PROOF OF CONCEPT FOR A BPMN-DRIVEN SEMANTIC ORCHESTRATION OF WEB APIs

Andrei CHIȘ

Babeș-Bolyai University, Faculty of Economics and Business Administration,
Cluj Napoca, Romania
andchis@gmail.com

Abstract. *Nowadays, the speed of information flows inside a company has become a vital factor in determining the outcome of a business project. In order to remain competitive at the highest rate, companies need to be able to easily access necessary data for supporting business decisions. Moreover, information must be delivered in a very efficient and effective way to the persons that have leading roles in each business. In a hedge fund business, the speed of data flows is the most important factor, making a difference between success and failure. These business goals can be achieved by automating steps in every business process with the help of web services by using APIs and semantic orchestration. In this work, we show the way in which a series of APIs can be orchestrated together with business process modelling techniques and data management tools in order to achieve speed and data management goals inside a company. The proposal of this paper is an orchestration method that combines the practice of BPMN modelling (typically associated to design-time) with run-time orchestration based on a semantic bridge enabled by the possibility of exporting diagrammatic models into RDF knowledge graphs. The work follows the Design Science methodology starting from identified requirements and following a solution engineering cycle that overall can inspire a new kind of software engineering method.*

Keywords: BPMN, RDF, semantic orchestration

JEL classification: D83

DOI: 10.12948/ie2019.04.08

1. Introduction

The goal of this work is to demonstrate how semantic orchestration of web APIs can be used to enhance a process' performance and adaptability. The contribution is a novel engineering method that relies on recent advances in the area of modelling method engineering, which are now incorporated into an existing BPMN [1] modelling tool called BEE-UP [2]. By combining the BPMN modelling standard, the RDF knowledge representation standard and PHP scripting, a proof-of-concept is showcased, demonstrating the idea of "semantic orchestration" that can be derived from the process knowledge captured within an enterprise on a diagrammatic level. Diagrammatic models are means of visualization – however this work emphasizes their quality of machine-readable knowledge graphs that can drive service orchestration engines.

The main motivation behind conducting this research project was the quest to find a solution for better data management flows using web APIs according to the logic captured in business process models.

The remainder of the paper is structured as follows: Section 2 will discuss about the problem statement. Section 3 will give detailed information about the used research method. Section 4 will provide the solution summary, while section 5 will present the design and implementation

details of the solution. Section 6 will comment on related works, while section 7 will present a concluding evaluation.

2. Problem statement

The problem addressed in this paper is frequently encountered in a hedge fund. The fund's directors must find new investment opportunities daily. Also the hedge fund's business model relies on gaining higher value commissions for the company at every transaction. In this type of business, information received at a high rate plays a vital role in taking the best investment decisions.

The scenario used to illustrate the problem is the following: The company's Chief Investment Officer must receive information about the stock ticker of a certain company (Apple Inc. in our case, stock ticker: AAPL) via SMS. Then, the company's Forex Trading department manager must receive information about the USD – EUR exchange rates by SMS in order to prepare for the next forex investment.

The process must be streamlined with minimum human interaction. Process knowledge typically exists within enterprises in the form of BPMN models and this work's proposal tries to leverage this existing knowledge beyond a simple visualization. Recent advances in knowledge engineering enables us to build orchestration engines that query the contents of the BPMN diagrams and drive automation with the help of the thusly discovered semantics.

3. Research method

The research methodology used in this project is *Design Science* [3]. The Design science methodology focuses on the way a solution can be built in order to continuously maximize its functional performance. Its main goal is to develop knowledge that can be reused by professionals to design efficient and effective solutions for their field problems.

In order to go through a full Design Science cycle, the article shows how the proposed artifact is implemented. In our case, the artifact is an engineering method combining business-relevant APIs, together with BPMN standards implemented in BEE-UP [2,4] and RDF4J [5] for the process repository. The goal of this method is to automate in an efficient and effective way the presented business processes and its reusability is supported by the BPMN quality of being a standard that already assimilated process semantics.

The evaluation criteria presented in section 7 are based on the execution speed of the whole process, automation customizability and efficiency.

4. Solution summary

The proposed engineering method is depicted in terms of component interactions in Figure 1. We start by modelling a process in BEE-UP using the BPMN standard. Then the process diagram is annotated with details on the use of API resources (see the upper part of Figure 2) – in the showcased example these are: Alpha Vantage [6] is an API which provides real time stock market data; Currencylayer [7] provides exchange rates data; Clickatell [8] is the API used for sending process relevant data via SMS to stakeholders indicated in the diagram.

We are performing a series of queries on the resulted graph in order to construct and execute at runtime the API calls as dictated by the diagrammatic flow. We use graph databases to store the process knowledge, a series of web APIs to get the necessary data and a series of graph queries that control the order of API calls, as dictated by the diagram contents. The PHP EasyRDF [9] library was used to interact with the process repository with the help of SPARQL[10] (the semantic query language).

