Business Capability-centric Management of Services and Process Models (Extended Abstract)

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Abstract. This research details a concept model for describing the business capability of services and business processes from a functional perspective in terms of actions together with related business properties. Furthermore, this work proposes the aggregation, indexing, discovery and design of configurable models for services and business processes using the concept of business capability.

Keywords: Business Capability, Services, Business Process, Aggregation, Indexing, Discovery, Configuration

1 Introduction

With the advent of Industry 4.0, more and more companies are actively working on digitising their assets (i.e., services, processes, etc.) for better control, collaboration, modularity, analysis, etc. By 2020 more than 80% of companies will have digitised their business processes and value chains. This creates more services and processes, making their indexing, discovery, configuration, etc. more challenging. Thus, properly digitising those assets needs a proper data model to describe them, and proper algorithms for indexing, discovery and configuration.

In this context, this research proposes a concept model for describing the business capability of services and business processes from a functional perspective in terms of what do they achieve together with related business properties [7, 1]. Furthermore, this work proposes the aggregation [6], indexing and discovery [8], and design of configurable models [5] for services and business processes using the concept of business capability.

The remainder of this paper is organised as follows: Section 2 introduces the business capability meta-model used for designing domain specific capabilities for the annotation of services and process tasks. Section 3 gives on overview of the capability aggregation algorithm proposed as part of this work. Section 4 investigates the use of Formal Concept Analysis for the indexing and discovery of business capabilities. Section 5 discussed the use of business capabilities in the design of configurable process models. Finally, Section 6 concludes the paper and discusses future research directions.

2 Towards a Structured Business Capability Description

The first objective of this work is to propose a conceptual model for describing Business Capabilities [7, 1]. The proposed model is implemented as a set of ontologies that can be used for creating semantic annotations of business process models or services. In this work, I consider a business capability as standalone entity that can exist outside the scope of service descriptions or invocation interfaces. A service, a computer program, a business process or even a manual task can be described using the business capability concept.

In a very simple definition, I consider a business capability as a set of actions enriched with zero or many properties. Properties allow to refine further the action that is taken for a domain related ontology. More formally, as shown in Fig. 1, in the proposed model capabilities are defined as an *Action Category* and a set of *property entries*. The *Action Category* concept is similar to an action verb [14] that defines, in a natural language, what is the action being described. Different to the concept used by Oaks et al. [14], I consider the category as a concept from a domain related ontology that comes form a shared agreement on its semantics. A category is a specific property that is present in all business capability descriptions via the property *achieves* (See Fig. 1). A *property entry*, defined with respect to certain declaration, is a couple *(property, value)* where *property* is a *domain-specific functional feature* or a *domain-independent non-functional property* and *value* is the value or the possible *values* that a property can have. Both *property* and *value* refer to ontological terms. For example, shipping services can be described using the action category "shipping" that can be extended with properties reporting on the "source address", "destination address" , etc.

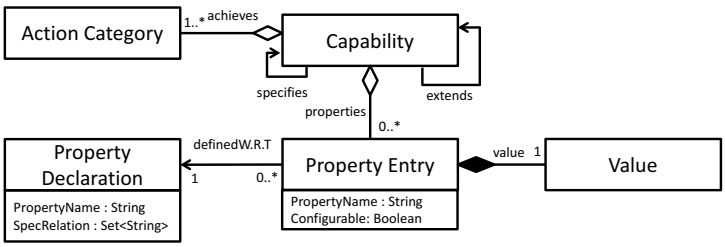

Fig. 1. Business Capability UML Class Diagram

The model was validated via Bunge's theory of ontology [2] to verify its syntactic correctness: no constructs' redundancy and no semantic ambiguity. Interviews with domain experts show that the model is suitable for end-users understanding. However, tool supports are required for facilitating its adoption.

3 Aggregation of Business Capabilities: Determining the Business Capability of a Process Model

The second objective of this research is to propose an abstraction technique that allows moving from an entire process model to its functional description by aggregating the business capabilities of the process elements into a single one. This feature is necessary when a user wants to have an overview of the capability of an entire business process model rather than a single activity.

