Business Process Configuration with NFRs and Context-Awareness

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Abstract. **[Context]** Business process models are an important source of information for the development of information systems. Good business processes need to be up-to-date and automated to represent the organizational environment. Representing and configuring business processes variability for a specific organization allows the proper execution of processes. In addition, dynamic environment calls for flexible configuration processes that can meet stakeholders' goals. **[Question/Problem]** Even though current approaches allow the representation of variability of business process models, the selection of business variants in a given context remains a challenging issue. **[Main idea]** In this proposal, we advocate the use of Non-Functional Requirements (NFR) and context-awareness information to drive the configuration of process models at run-time. In particular, we evaluate the use of NFRs to describe the stakeholders' preferences. **[Contribution]** We propose a model-driven business process configuration approach that is driven by NFRs and contextual information.

Keywords: Business Process Configuration, Non-Functional Requirements, Context-Awareness

1 Introduction

Business process models are designed to represent organization practices that create value to a business. By modeling the business processes in terms of activities, the stakeholders can analyze, control and specify systems that will achieve their business goals. Despite the existing methodologies and frameworks to support the development of such systems, a new challenge arises when considering dynamic environments. Sometimes the surroundings of an organization may affect the execution of business processes, which in turn may impact vital areas of a business. In this kind of dynamic environment, variations of external factors such as weather, seasonal variation on demand, dependency on the supply chain and so on, may impact the ability of the business process to properly maintain its activity. In this context, business process flexibility is required to allow continuity in the business process even under these dynamic circumstances. For self-adaptive systems, the adaptation strategy is supported by software systems that automatically evaluate the situation and use some mechanism to change the business process being enacted, in order to fit the current needs.

In order to face the challenge of providing guidance and support for dynamic business processes configuration we proposed the Business Process Variability Configuration with Contexts and NFRs (BVCCoN) approach [1]. The configuration of a business process is driven by various additional models including information about contexts that affect the process and quality attributes that influence the choice of variants. BVCCoN also represents the variability of business process models, expressing alternative ways to perform the business process represented by BPMN models. This variability description is essential to achieve flexibility, albeit not enough to do it automatically at run time.

We also use Non Functional Requirements (NFRs) [2] models to represent stakeholders' preferences over process variants, allowing the identification of the best configuration when a change in the process is required. Moreover, we make use of context-awareness [3] to trigger these changes and to define what are the valid variants in a process model for a given context. The context-awareness is also the mechanism that aligns the process with the environment and allows the identification of requirement for runtime reconfiguration.

This paper is organized as follow: section 2 presents the objectives of our research. In section 3, we detail the scientific contributions. In section 4 we present related works. At the end we present on going and future works.

2 Objectives of the research

The core objective of this research is to provide guidance to the configuration of business process models, to offer a mechanism that take into account multi-criteria during configuration, as well as a way to reduce user's intervention during the configuration. Therefore, we propose the Business process Variability Configuration with Contexts and NFRs (BVCCoN) approach. The BVCCoN is a business process configuration approach that aims to provide support to configuration of business process based on NFRs and contextual information. It is composed by two parts the BVCCoN model and the BVCCoN process. The model describes the information necessary to perform the configuration including the variability description, the NFR model and the contextual information. The BVCCoN process identifies variation points and variants in a business process model. Moreover, a selection mechanism is used to create new business process models (configurations) with the variants that better suit the system's context and its NFRs. An essential step in this approach is the identification and linking of business process variants with NFRs and contextual variables, which will guide the configuration of the business process.

3 Scientific contributions

The goal of BVCCoN model to provide a variability model which can be applicable to business process models expressed in BPMN language, and integrate Non-Functional Requirements and Contextual information with the variability model. In order to formalize the BVCCoN model we described an abstract and concrete syntax that integrates the various models in a same framework. The meta-model uses a BPMN meta-model to represent business process models. We also extend other models to represent perspectives of variability, NFRs model and Context model. These models are designed following the BVCCoN process. The process in BVCCoN approach is presented in Figure 1. It is composed of five main tasks: Elicit Variability, Describe Variability, Analyze Context, Link NFRs and Variants, and Perform Configuration.

