A Business Process Services Portal

IBM Research Report RZ 3782

Cédric Favre[1], Zohar Feldman[3], Beat Gfeller[1], Thomas Gschwind[1], Jana Koehler[1],
Jochen M. Küster[1], Oleksandr Maistrenko[1], Alexandru Marinescu[1], Biplav Srivastava[2],
Hagen Völzer[1]

[1] IBM Research - Zurich, Rüschlikon, Switzerland
[2] IBM Research - India, New Delhi, India
[3] IBM Research - Haifa, Haifa, Israel

Abstract. We introduce the Business Process Services Portal as an approach to make business processes more actionable and to reduce the entrance barrier for tool developers in adopting novel process-related technologies. The business process services portal makes several process-related web services available in a tool-independent manner, relying on REST technology and making use of the BPMN 2.0 standard. The current set of services includes for example the hierarchical decomposition, control flow analysis, comparison, simulation, and summary of business processes. The provisioning as services makes it easy for third party tools to include and further compose the technologies based on their needs. In addition, a portal providing a web-based graphical user interface helps human users to explore and familiarize themselves with the services.

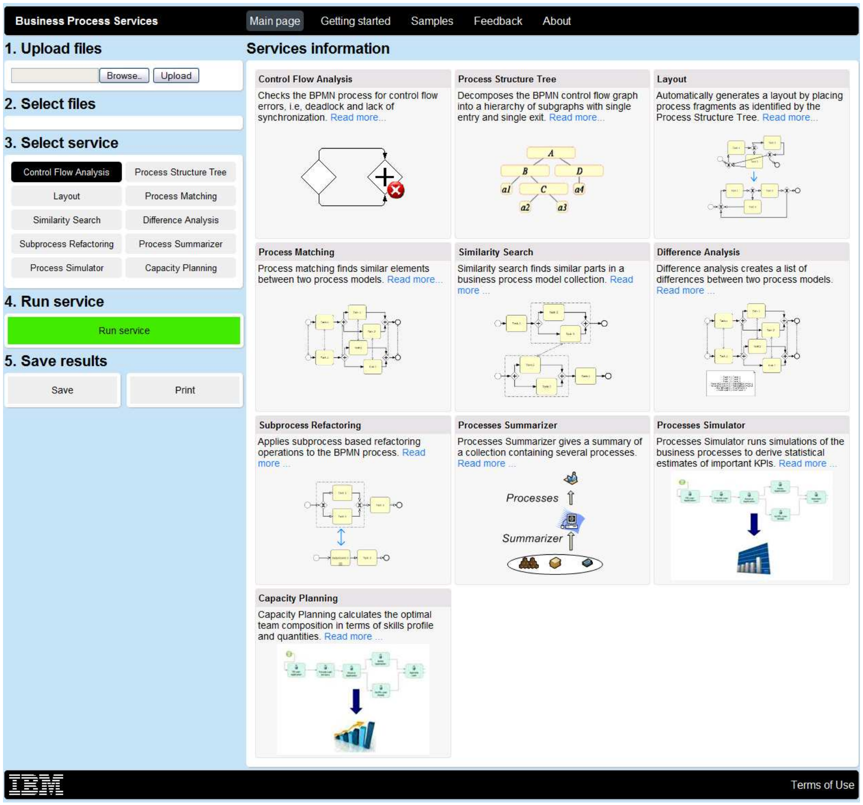
1 Motivation

Many interesting technologies have been developed in the past that help users gain additional insight into their business process models. Usually, the algorithmic solutions underlying a technology are published in a research publication and a prototype is implemented in some business process modeling tool. Unfortunately, this approach makes it very hard for other researchers to reuse and extend existing technology. In order to do so, they often need to reimplement an algorithm based on the publication that omits relevant details. If the prototype is made available for download to other users, reengineering of the code is frequently time-consuming and not always an option of choice. Typically, the prototype is part of a larger tool and it is hard to refactor it for use in a different context, due to missing componentization. Frequently, the user interested in a technology also discovers that only a subset of models in a given process modeling language is covered and that other technical requirements remained unaddressed. Consequently, reusing a technology is very expensive and often ineffective. More than a few reuse attempts have failed at an early stage.

