

# MODELLING USER INTERACTIONS IN WEB SERVICE-BASED BUSINESS PROCESSES

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Keywords: User Interface Modelling, Model-Based Design, Task Models, Business Processes, Web services.

Abstract: This paper presents a methodology that defines a model-based approach in composing User Interfaces for Business Processes based on Web service technology. The core concepts of the methodology are represented by an integration of modern task model notations developed in the HCI area, such as ConcurTaskTrees, with a mainstream notation for Business Process modelling (BPMN) developed in the workflow/business process area. The main advantage is to obtain thorough support in designing complex interactive business applications able to flexibly compose Web services and obtain meaningful associated user interfaces which can be not only Web interfaces but also extended to a multi-modal fruition. The proposed methodology allows a collaborative work between business process modellers and user interface modellers remaining open to iterative refinements. In this paper we also briefly compare the considered notations and discuss an example application of the proposed method.

## 1 INTRODUCTION

Business Process solutions enable enterprises to consolidate and optimize their business operations and to gain competitive advantage in the fast evolving global market. Business process modelling is the activity of representing enterprise processes. In particular, the Business Process Modelling Notation (BPMN) is a standard for business process modelling, based on a flowcharting technique, able to represent complex process semantics. With a broad adoption of Web service technology, business process management solutions (and workflow systems in general) started to include Web service support as a natural component in processes specification.

Model-based user interface design has mainly focused on how to obtain user interface implementations from user interface description languages or task models. Business process models have addressed a different topic: how to organize workflows using business. Business process notations do not seem suitable to specify user

interfaces for those process units that require user interactions nor they provide a modelling methodology for them. Also, Web service specifications and standards do not include a formalism to describe and associate user interfaces related to services, so they have to be composed and authored from scratch depending on platform, media and programming languages constraint. This becomes even more complicated in case of SOA applications based on Web services and designed as Business Processes. Thus, it is important to investigate novel solutions able to integrate business process-oriented approaches with approaches coming from the HCI field, such as task models. They can lead to new methodologies for designing customizable systems supporting business processes, which benefit from model-driven user interface design to support business process management environments with adaptable, process-specific and task-specific interfaces. There is a general agreement on the abstraction layers relevant for interactive systems, like the CAMELEON Reference Framework (Calvary, 2003), and there has been a

considerable amount of work on how to support transformations across such layers in order to address multi-device environments, i.e. (Mori, 2004). In this case the generated user interfaces adapt to the interaction resources available in the target devices. Thus, the methodology proposed in this paper can also support derivations of user interfaces for various types of devices (desktop, mobile, vocal, ...), which can be used depending on the current context and task.

In this paper we propose an integrated approach which combines BPMN notation for business process modelling with ConcurTaskTrees (CTT) for task modelling, to fulfil the design of user interfaces for interactive business processes based on Web services. Lastly, some conclusions along with indications for future work are provided.

## 2 RELATED WORK

The relations between HCI task modelling and business process modelling are stimulating increasing interest in deriving user interfaces for human-based activities in business processes.

In (Traetteberg, 1999) the integration of task modelling with workflow modelling languages is motivated from a general point of view, making the assumptions that workflow models can provide a useful context for task modelling at different levels since they essentially face the same domain and, in particular, low-level workflow activities can be considered high-level tasks in task models, hence a task model can be viewed as a refinement of a workflow model from the perspective of a particular user role. However, differently from our approach, this work is not much focused on business processes based on Web Services, which raise specific design issues.

In (Zhao, 2007), information inference from a business process specification is used within a model-based approach where automatic user interface generation is achieved through a set of transformations that exploit the definition of several heuristic rules to obtain task models directly from business processes. However, in this work, the issue of how to transform a task model into a UI structure is a decision of the UI designer, while in our approach we make provision for several rules and guidelines to move in a semi-automatic way from task models to final UIs. In (Guerrero, 2008) a user interface modelling approach in the context of workflows is proposed but it does not use the BPMN notation. Other works have focused on rapid prototyping of low-fidelity user interfaces mock-ups

using business process models as a starting point: (Sukaviriya, 2007) and (Pontico, 2006) highlight the need of integrating UI aspects in business process models and the fact that business notations, such as BPMN alone, are not suitable to analyze user activities because user interactions are disjointed throughout the process and stress that a mixed user-centred approach can lead to several advantages in eGovernment applications. Moreover, an interesting work (Sousa, 2008b) has proposed a model-driven approach in aligning business processes, expressed using BPMN, with user interfaces, in which assumptions made on associations between elements of those models are exploited to automatically transform business process models into user interface models to then complete the user interface development cycle. Therefore, also the latter work mentioned assumes the concept that the information contained in business processes are not sufficient for supporting the related UI design.

