the scientific committee, external reviewers and editorial board depending on the subject matter of the paper. Reviewing and initial selection were undertaken electronically. After the rigorous peer-review process, the submitted papers were selected on the basis of originality, significance, and clarity for the purpose of the conference. The selected papers and additional late-breaking contributions to be presented as lectures will make an exiting technical program. The conference program is extremely rich, featuring high-impact presentations.

The high quality of the program – guaranteed by the presence of an unparalleled number of internationally recognized top experts – can be assessed when reading the contents of the program. The conference will therefore be a unique event, where attendees will be able to appreciate the latest results in their field of expertise, and to acquire additional knowledge in other fields. The program has been structured to favor interactions among attendees coming from many diverse horizons, scientifically, geographically, from academia and from industry. Included in this will to favor interactions are social events at prestigious sites.

We would like to thank the program chairs, organization staff, and the members of the program committee for their work. Thanks also go to Editor Ms. YANG LI, International Association of Computer Science and Information Technology, for her wonderful editorial service to this proceeding.

We are grateful to all those who have contributed to the success of ICSTE 2010. We hope that all participants and other interested readers benefit scientifically from the proceedings and also find it stimulating in the process. Finally, we would like to wish you success in your technical presentations and social networking.

We hope you have a unique, rewarding and enjoyable week at ICSTE in San Juan, Puerto Rico, USA.

With our warmest regards,

The Organizing Committees
October 3-5, 2010
San Juan, Puerto Rico, USA

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# From BPMN business process models to SoaML service models:a transformation-driven approach

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***Abstract*—Business process modeling, simulation, deployment, execution and evaluation support have been improved in last years, through research efforts from both the academic field and industry. Organizations are now aware of the importance of explicitly defining the business processes of which their businesses are comprised realizing them by means of services. Service support helps to reduce the gap between the areas of Business and Information Technology (IT), thus easing the communication and understanding of business needs. Business Process Management (BPM), Service Oriented Computing (SOC) and Model Driven Development (MDD) paradigms are integrated, based on standards and tools which support them. MINERVA is a framework that aims to provide such an integrated solution. In this paper we present the MINERVA proposal for automating transformations from BPMN to SoaML models in order to automatically generate services from business processes.**

***Keywords- Business Process Management (BPM), automatic transformations, Service Oriented Computing (SOC), Model Driven Development (MDD), BPMN, SoaML***

## I. INTRODUCTION

The importance of defining business processes in an explicitly manner is currently widely accepted by organizations as a means to gain insight into and better control of their business. The realization of business processes with services provides the necessary software support and detaches business process definition from its technical implementation, thus easing the communication and understanding of business needs while helping to reduce the gap between the areas of Business and Information Technology (IT). To achieve this goals, Business Process Management (BPM) [1][2], Service Oriented Computing (SOC)[3][4][5] and Model Driven Development (MDD) [6][7][8] paradigms are therefore being integrated on the basis of the standards and tools with which they are implemented. Many of these standards and tools are not yet in a stable form, and this leaves gaps that need to be filled if organizations and their business areas are to be provided with the necessary IT support.

MINERVA [9] (Model drIveN and sErvice oRiented framework for the continuous business processes improVement & relAted tools) is a framework which aims to provide an integrated solution for the service oriented development of business processes, and it integrates concepts, methodologies and tools that combine the application of SOC and MDD paradigms to support BPM. It is defined to support the business process lifecycle [10] and covers the four phases of: Design and Analysis, Configuration, Enactment and Evaluation. Business process models can be expressed in several different notations, one of the most important being Business Process Modeling Notation (BPMN) [11]. The same occurs with service oriented models, which are mostly expressed in UML [12]. Service Oriented Architecture Modeling Language (SoaML) [13] provides a UML profile and metamodel for designing SOA services, and defines the concepts and stereotypes needed to model services in UML. MINERVA integrates a methodological approach for service development, the Business Process Service Oriented Methodology (BPSOM) [14] which includes QVT [15] transformations from BPMN business process models to SoaML services models, with the aim of, as far as possible, automating the generation of services from business processes.

The organization of this paper is as follows: Section 2 presents the problem statement. Related work is discussed in Section 3. Section 4 presents the defined transformations along with their use within the service oriented methodology of the framework. Section 5 includes an example to illustrate the execution of the defined transformations, and finally, some conclusions and future work are discussed in Section 6.