With the Business Process Services Portal, we present a software vision for Business Process Management (BPM) where tools are developed as an assembly of distributed services encapsulating existing BPM technologies and simplifying their reuse. Human users can explore the functionality of services through a graphical user interface, whereas tools can leverage the services following common principles of a service-oriented architecture.

2 Portal Overview

The Business Process Services Portal is publicly available via the IBM Research Labs Experimental Technology site at *http://process-services.researchlabs.ibm.com*. It features an evolving set of services that address various needs of stakeholders in business process management. A business process modeling tool can include and benefit from an available service by exploiting its REST interface and easy-to-use Java stubs. A human user, for example a business analyst, can try out the services using the graphical user interface provided by the portal. Service documentation, an intuitive user interface for humans to try out a service, and sample data are available at the portal. IBM researchers benefit from the portal, because it allows them to make their technology available in a tool-independent manner to a wider audience and to get early feedback on the functionality and non-functional properties, such as for example performance and consumability, of a service.



Control Flow Analysis
Checks the BPMN process for control flow errors, i.e, deadlock and lack of synchronization. Read more...

Process Structure Tree
Decomposes the BPMN control flow graph into a hierarchy of subgraphs with single entry and single exit. Read more...

Layout
Automatically generates a layout by placing process fragments as identified by the Process Structure Tree. Read more...

Process Matching
Process matching finds similar elements between two process models. Read more...

Similarity Search
Similarity search finds similar parts in a business process model collection. Read more ...

Difference Analysis
Difference analysis creates a list of differences between two process models. Read more ...

Subprocess Refactoring
Applies subprocess based refactoring operations to the BPMN process. Read more ...

Processes Summarizer
Processes Summarizer gives a summary of a collection containing several processes. Read more ...

Processes Simulator
Processes Simulator runs simulations of the business processes to derive statistical estimates of important KPIs. Read more ...

Capacity Planning
Capacity Planning calculates the optimal team composition in terms of skills profile and quantities. Read more ...

Fig. 1. User Interface of the Services Portal.

With the increased adoption of the BPMN 2.0 standard, many tools move towards a standard representation of business process models. Furthermore, the BPM community focuses on the semantic properties of the BPMN language when developing algorithmic techniques that provide further insight into these models. This facilitates the reuse of existing BPM technologies in different environments. Finally, the need for reuse increases as users in general are becoming more demanding in what they want to achieve with business process models.

The graphical user interface of the portal is shown in Figure 1. Note that the set of services on the portal is changing and it may happen that not all described services are always online. Some services may also exhibit a changed behavior due to our ongoing research and new services, not described here, may appear on the portal at anytime, whereas others get removed.

3 Summary of the Current Set of Business Process Services

The following services are available on the portal at the time of writing of this technical report:

Process structure tree generation: This service computes the process structure tree (PST) [7] for a given business process. The PST is the result of parsing the control-flow graph of a business process model into a hierarchy of subgraphs, called *fragments*, with a single entry and single exit. While this service may provide limited value just by itself, it is a core component of many other services, viz. control-flow analysis, layout, process matching, similarity search, or subprocess refactoring. The PST can be thought of as a parse tree of the control-flow graph of the business process that allows different applications to analyze the business process by analyzing its fragments in isolation, which helps to deal with the complexity of larger business process models.

Control-flow analysis: This service checks the soundness of a process, i.e., the absence of deadlock and lack of synchronization errors in its control flow. The analysis is performed using state space exploration. This service uses the PST to decompose the process into fragments. Each fragment can then be analyzed in isolation, which speeds up the analysis. Moreover, many fragments have a simple structure that can be analyzed efficiently using heuristics. The fragment decomposition makes it possible to detect multiple errors in one run of the service with each error localized in a specific fragment. More details are given in [1].