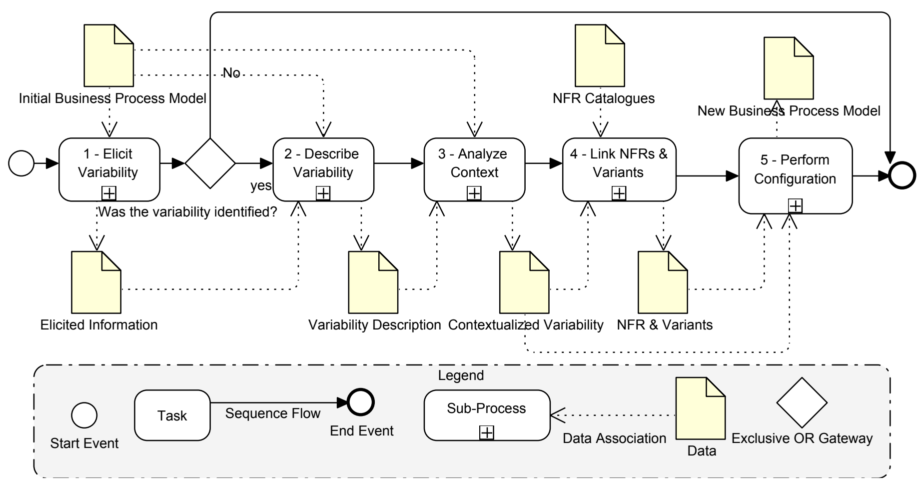

Fig. 1. Process of the BVCCoN approach

The variability elicitation starts by analyzing a reference model. We derived a set of questions to help the identification of process variants. By applying these questions to the model elements we can identify some variations in the way the process is performed. This raw data will be analyzed and then be represented as variants, variation point or as contextual information. It is up to the analyst to decide which data is actually relevant to the process in question. Based on the business analyst knowledge the information is described as process parts using BPMN. The process parts are associated to variants and grouped in variation points.

The process variability is expressed in terms of variants and variation points. The Variation Points indicate where the process can vary, by means of *begins* and *ends* points. The idea is to indicate how and where the main flow (reference process) can change. The variation points have an operator that indicates how the variants are grouped - they can be AND, OR, or XOR. The variants are associated to business process fragments. The use of process fragments allows the business analyst to describe coherent processes that will still be valid after the process change. To do that it is necessary to assure that the granularity of the process parts are equivalent to the variation point, and that the begins /ends of both match.

After the description of variability, the next step is to associate contexts to process variants. The contexts describe states of the world that can affect the process. In some cases the process may be affected by several factors that can occur within or outside of the control sphere of the organization, such as the availability of resources or changes in weather conditions. We represent the contextual information through logical expressions that can be assessed through data monitoring. The contextual data may be obtained by sensors, by consulting information services, by analyzing profiles, or by user inputs.

We propose the use of NFRs to describe the quality attributes that may be relevant for the stakeholders. In our approach we use the qualitative analysis, where the analyst expresses the way he believes a variant may affect the process configuration in a controlled range: from the most positive (++) to the most negative ($--$). Based on this analysis and using prioritization it is possible to select a configuration that is closer to the analyst expectations. Of course the model obtained by this NFR is highly subjective and depends of analyst. Hence, alternative models could have been generated.

The last step of BVCCoN approach generates a new business process model as output. In this step we consider the Variation Points and the Variants of the business process, and how they impact the non-functional requirements. This information can be used to support the configuration itself. It can be performed based on Variants selection for the most critical NFRs. Since we are dealing with runtime adaptability, it may not be possible to rely on experts (e.g., they could not be available). Thus, the definition of priority allows solve potential conflicts at runtime. In our proposal NFRs with higher priority have higher weights. In order to obtain a ranking that takes into account the NFRs contributions, we adopted the Analytic Hierarchy Process (AHP) method which generates a global preference measure based on the choice among alternatives. The contexts defined in our model will be monitored to identify changes in the context variables. Once context changes are detected the selection algorithms run and define the variants that will be part of solution. Using model transformations designed in a specific language (QVTO), we generate new business process models with the variants selected by the algorithms.