## II. PROBLEM STATEMENT

The execution of business processes usually involves expanding several sections or areas in single or even different organizations. The traditional vertical vision of software development based on areas or technology grouping has led organizations with several independent software systems that require important integration efforts to work together. Business process realization with services is currently the preferred means to tackle this problem through a horizontal vision of business processes. Although the realization of business processes with services implies many benefits, the definition of "the right" services to support these processes is still a challenge. There have been many

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initiatives to provide methodological support for deriving services from business processes, automating the process when possible, but the problem is still being studied. In order to guide service oriented development we have defined BPSOM methodology included in MINERVA framework, to which we are adding the automatic generation of services from business process. The importance of automatically generating services directly from business processes is that of automatic generation: this allows knowledge reuse, which reduces design errors, explicitly traces the relations between elements in different models, and improves productivity.

Several questions arise when defining which are "the right" services to obtain from a business process: from the point of view of software this consists of defining service functionality, granularity, coupling and cohesion, applying design patterns; from the business view it is the definition of business functionality, business domain, identifying reusable pieces of software that can be used to carry out different business processes, applying process patterns. The relations between elements from a business process model and a service oriented model is one key element for defining the transformations. We have tackled this by defining an ontology for service oriented modeling supporting business processes [16], which is the basis for the definition of the transformations we are presenting here.

When designing and or generating services, another main issue is the existence of services already implemented in the organization that can be reused in the application under development. It is desirable that existing components implementing the same, or at least similar, functionality corresponding to existing services, could be reused, and preserved when re-generating the models. For the first statement we have defined an activity in BPSOM [14] with which to explicitly discover existing services in the organization, based on a services Catalogue, defined to keep track of services, their contracts and associated software. The reuse of existing components can be modeled in SoaML by utilizing a Participant component using an adapter or wrapper component pattern to isolate invocation to the existing component.

## III. RELATED WORK

Many approaches have been proposed to transform and generate software models from business process models, where existing languages and standards such as OMG Query/Views/Transformations [15] and ATL [17] can be used to define mappings and transformations, although new or different approaches have also been defined. BPMN and UML are the most used notations for business process models and services and software models, respectively. In [18] the BPMN BP model is annotated with information processed by transformations to obtain UML software artifacts such as UML AD, use cases, collaboration and deployment diagrams. [19] also proposes BPMN to UML transformations, but with a focus on security elements added to the BPMN model in order to obtain UML AD and use cases and analysis classes from it. Both proposals differ from ours in that we define transformations from BPMN directly to SoaML models without intermediate software artifacts. In [20] four PIMs are defined to model system behavior for Web Systems, defining mapping rules between corresponding models that can be completely or partially automated. Differently, we derive services directly from business process models using standard metamodels/models.

In [21] three different architectural approaches for software systems are used: centralized and decentralized broker and brokerless, in which services are derived from a CIM description of business. This approach has a more architectural focus than ours, in deploying solutions based on the broker pattern. [22] applies transformations successively based on defined patterns, from macroflow-microflow pattern and the process-based integration architecture pattern that guides the design of an architecture based on sub-layers for the service composition layer. In [23] conceptual transformations are defined based on the successive application of patterns from the top to the bottom layer, using graphs for pattern matching. [24] identifies tasks in BP representing service invocations, then integrates the BP and object modeling into a Business Service Model (BSM), mediating between business requirements and implementation. In contrast to these, we do not propose our own patterns, but use existing ones, the process patterns [25], mainly to validate business process models.

In [26] a three level conceptual framework is defined to relate business processes with implemented services, adding a service mediating layer and a Service Invocation Coordinator (SIC) to implement service invocation. In [27] transformations are defined from a value model to use case models, with mapping rules from the CIM level to the PIM level between model elements which are automated with ATL. In [28] two types of transformation rules are defined: basic generation to create elements of the target model, and binding rules to generate links between them, also using ATL. We, on the other hand, use OMG standards to model business process and services, BPMN and SoaML, and QVT for transformations, which is aligned with the MDA standard, thus defining an standardized framework.

## IV. QVT TRANSFORMATIONS FROM BPMN TO SOAML

In order to clarify the elements to which we are referring, a brief introduction to BPMN and SoaML main concepts is provided, along with the defined QVT transformations.