Automatic layout: The automatic layout service determines how to arrange the activities and gateways in a business process model to facilitate human comprehension. It uses a linear time algorithm to lay out the control-flow graph of a process model. The algorithm reuses the process structure tree service to compute the hierarchy of so-called Single Entry and Single Exit (SESE) fragments. Once the fragments are computed, the algorithm categorizes the fragments into sequence, loop, and unstructured fragments and applies specific layout methods to arrange a fragment category. The layout algorithm for unstructured fragments is based on a spanning tree computation of the workflow graph of a business process model.

Process matching and difference analysis: Process matching establishes a mapping between the elements of two process models, which can for example be used to compute their common parts and differences. The current version of the process matching service matches the activities of two process models based on their name similarity using the string-edit distance and then aggregates this matching into a matching of fragments reusing the PST of the models. The difference analysis service takes two process models and a matching as for example computed by the matching service as input and returns a difference model as described in [3, 5, 2].

Similarity search: The similarity search service analyzes a collection of business process models to find similar parts of processes which occur in different processes. It makes it possible to identify redundancies and differences between two or more process models, within a process model collection, or between two different process model collections.

More precisely, the similarity search compares all processes one by one, and tries to find pairs of tasks with similar names in them. Based on these task pairs, similar process fragments between the two processes are found. For aggregating tasks into sets of tasks, so-called fragments, the refined process structure tree is used. Each pair of similar process fragments is evaluated using several measures, which describe how well the fragments match under different viewpoints:

- Quality: the average similarity of the matched tasks.
- Completeness: the percentage of tasks that are matched.
- Jaccard: the number of tasks that occur in both fragments, i.e., the number of matched pairs of tasks in the two fragments divided by the number of tasks which occur in only one of them.

The output of the service consists of a list of fragment pairs found, grouped by pairs of processes. The fragments pairs are filtered as follows: If there are several fragments which contain the same set of matched tasks, then only the fragment with fewest unmatched elements is displayed. Current work investigates the use of graphical visualizations to provide more detailed insights and improve the consumability for human users on large process collections.

Processes summarizer: A large number of processes, sometimes in different notations, are being created, stored and reused during business process driven IT implementations. However, a user today can get little insight from such a collection other than to search it with a keyword based query interface. In response, we consider the problem of summarizing processes in a collection and provide a flexible solution that is agnostic to any input representation. The service works on any available type of process content ranging from metadata, syntactic step information, process features interpreted as semantic annotations to multi-dimensional textual content. The summary provides insights about what the repository contains at the aggregate level as well as in subsets (clusters) of processes using an extensible set of process distance measures [6]. Applying the technique on diverse process repositories consisting of hundreds of processes has shown that the technique can shed correct and valuable information where none existed before.

Subprocess refactoring: Re-organzing the subprocesses within a business process model is one of the key changes applied during process modeling to keep the process model readable and well-structured. The re-organization includes the disaggregation of an existing subprocess and the embedding of the subprocess elements into the surrounding parent process as well as the selection of a set of process elements for aggregation into a newly created subprocess. The subprocess refactoring service provides both capabilities. It extends our previous refactoring implementation to extract and inline subprocesses for IBM WebSphere Business Modeler [4] to BPMN 2.0 models.

Processes simulation: Simulating the business processes fluent operation is one of the most vital ways to obtain a sense about the expected performance. The simulation model is built from the business processes models and additional operational details such as typical (stochastic) process times and rates, resource requirements for each activity of the processes and the resources availability. This service runs Monte-Carlo simulation in order to provide statistically accurate estimations of diverse Key Performance Indicators (KPI) such as the expected time from initiation until completion of the processes, the probability to meet the processes deadlines, etc.

Capacity planning: This service proposes resources capacity levels that maximize the business value with respect to some objectives such as staffing costs and service levels. The resources that handle the various activities of the business processes can be either skilled personal or equipment. The capacity planning is based on Monte-Carlo simulation and takes as input the business processes models with additional operational details and business objectives. The current version of the capacity planning provides the number of people of each skill profile that is required to meet the service levels constraints with minimal costs.

