# BP Research Lines at PROS

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## Abstract

This paper provides an overview of the past, current and future research interest of the ProS research center focusing on the Business Process field.

## 1. Introduction

The *Research Center on Software Production Methods* (ProS) has always been interested in the development and application of techniques that improve (in terms of time, quality, and productivity) the construction of software systems. To achieve these improvements, we proposed the use of Model Driven Engineering techniques. These techniques allowed us to specify systems independently of technological details and to (semi)-automatically generate software applications by means of model transformations. Initially, in the early 90s, the research results were sucessfully applied to the development of information systems [10]. Since then, we have applied these results for developing web applications and managing smart homes. However, in the last years, we are being witnesses of how software applications are transcending the barriers of traditional desktop applications. As a result, nowadays we can find many ubiquitous applications that are integrated into the user environment, by means of mobile or embedded devices, to support her daily activities (e.g. to control domestic heating, to check flight schedules or to book accommodation). However, this type of applications are highly complex to develop since they run in dynamic environments, require a high degree of autonomy and adaptation to context, and require new kinds of interaction mechanisms to support everyday tasks. In this context, the ProS is working on research lines that contribute to solve some of the challenges that introduce these type of applications. Specifically, focused on the Business Process Management (BPM) field, the PROS is interested in the role played by business process models in this type of applications.

## 2. Background

ProS members have a strong background in the development of methods for the construction of software applications. Related to the Business Process field, the centre is conducting a research line dedicated to align business processes with IT applications and to solve the challenges that introduce this alignment. Initially, the research work was focused on the development of Web applications from business process models. For this purpose, business process models were introduced within the software development process as main artefacts. The knowledge contained in these models were used, jointly with other models, to build new models (i.e. navigational and presentation models) and to derive (semi)-automatically the corresponding software application in terms of a specific technology. This was possible since the development process was designed using Model Driven Engineering techniques. The whole system was represented by means of models and by the application of model-to-model and model-to-text transformations we could derive the specified system into an executable code implemented in a particular technology. Another challenge faced in this line was related to the integration of the physical and virtual worlds. Information Systems can be aware of physical objects thanks to Automatic Identification (Auto-ID) technologies such as Radio Frequency Identification (RFID). However, due to the technological heterogeneity in Auto-ID and the fast-changing requirements of business processes, there was a need to move from ad-hoc solutions to sound development methods in order to assure the quality of the final product.

Therefore, considering the specific requirements of the linkage between physical and virtual worlds, this work resulted in the definition of a development process that covers from the specification to the implementation of this type of systems. Again, this work was based on Model Driven engineering foundations, what allowed us to systematize the process to improve their construction, maintenance and evolution. Another research line not directly related to business processes but whose results are being applied in this field is related to the Autonomic Computing field. In this case, considering the emerging necessity of adaptation in highly dynamic systems such as context-aware or ubiquitous systems, the research challenges that were faced are to provide new guidelines, techniques and tools to help autonomic system development. To handle variability at run-time this work provided a Model-Based Reconfiguration Engine (MoRE). Given a context event, MoRE queries the variability models to determine how the system should evolve, and then it provides the mechanisms for modifying the system architecture accordingly. To successfully move towards implementing the key self-management properties associated with autonomic computing, this work combined Model Driven Engineering and Software Product Lines techniques.

## 3. Current Research

There are several research lines in which business process modelling and execution are considered. In this section we provide an overview of the specific aspects in which we are interested in.

### 3.1. Service and Business Process Variability

In some domains, applications are governed by business processes to achieve a specific goal. Considering a dynamic context where applications should reconfigure and adapt to satisfy new requirements, application changes should be made according to their underling business processes.

Therefore, in this research line we are interested in dealing with variability issues in business processes. In order to properly deal with these issues we have to considered variability from two complementary points of view, the modelling and execution point of view. On the one hand, from the modelling point of view, it is necessary to provide techniques that help and assist the business analyst during the definition of business process models. Business process modelling has been recognized as a non-trivial task and its results strongly depend on the skills of the modeller [9]. The challenges that arise at this point relate to the definition of reference process models and their variants:

- Identification of the common elements of a process model
- Identification of the process parts that vary depending on the context.
- Identification of the different alternatives (variants) that fit in each "whole" of the process.
- Deciding the granularity of the variants.

The way in which these challenges are faced will determine other aspects such as (1) model and fragments reusability, (2) model scalability or (3) model change propagation. An important aspect to take into account during the modelling phase is that this is going to be performed by business analysts. This type of stakeholders has a deep knowledge on the domain (business) but at the same time are not experts on software modelling. For this reason, it is necessary to provide languages and techniques that are close to their knowledge.

Within the business process modelling area, several works have been developed to deal with variability modelling. These solutions either (1) extend existing languages, such as EPC [12] or BPMN [11] to explicitly distinguish between normal branching and variability at design time or (2) define mechanisms to model separately the base case from the possible variants [6]. Obviously, the former solution introduces complexity to the model in terms of size (all the possible variants are modelled within the same diagram), reusability (same variants have to be included each time in the diagram) and maintainability (changes in a variant that is used more than once has to be propagated accordingly). Regarding the latter solution, even though it solves the drawbacks found in the former, it still shows limitations when defining variants. For instance, it is not possible to reuse variants within own the definition of variants.

On the other hand, from the execution point of view, business process models are seen as a composition of services that should change according to the current context and the variants that were previously identified during the modelling phase. The challenges that arise in this case are:

- The reconfiguration of already running process instances
- Guaranteeing the correctness of the new composition.