### A. *BPMN and SoaML concepts*

BPMN specifies one type of Business Process Diagram (BPD), a set of core elements to model most of the required business process and a complete set. The four main groups defined in the standard are: flow objects, which are events, activities, decision/union nodes (split, join); connecting objects, which are sequences, messages and associations; swimlanes (pool, lanes) and artifacts (data, annotation, groups). A pool represents a process participant which is a business entity (enterprise, section) or a business role (seller, buyer), and a lane in a pool is a sub-partition used to organize activities. An activity represents the work that an organization performs, and can be atomic or a sub-process composed of other activities. A gateway is a decision point used to control the divergence and convergence of process flow and can be parallel (AND), exclusive (XOR), inclusive (OR) or complex. Sequence flow shows the order in which process activities are performed, from start to end, and messages show the message flow between two participants. An event indicates something that happens in the course of a process affecting its flow, can be start, intermediate and end, and can have a type such as time or error.

SoaML defines Service as a resource that enables access to one or more capabilities, where the access is provided by using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description. A service is provided by an entity (provider) for use by others (consumers). A service can have one or more interfaces and an associated contract. A Service Interface is defined by three main sections: the interfaces provided and required, the interface class, and the behavior protocol. A Service Contract defines terms, conditions, interface and choreography in which participants agree to use services. Participants are software components, organizations or systems that provide and use services, offering capabilities in ServicePoint and requiring them at a RequestPoint, both specializing UML Port. A Service Channel enables communication between them, and messages specify the type of information exchanged. The general architecture of participants and services involved is shown in a ServicesArchitecture collaboration. It is worth mentioning that the SoaML standard is now in its beta2 version, in which some elements have been changed.

### B. *BPMN to SoaML transformations*

The MINERVA BPSOM [14] guides the derivation of services from business processes, starting with business process modeling in BPMN. Figure 1 shows the steps needed to execute the transformations.

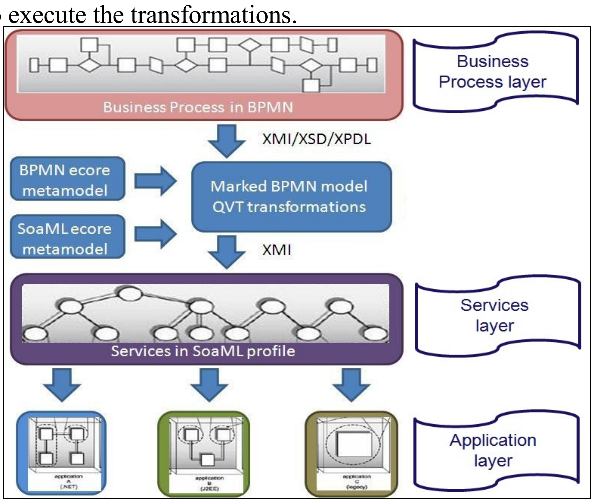


Figure 1. BPMN to SoaML transformations proposal of MINERVA

As it can be seen in Figure 1, one of the most important inputs for the development process is the BPMN business process model. A tool that allows the model to be exported in a particular format (XMI, XSD, XPDL) is used to permit the file to be loaded into the IDE used by developers, who can then mark it and extend it with additional knowledge to be used by the defined transformations. The type of activity has to be set using the definitions provided in BPMN, such as "Service" to indicate that the activity needs service support or "Manual if a person should perform it. Other information is needed such as input and output messages from activities and data, among others. This step can be viewed as part of architecting the software solution. When all the information is set, transformations can be executed to obtain the services model in SoaML for those activities that have service support. Several views of the model should be described in different diagrams, such as the Services Architecture. From the SoaML model code can be generated in the desired technology, using MDA engines.

Given the conceptualization done by means of the defined ontology [16], we have identified several correspondences between the concepts involved in modeling business processes and services, then transferred to BPMN and SoaML metamodels elements. Thus far we have defined transformations for the basic elements of a business process model: diagram, pool, lane in a pool, activity, and message, whose relations were presented above. These transformations allow us to obtain the desired elements of the SoaML model from a business process in the form of an XMI file with the elements generated from the BPMN model XMI file. A sub-set of the defined relation rules in QVT are shown in Table I.

We present the transformations only for the ServicePoint that a Participant provides, but the RequestPoint that a Participant requests from other participants are defined in similar way. The first rule, named "ProcessToModel", generates a SoaML "Model" element from a "BpmnDiagram" element corresponding to the BPD of BPMN, relating the top level business process to the service model. The second rule, "PoolToParticipant", generates SoaML "Participant" elements from the "Pool" elements of the BP model, one Participant from each Pool. These participants will be used to define the ServicesArchitecture for the complete BP. The third rule named "LaneToParticipant", also generates SoaML "Participant" elements from "Lane" elements inside the pools of the BP model, one Participant from each Lane in each Pool. These participants will be used to describe the internal architecture of each participant involved in the ServicesArchitecture.