Several of the services, for example the automatic layout and the control-flow analysis, are composite services that use other services, notably the process structure tree service, to produce their desired results. Additionally, low-level services exist, but at this stage, they are not exposed for reuse. However, we already noticed that the value of these low-level services is much higher than anticipated and thus expect that an entire eco system of services will emerge as the portal evolves further. Adapters to convert between different business process modeling languages as well as transformers that abstract major features of a business process model such as for example the underlying control-flow graph into a common language-independent representation are examples of low-level services that could also be added to the portal if the community feels a need for these services.

4 Architecture

The services portal is based on the layered architecture comprising a presentation, service, and component layer as shown in Figure 2. A modeling tool can access the services connecting directly to the service layer via the service stubs. A human user will access a service through the web-based graphical user interface. Components in the component layer implement the required functionality of each service as specified in the service interface.

Application tools and the presentation layer interact with the services by calling service requests with an input message and receiving a return message upon completion of the service. If the service cannot be executed on the provided input, or there is an error during the service execution, then the error field of the service response provides information about this outcome.

The portal permits arbitrary input messages of up to one megabyte of size. The documentation of each service, as available on the portal, specifies the exact message format. The output result also varies for each service. For example, it is a modified BPMN model in case of the refactoring and process structure tree services or a summary report in case of the processes summarizer. Some return messages also include a URL from which the graphical output can be downloaded.

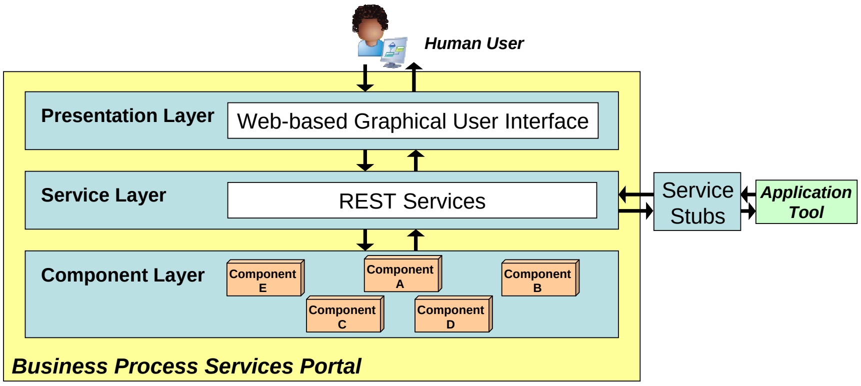


Fig. 2. Architecture of the Business Process Services Portal.

5 Conclusion

The business process services portal is an experimental web-based platform that provides services of interest to various stakeholders in business process management. The portal targets the general BPM audience interested in technology that makes business processes more actionable. Tool developers and vendors learn about reusable technologies and a web-based framework that facilitates reuse based on service-oriented architecture principles.

References

1. D. Fahland et al. Analysis on demand: Instantaneous soundness checking of industrial business process models. *Data and Knowledge Engineering*, 2010. To be published. A preliminary version appeared at BPM 2009.
2. M. Fazal-Baqaie. Business process matching for version control. Master's thesis, University of Paderborn, 2009.
3. C. Gerth et al. Language-independent change management of process models. In A. Schürr and B. Selic, editors, *MoDELS'09*, volume 5795 of *LNCS*, pages 152–166. Springer, 2009.
4. T. Gschwind et al. IBM Pattern-based Process Model Accelerators for WebSphere Business Modeler. IBM developerWorks, 2009. See http://www.ibm.com/developerworks/websphere/library/techarticles/0906_gschwind/0906_gschwind.html.
5. J. M. Küster et al. Detecting and Resolving Process Model Differences in the Absence of a Change Log. In M. Dumas and M. Reichert, editors, *BPM'08*, volume 5240 of *LNCS*, pages 244–260. Springer-Verlag, 2008.
6. B. Srivastava. Summarizing processes. IBM Research Report RI100008, IBM Research - India, 2010. Available online from: domino.research.ibm.com/library/cyberdig.nsf/index.html.
7. J. Vanhatalo et al. The refined process structure tree. *Data Knowl. Eng.*, 68(9):793–818, 2009.