## 3 CONCURTASKTREES AND BPMN NOTATIONS

The strong motivation of workflow systems is to provide automatic support to organisation processes by incorporating the rules that define how activities should be carried out, how they should communicate/coordinate/synchronise with each other, and how to manage the involved information objects while harmonising their solutions with existing operating systems, databases, software applications and hardware infrastructures.

Task modelling deals with similar concepts, as its objective is to identify the activities users are supposed to carry out in order to achieve their goals while using an interactive system and information contained in task models can be used to generate effective user interfaces accordingly.

However, on the one hand workflow systems share some concepts with task modelling, especially when methods based on task analysis are applied to multi-user applications, since both of them cope with identifying roles, specifying constraints between the activities carried out by the various roles for accomplishing their work, the information objects manipulated, and so on. On the other hand, two basic differences can be identified between them; the first one is the granularity of the considered activities: in workflow systems the focus is generally on entire processes at the organisational level, which might even have a long duration, whereas task analysis focuses more on individual

users' interactions with applications, which in some cases can be almost instantaneous. The other difference is the area in which they have been developed: workflow systems originated in the area of information systems, where their original aim was to allow different users to have access to the same information in a consistent manner, while task analysis is basically connected with human-computer interaction, since it provides relevant information that can be appropriately used in the design of user interfaces.

The Business Process Modelling Notation (BPMN), is a visual notation for business process flows modelling, composed of graphical elements, semantics, attributes and properties, which visually compose a Business Process Diagram (BPD) (OMG, 2007). It is conceived to provide a readily understandable formalism by both business analysts and technical developers. BPMN fits well with Service-Oriented paradigms and Web service technology since it can be almost finally mapped to process execution languages (Owen, 2005) in order to obtain an executable process from a BPMN diagram, providing a notation for them. BPMN supports modelling a business process flow using activities, events, gateways for business decisions and flow branching. Activity is a generic term in which are included processes and sub-processes and, when it is not possible a further decomposition, in tasks, which are the lowest-level, atomic activity definition that are generally executed by an end-user and/or an application, like invoking a Web service operation. However, the concept of task in the BPD context focuses on what should be accomplished in performing a task and does not specify how the task is performed. Indeed, it does not provide any formalism to describe all user interactions in accomplishing a particular task when a human intervention is needed. In this case, task modelling from HCI could result useful to describe the user interfaces for the interactive steps involved in the particular human activity.

ConcurTaskTrees (Paterno, 1999) is a de facto standard notation for task modelling, also thanks to the availability of a number of tools that support editing and analysis of CTT specifications. Its combination of hierarchical structures (inherited from Hierarchical Task Analysis) with a flexible set of temporal operators allows designers to easily specify complex interactive sessions.

BPMN and CTT notations share similar concepts and, sometimes even expose similar semantics, these similarities can lead to definition of automatic transformations between notations, as discussed in (Sousa, 2008a), but it is also necessary to take into

account the general lack of support of BPMN for domain data objects, and that the CTT notation, beside direct reference to them, offers a more detailed view on user-applications interactions. So, we believe that an integration between BPMN for general business processes design and CTT in refining the specification of user oriented tasks achieved through the use of Web services based applications, can be useful and suitable in defining a methodology for related user interface design.

The BPMN Task specification includes a TaskType attribute, where a value of Service, Receive and Send task types can be used to specify a Task that provides or uses some sort of service, which could be a Web service or an automated application, whereas User task type value denotes a task where a human performs it with the assistance of a software application and that type is taken into consideration our approach.

These features can be used to describe, at a higher-level of abstraction, a complete SOA application based on Web service technology where: a) Tasks which are conceived as completely automatic activities are achieved through the invocation of Web services operations, can be labelled as Service or Receive or Send task types, b) Tasks in which a human user/performer accomplishes the task using a software application, can be labelled as User task type. In the former case, no human involvement or actions are expected, so no further modelling is required. More interesting is the latter case, in which human activities are required to be achieved and a user interface could be presented to the user in order to accomplish the task. This is the case in which task modelling with CTT helps to define in detail the conceptual model of user interactions. On the other side, also the CTT main concept is the Task, although different from BPMN Task. In CTT, tasks can be used to detail activities with different levels of granularity thanks to the hierarchical structure of the notation which allows to detail them and retain the ancestor's relations.