The fourth rule named"ActivityMessageToServicePoint", generates SoaML "ServicePoint" elements from those activities in the BP model which have incoming messages from another activity in the model, associating them with the participant that provides the service. We are only transforming activities and pools connected with messages, that is, the interaction between the different parties involved. The OCL expression in the "when" clause of the rule evaluates all the activities in the model, checking whether they have outgoing messages to the activity in which the evaluation is situated at that moment, and also comparing whether the type of activities is the same. This is a restriction of the BPMN Modeler metamodel we are using, in which events and gateways are also defined as activities, so we had to change the original restriction that the type of activity was Service. The final rule called "PoolMessageToServicePoint" generates the ServicePoint that are not directly associated with activities but with Pools, as permitted when a BPMN

Pool is not expanded. These transformations are not the only ones that can be defined for the elements that we are transforming, so we are also investigating other ways to obtain them, and to get the rest of the elements to generate full SoaML models.

TABLE I. SUB-SET OF THE QVT TRANSFORMATIONS DEFINED

| Relation rules defined |
|---|
| **top relation ProcessToModel** { checkonly domain bpmn bp : bpmn::BpmnDiagram{name = pn}; enforce domain soaml sm : SoaML::Model{name = pn }; } |
| **top relation PoolToParticipant** { checkonly domain bpmn p : bpmn::Pool{name = pn}; enforce domain soaml s : SoaML::Participant{name = pn};} |
| **top relation LaneToParticipant** { checkonly domain bpmn p : bpmn::Lane{name = pn }; enforce domain soaml s : SoaML::Participant{ name = pn };} |
| **top relation ActivityMessageToServicePoint {** checkonly domainbpmnc:bpmn::Activity{lanes=p:bpmn::Lane{}, activityType = bpmn::ActivityType::Task, incomingMessages=im:bpmn::MessagingEdge{},name=cn} ; enforce domain soaml t : SoaML::ServicePoint { participant = s : SoaML::Participant {}, isService = true, name = cn}; when { p.pool.bpmnDiagram.pools.lanes.activities-> exists (x:bpmn::MessageVertex\|(x.outgoingMessages.target= c.incomingMessages.target) and (x.oclAsType(bpmn::Activity). activityType = c.activityType)) or (p.pool.bpmnDiagram.pools- >exists (x:bpmn::MessageVertex\|(x.outgoingMessages.target= c.incomingMessages.target))); PoolToParticipant (p.pool, s); }} |
| **top relation PoolMessageToServicePoint** { checkonly domain bpmn c : bpmn::MessagingEdge{ target = d : bpmn::MessageVertex {name = cn} enforce domain soaml t : SoaML::ServicePoint { participant = s : SoaML::Participant {}, isService = true, name = cn }; when {PoolToParticipant (d, s);}} |

## V. EXAMPLE OF TRANSFORMATIONS EXECUTION

The proof of concept we are working on takes a simple BPMN diagram with a selected set of elements: pools, lanes, tasks, gateways, start event and final event, and generates the corresponding SoaML model with participants along with the services they offer. The business process is modeled in the Eclipse BPMN Modeler plug-in and the source XMI file, which conforms to the BPMN Modeler metamodel, that is obtained is then transformed to obtain the target XMI file which conforms to the SoaML metamodel. We decided to use the BPMN Modeler metamodel as it corresponds to the elements in the BPMN graphical modeler tool, and because it also provides a synchronized XMI file corresponding to the model. One disadvantage of this is that the defined metamodel is a simplified BPMN metamodel.