There are several works that deal with variability at the execution level. In the literature we find for instance VxBPEL [8], an extension to the WS-BPEL language to deal with variability. However, this solution just allows managing variability at run-time that has been previously considered at design time. On the contrary, we are interested in achieving business process reconfiguration when new variants (variants that were not considered during design time) appear.

To face these problems, those arising at the modelling and execution level, we propose to support the business process changing nature by the application of Model Driven Engineering techniques. At the modelling level we propose the use of a DSL to properly specify BP variability (in particular we propose the use of CVL (Common Variability Language). At the execution level we propose the use of business process models at run-time to decide which WS-BPEL configuration is the most adequate at each moment. In addition, MDE techniques can be also used to move from business process modelling to execution. These techniques would allow us abstracting all the complexity required by the underlying technology (e.g. WS-BPEL and Web Services) to successfully implement process variability.

### 3.2. Physical Mobile Workflows

Business processes in organizations usually involve real-world objects such as baggage in an airport or books in a library. However, there is a gap between the real world where things happen and the digital world where information is handled. The Internet of Things (IoT) vision [4] is about reducing this gap between the physical and the digital world in order to make daily activities more fluent. For example, a librarian can access the book-related services just by approaching his/her mobile device to the book.

Existing business process management solutions are mainly focused on the digital world, providing orchestration capabilities for Web Services (e.g., based on WS-BPEL). Automatic identification (Auto-ID) technologies such as RFID have been successfully applied for long to automate workflows in different areas such as manufacturing and logistics, retail, animal tracking, and transport and admission ticketing [14]. Different proposals exist with the goal of linking the physical and virtual worlds at the technical level. Proposals such as [3] [7] [13] provide middleware that automatically processes identification events. However, the way in which the physical-virtual linkage has not only impact at the technological level but also at process design. We believe that it is important to describe the physical-virtual linkage for a workflow at design time since the way in which a business goal is achieved depends on the properties of the physical-virtual integration. Certain business models are only feasible with an adequate level of automation in the physical-virtual linkage [2]. For example, using RFID for identifying products in a supermarket allows checkout to be automated, and does not require the participation of a cashier in the process. Thus, when modelling a business process it is not possible to determine which tasks are required for handling physical elements (e.g., requiring a cashier to handle them or not) if there is no notion of how they participate in the process. Models are key in our proposal to provide this notion by linking identification requirements to technological requirements in a gradual manner.

In this context, we have been developed a model-based architecture named Presto [5] to capture the concepts that are involved in the physical-virtual linkage for business processes, and derive a software solution by means of Model Driven Engineering techniques (currently generation is supported for the Android platform). The resulting system is capable of presenting to each participant in the process the services that are associated with their physical environment according to their role in the process and the current pending tasks.

## 4. Future Research

Regarding the future research related to business processes, we are planning to (1) apply the results obtained in the business process variability research line to the Method Engineering research line (see section 4.1) and (2) improve the coordination between embedded services and users to provide workflow driven services in an adequate level of obtrusiveness (see section 4.2).

### 4.1. Method Engineering

Within the context of this research line, we are interested in giving support to the limitations found in the Situational Method Engineering (SME). This discipline deals with the adaption of Software Production Methods (SPMs) and tools to specific Information System Development projects. Adaptation is required from two different perspectives which are the *product* and the *process* of the SPM. Focusing on the process perspective, we are planning to apply the research results obtained in the BP Variability line to the current challenges of the SME. These challenges are (1) the proper definition of process variability at design time (within a CAME environment) and, (2) the reconfiguration of the SPM supporting CASE tool based on the process (and variability) definition. Therefore, the main outcome expected from this research line is, in a first stage, a methodological framework for the definition of SPMs and for the automatic construction of their supporting tools and then, in a second stage, we plan to enrich this framework to deal with the required adaption of SPMs and tools according to the current application context (e.g. project resources or time constraints).

### 4.2. Obtrusiveness Orchestration

Service orchestration is normally performed in terms of functionality. Nevertheless, in practice we found that in our experimentation with physical mobile workflows most of the complaints were not related to the functionality provided but the way it was provided instead. In particular we are carrying out research in orchestrating the attention resources of the user.

Imagine a future in which your fridge announces to you the recipes that can be prepared with the available goods, your TV tells you that your favourite program is beginning, the book you want to start reading is suggesting you try other similar books; and all of this is happening at the same time. Clearly living in such an environment on a daily basis would be annoying. On the other hand, if services behave in a completely automatic manner (without requiring human input), users can feel that their environment is out of their control, which is also undesirable.

Since user attention is a valuable but limited resource, we believe that an environment full of embedded services must behave in a considerate manner, demanding user attention only when it is required. In the same way that a musical orchestra requires a conductor to indicate who should play and the tempo to be followed, we propose to incorporate orchestration techniques in smart environments, in order to achieve a balance between automation and user participation. We are currently exploring the use of orchestration techniques and model-based reconfiguration [1] to provide the services that are part of a workflow at an adequate level of obtrusiveness (e.g., making a mobile device rang only if the message relevance and the context is appropriate for doing so).

## 5. Conclusions

This short paper has provided an overview over the past, current and future research interests of the ProS members in business process field. Nowadays, the challenges associated to the presented lines constitute very hot topics in the business process field. In addition, the background and experience of the ProS members in business process modelling and execution, model driven engineering and system variability constitute a proper context to face the presented challenges.

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