CTT supports four task categories, which indicate to what agent the performance is allocated: a) Abstraction: which represents complex Tasks (with sub-tasks differently allocated); b) User: denotes a cognitive human activity; c) Interaction: involves a human interaction with the system; d) Application: represents a completely automatic task performed by the system.

## 4 AN INTEGRATED APPROACH

In the proposed approach we make the assumption

that several business activities are performed using Web services and that some of these activities (Tasks) require user interactions. Then, we first model the business process using a standard business notation (BPMN). This is useful to identify the main activities in the process, with large granularity, and the Web services or their compositions that are required to support them. Then, each main activity in the process that requires some user interaction becomes the root for a corresponding task model specified using CTT and describing more in detail how such activity should be performed (see Figure 1). In developing the task models, designers should consider on the one hand the user requirements elicited through interdisciplinary teams and the available Web services, in particular their operations and parameters. Web services can be considered system tasks in the CTT classifications, since they are automatically performed, and the CTT model has to be refined until a system task for each possible used service operation is reached.

Obviously the task model should include not only system tasks but also interactive tasks to describe the required user interactions and user tasks, to indicate tasks that involve particular internal cognitive processing by the user. From the task model then an abstract, platform-independent description of a user interface can be derived. This, in turn, can be transformed into a concrete user interface description ready for the generation of the implementation once the target platform is identified (i.e. XHTML, voice, Java Swing, etc...). The main advantage of this solution is that the business process can be supported by users working in flexible multi-device contexts, in which users can vary the interaction device to use, and still receive user interfaces adapting to the varying interaction resources.

Since a task model can imply the access to multiple Web services, the building of the corresponding user interface can be considered a composition of the user interfaces associated with each Web service. Such composition can be performed according to various dimensions: the abstraction level considered, the granularity of the elements composed (interface elements or groups or entire presentations), the user interface aspects involved (perceivable elements, dynamic behaviour or content), and in which phase the composition is expected to take place (e.g. at runtime or at design time).

When designers have to refine the task model associated with each main interactive activity in the BPMN model, they have to consider the Web services to access and their operations in such a way

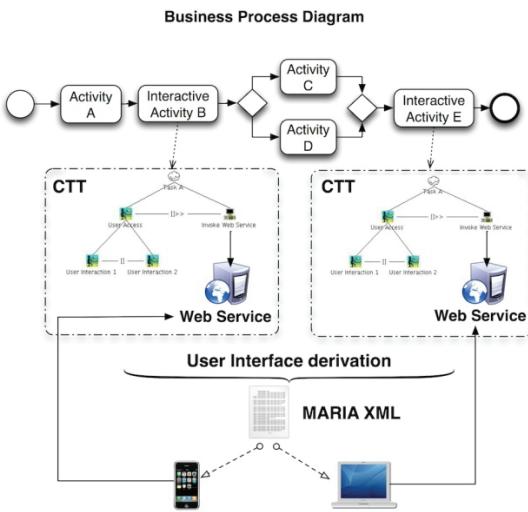


Figure 1: The proposed approach.

that system tasks are associated with the operations to access. The task model is then transformed into a MARIA (Paternò, 2009) specification: a recent XML language that provides the possibility to specify abstract and concrete user interface descriptions. It overcomes limitations of previous languages in this area because it also includes a data model, which is useful to specify the format of the information manipulated by user interface elements; and an event model, which allows the description of flexible interactions with any type of interaction objects. It also provides support for complex scripting and Ajax-style interactions.

In this transformation from task models into logical user interface descriptions we also consider the existence of user interface annotations associated with Web services. They can be useful to provide hints from the service developers regarding attributes to consider when designing the user interface of applications accessing such Web services. For example, such hints can provide suggestions regarding labels or icons to use rather than those automatically generated or regarding the type of interaction object to use for accessing the service or regarding other aspects of the service (e.g. its importance or criticality).

## 5 AN EXAMPLE APPLICATION

We clarify the proposed approach through an example taken from a business application. The BPMN diagram visualised in Figure 2 shows an excerpt of the flow of cooperation occurring between a customer and a sales representative when

some orders have to be created by the customer and sent to the sales manager and some business activities are performed using Web services.

In particular, Figure 2 uses two lanes to show that there are two basic entities/participants (or pools) involved in the process (the Customer and the Sales Manager), which are responsible for two different groups of tasks. Regarding the Customer, whenever she decides that some items have to be bought, s/he has first to login into the system, then s/he has to create a new order (see “Create new order” activity in Figure 2). The latter activity automatically triggers gathering the list of available products. This is done through a Web Service operation invocation associated with the “Get available products” activity in Figure 2. Such an output is in turn sent to another Web service operation (associated with the “Get quotations of products” activity, see Figure 2). In this way, it has been specified a Web service composition. After providing this information to the user, the customer has the necessary information for appropriately modifying the newly created order, by adding further details to it (e.g. by adding/deleting items).