In this context, the contribution is an algorithm that automatically generates the aggregated capability of an entire capability-annotated business process model [6]. It is a capability propagation algorithm that starts from the initial node of a process model and traverses the model by firing one node at a time. Each node introduced new changes to the propagated capability. The algorithm is formally verified with formal semantics using Petri Nets [15] and implemented in a tool to support the validation by interviewing domain experts. The experts find that the approach is very well aligned with their expectations, the results of the aggregations are easy to interpret/understand and the tool support was simple and intuitive to use.

4 Indexing and Discovering Business Capabilities

The third objective of this work is to explore the use of Formal Concept Analysis [11] (FCA for short) for providing efficient indexing and discovery of business capabilities that are described using the proposed model [8]. Rather than inventing a new set of indexing and discovery algorithms, I reused FCA as a mathematical classification tool. Using FCA has the advantage of benefiting from already well established indexing and search algorithms that I have adopted for discovering a set of service descriptions (i.e., capabilities).

In the evaluation of this work [8], I used in a first experiment, a set of real-world sensor services descriptions to validate its applicability in managing a reduced number of capabilities. In a second experiment, I used synthetic data set and measured the time required to create and traverse an index of a large number of capabilities with different configurations. Results of the evaluations show that the approach is effective and performs better than related approaches as shown in Table 1.

5 Using Business Capabilities in the Design of Configurable Business Process Models

The fourth objective of this research is to reduce the business process modelling effort when using configurable process models by proposing an algorithm for creating business capability-annotated configurable business process models that capture configuration options in terms of business capability features.

After the analysis of reuse-oriented business process modelling techniques in order to find how capabilities were used and how can the business capability

Table 1. Comparing Time Performances of Indexing Approaches

Indexing Mechanism	Time Performance
Inheritance between OWL-S services [3]	N/A
Topic extraction and Formal Concept Analysis [13]	size: 1088 services, query response time between 300 and 3000 ms
Reasoning-based matchmaking [18]	size: 50 services, index construction + advertisement time: $\sim$ 4 s
Numerical encoding of ontological concepts and codes comparison [17]	size: 100 services, index construction + advertisement time: $\sim$ 500 ms
Capabilities Indexing using Formal Concept Analysis [8]	size: 1000 capabilities, index construction + parsing time: $\leq$ 25 ms

model contribute to this area [9], I found that configuration-based modelling was a suitable starting point. The idea is to start from a reference process model [16] (called a configurable model) and tailor this model to meet the end-user needs by enabling or disabling several branches of the model.

The current state of configurable model requires an extensive process modelling techniques to carry out proper configurations (captured in terms of model restrictions and parameters) or extensive manual effort for creating an abstract configuration layer [12] that reflect the business needs of the end-user.

I suggest in this work the early integration of business capability descriptions of activities in process models and proposed an algorithm for creating configurable models that capture configuration options from a functional perspective (capabilities parameters) in order to shift the configuration from manipulating the model directly to manipulating the parameters of its capabilities. My proposed solution [5] has been tested on real world business process models from municipalities (used in existing case study [10]) and customs clearance procedures. Furthermore, I carried semi-structured interviews with domain experts to assess the usefulness of the proposed approach. Results show that the experts are familiar with reference models and the proposed work simplifies the understanding of configuration options and the impact of configuration decisions. However, the current state is not mature enough to be integrated in their systems.

6 Conclusion

The core contributions of this work can be summarised as follows: (1) a capability conceptual model for describing the action performed by services and process models, (ii) an algorithm for the aggregation of business capabilities that is comparable to process abstraction techniques, (iii) the validation of the applicability of formal concept analysis for the efficient indexing and discovery of capabilities and (iv) an algorithm for automatically creating a capability-annotated configurable process model by merging a set of process variants. Further research directions can be explored for each of these contributions that have beend discussed in details in my thesis [4].

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