Figure 1 presents an example of our proposal. The model represents the check-in and boarding process in an airport domain. The business process in the bottom is a reference process that represents the standard workflows with activities such as *Verify passport or identification*, *Perform Check-in*, *Baggage Drop-off* and so on. The reference process is marked with Variation Points (triangle shape). For example, the VP1 covers three tasks and is associated with the

Perform Check-in, *Perform Check-in manually*, and *Perform On-line Check-in* variants. Observe that variants may be associated to contexts (box shape), which indicates when variants are valid. In the example, the *Perform On-line Check-in* is valid when passengers can check-in for the flight through a website. Moreover, the model also presents a representation of NFRs contribution. The NFRs are represented by clouds and linked to variants through contribution links.

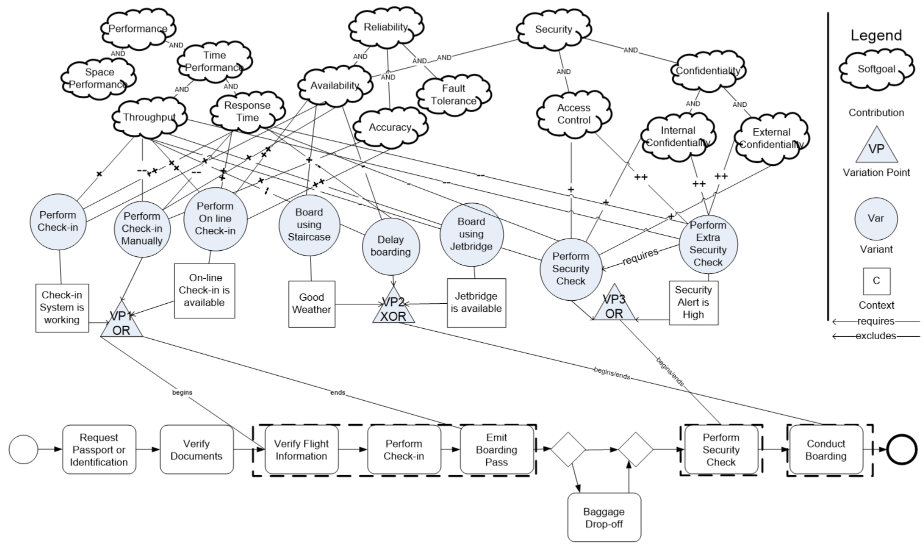

Fig. 2. Example of BVCCoN Model

4 Conclusion

The adoption of NFRs as configuration criteria is one of the key points in the solution proposed by BVCCoN. NFRs describe preferences of stakeholders over variants allowing the selection of the preferred variants in the situation. It is worth mentioning that in BVCCoN we are not dealing with the standard satisfaction notion of NFRs. Since we are dealing with a mutable set of variants, the analysis of NFR satisfaction may not give proper results. In order to address this limitation we applied the Analytic Hierarchy Process (AHP) as part of the selection mechanism. Since AHP is a robust multi-criteria decision analysis method, it can deal with the inconsistencies and still produce a reasonable result.

The second main decision during in BVCCoN design was the use of contextual information to trigger changes in the process models. With that we provide the means to perform process configuration at runtime.

5 Ongoing and future work

Currently, the BVCCoN approach tool support is still under development. We already have concluded some modules such as the BVCCoN modeling tool and the model transformations. Moreover, the algorithms used in the configuration have been implemented as proof of concept and are in process of integration to create the first prototype. However, an integrated environment is still far from the end.

As future work we can highlight: the development of the runtime modules including the context monitor and the integration with a BPMN execution engine, as well as to finish the implementation of tool support. Moreover, we also plan to improve the user interface of our BVCCoN tool.

We may also investigate the use of metrics as contextual information as proposed by [4]. Some study is still necessary to see how to adapt our approach to the use of metrics. One possible solution is to try to include this information during the selection of variants since the AHP supports numerical values. Another solution may be to investigate if it is possible to the represent metrics as context information.

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