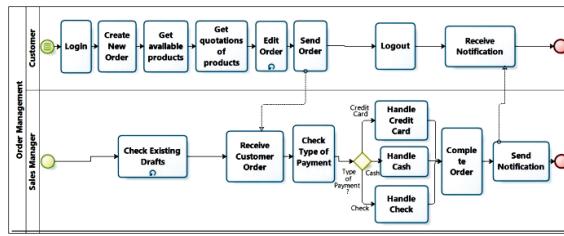


Figure 2: BPMN Diagram (two swimlanes: Sales Manager and Customer).

As soon as s/he finishes to modify the order, s/he sends it to the Sales manager, and then the Customer can logout from the system. After some time, s/he will receive a notification (from the Sales Manager) about the result of her order request.

If we focus on the swimlane of the Sales Manager, her main activity is to iteratively check information regarding drafts that already exist within the system. However, as soon as a new order from a customer is received, s/he decides to handle the newly arrived order: this means to check the type of payment requested by the customer, and then complete the order by also sending to the customer the notification about the result of processing the order.

Within these two lanes there are some activities (Tasks) that can be further refined and specified through suitable task models since they required a direct user interaction. It is the case, for instance, of the “Edit Order” activity performed by the Customer

(see Figure 3 for a refinement of this activity represented as a CTT task model), as well as the “Complete Order” carried out by the Sales Manager user (see Figure 4).

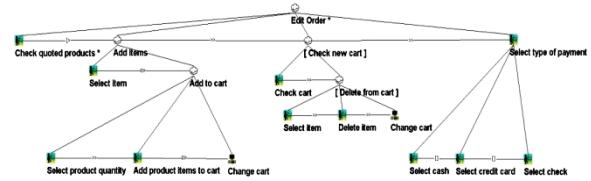


Figure 3: Task model of the “Edit Order” activity (Customer).

As shown in Figure 3, the Customer is supposed to perform several tasks in order to edit the order. More specifically, after having checked the list of available quoted products, s/he can iteratively add (and also delete) items from her current shopping cart. In addition, s/he has also to specify the type of payment requested for buying the items specified. Please note that, as we mentioned before, the input of this “Edit Order” task is actually the result of composing two different services. In addition, please note that the activity “Edit Order” is consistently represented as iterative in both diagrams visualized in Figure 2 and Figure 3 (in the BPMN diagram a “Loop type” has been used, while in the CTT notation an iterative task is specified).

In Figure 4 there is a refinement of the “Complete Order” activity performed by the Sales representative user. Depending on the type of payment requested by the Customer, the Sales Manager activates the concerned check, and the system notifies him about the result of the process.

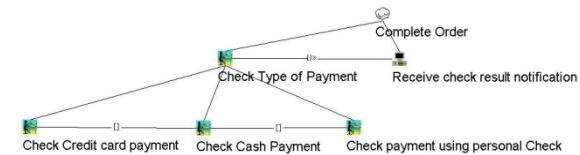


Figure 4: Task model of the “Complete Order” activity (Sales Manager).

Then, the possibility to integrate the business process specified in Figure 2 with the information specified in the task models of Figure 3 and Figure 4 allows us to provide an “extended” diagram in which the associated interactive part of the business activity considered in the example are further specified with CTT. Having done this, it is then possible to derive the user interfaces associated with the various task/activities, by transforming the information contained in the CTT task model into an

abstract description of the user interface (expressed with MARIA XML language).

In addition, also the system-supported services specified in the BPMN diagram can be translated (through suitable transformations) in order to obtain the associated abstract UI descriptions for supporting the access to such services.

After this, and depending on the specific platform at hand, it is possible to obtain a concrete description which is in turn transformed into a final user interface implemented a particular language.

## 6 CONCLUSIONS AND FUTURE WORK

In this paper we present an approach to integrating business process models with task models. The goal is to exploit the potentialities of the two fields in order to obtain a comprehensive approach able to support the design of complex interactive business applications based on Web services in which not only them are composed together, but also their associated user interfaces. We have also shown some example application of the proposed method.

Future work will be dedicated to developing tool support for this method in such a way to use a single environment for editing integrated BPMN and CTT specifications, which can then be used to generate user interfaces for various type of interactive platforms exploiting intermediate logical user interface descriptions.

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