The BPMN Modeler metamodel and the SoaML metamodel are loaded into the Eclipse environment as Ecore metamodels using the facilities provided by Eclipse. QVT transformations are defined using the Medini QVT plug-in, by means of a set of relation rules that associate elements from the BPMN Modeler ecore metamodel to elements in the SoaML ecore metamodel. The selected business process, Make appointment process from a Hospital, is shown in Figure 2. It begins when a Patient Requests an Appointment with a Hospital's Doctor. The Receptionist checks the Patient's information and assigns a Doctor to him/her. Two activities are then executed in parallel: the Doctor registers the appointment with the Patient and a communication is sent to the Patient with the information of the appointment. After executing the defined QVT transformations the SoaML elements are generated into an XMI file, where two participants were generated, each corresponding to one Pool in the BPMN model, and three participants each corresponding to each Lane within the Pools. Each Participant obtained from Pools has an associated ServicePoint which defines the services it provides, corresponding to the activities that have incoming messages in the BPMN model. The SoaML model associated to the obtained XMI file generated from the BPMN model, defining the CIM and PIM models, is also shown. To be able to see the SoaML model it is necessary to load the XMI file obtained into a graphical tool implementing the SoaML profile. As we wish to have all the MINERVA supporting tools in Eclipse IDE, we have used an evaluation of the MagicDraw Cameo SOA+ plug-in for Eclipse to be able to work with SoaML models. But as the generated SoaML model is not complete it was not possible to directly import it yet. Nevertheless we show what the model should look like when specified with the plug-in, along with its correspondence with the defined business process.

## VI. CONCLUSIONS AND FUTURE WORK

A proposal for obtaining SoaML service oriented models from BPMN business process models by means of QVT transformations has been presented with the aim of, as far as is possible, automating the steps for service generation. The defined QVT rules have been presented and explained, along with some concepts of the ontology used as basis for defining them. A proof of concept example has been developed using the Eclipse IDE integrating various plug-ins for the different steps. Although the transformations correspond to a reduced set of rules for a set of selected BPMN and SoaML elements, we believe that they could serve as the basis for the further definition of transformations for the remaining elements involved, on which we are currently working. All participants and their Service and Request points corresponding with services provided and consumed are generated; we have shown the first one as example. We will add the definition of the contracts, interfaces, messages, operations and data needed. The complete set of QVT transformations along with the methodological and tool support integrated in the MINERVA framework will support the entire development process for service oriented applications from business processes, thus guiding the definition of services from BP in both a methodological and automated manner.


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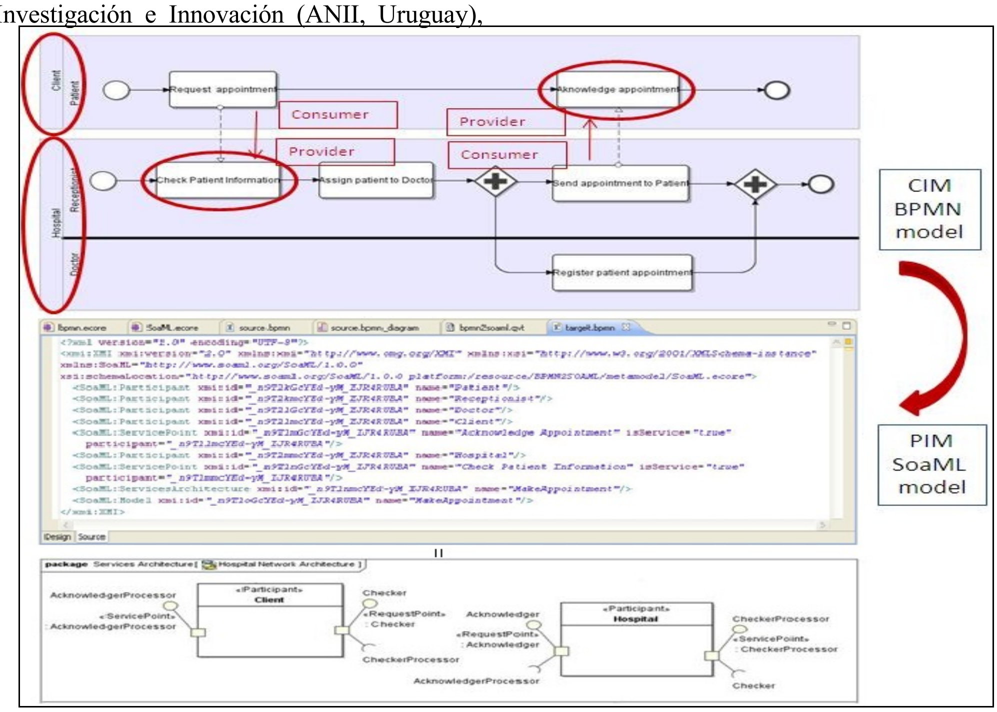


Figure 2. BPMN business process and generated SoaML XMI file obtained with associated services model

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