Figure 1. Architectural diagram that displays the interactions between the used tools

5. Design and implementation details

The middle part of Figure 2 shows how the business process is stored as a knowledge graph in the RDF4J repository. The main advantage of a graph database compared to a SQL database is the fact that graph databases are more adequate for graph-like information, including BPMN diagrams and their annotations to relevant APIs.

The BEE-UP modelling tool offers several business process modelling standards that can be used in designing process diagrams. For this research project, we used the BPMN standard but the idea can be expanded to other process modelling languages (UML, EPC etc.).

The script that automates the process can be divided into three main queries to the RDF4J repository where all the data regarding the analyzed business process is stored.

The first query constructs the API call to the Alpha Vantage stock market service. Data is retrieved and formatted so that it can be passed to the Clickatell SMS API. The properties of the task that are used to construct the API request, such as `<http://www.andrei.ro/api_base>` or `<http://www.andrei.ro/api_key>` can be configured for each task inside the BEE-UP properties window, as shown in Figure 2.

The data is then retrieved from one API and passed to the next. The second graph query is used to construct the API call for the Clickatell SMS API, which is used for sending the retrieved data from the other 2 APIs. All API requests are composed in the same manner, by deriving from the process graph the task flow and task annotations. This also requires a more dynamic API modelling language, but in this stage a simple schema for API description is suggested in the figure.

The third query is used to construct the API call for the Currencylayer API and then, the gathered data is sent to the Forex Trading Department manager via SMS using a second call of the SMS API.

The properties necessary for each API call can be adapted to making the structure of the queries more intuitive to the user. This can prove to be very useful when working on large scale projects that integrate a large number of requests, as it frequently happens in a company that has a large number of employees. It would be possible to store all the API and IT services data into one separate diagram, then connecting it to the main process diagram. This would be useful to

separate the orchestration part from the data request part. In this paper we did not chose this approach in order to have an easier to understand example.

Figure 2. Displaying business process and the design, serialization and execution of a task. It merges BEE-UP BPMN modelling, graph database storage and PHP scripting

6. Related works

This paper proposes an engineering method for automating business processes with the help of semantic technology acting as a bridge between the process knowledge and run-time relevant web APIs attached to the process on a diagrammatic level. The paper enhances the BEE-UP modelling procedure for the goal of creating a knowledge base to drive an automation script [11]. Moreover, the paper provides a way in which the API requests can be linked to user defined ontologies, adding more adaptability when working on real life business projects and thus being connected to the goals of [12].

This work proposes an approach to a data flow management system that can be used in the financial sector [13]. Maximum efficiency is obtained because the process is fully automated and there is no need for human interaction beyond the initial process design. The work also connects to certain aspects of Robotic Process Automation (RPA) [14]. Even though RPA is generally achieved with dedicated software such as UiPath [15], we are automating the process by using semantic data and web APIs, orchestrated with the help of the diagrammatic process. The goals of this paper are similar to the goals of [16] but in terms of automating the process of pulling information from web APIs, not from text documents. The paper [17] proposes a knowledge stepping mechanism that uses a similar approach to retrieving process information, but does not employ a modelling standard for the process descriptions, nor does it aim to orchestrate APIs based on those descriptions.

7. Concluding evaluation

Table 1 displays the performance of the orchestration script. The automated approach is more effective than the traditional approach that needs employees transmitting data between them with the help of reports, e-mails or non-automated text messages. It remains to be seen how it compares with an RPA-based approach, and this sets goals for our future work.

Table 1. Time duration for executing the main steps in the automation script

Task	Execution time (s)
Construction of Alpha Vantage query	0.90705
Construction of Currencylayer query	0.61904
Construction of Clickatell query	0.01300
Executing the Alpha Vantage & Clickatell request	0.90205
Executing the Currencylayer & Clickatell request	0.41902
Execution time of the whole script	2.86016

To conclude, a *SWOT analysis* will summarize the paper's proposal:

Strengths: The use of semantic orchestration and graph databases enables a process automation method that can be easily customized to the run-time environment's specific API resources.

Weaknesses: Further evaluations are needed on real industry-based scenarios. Also, from an ontology point of view, the API modelling language needs to have a few regulatory standards imposed in the form of some API description schema.

Opportunities: This paper proposal opens opportunities on employing Enterprise Modelling methods to enhance service orchestration systems [18].

Threats: Till now, real world companies don't use semantic and reasoning technologies at their full potential. Even though a few large companies are in the process of adopting semantic technologies in their daily activities, the use of these techniques is still limited.

Acknowledgment

The author highly acknowledges financial support from the Babeş-Bolyai University through a Special Scholarship for Scientific Activity during the academic year 2018–2019, contract number 36.039/28.11.2018.

References

- [1] The BPMN Standard, Available at: <http://www.bpmn.org/>
- [2] D. Karagiannis, R. A. Buchmann, P. Burzynski, U. Reimer and M. Walch, “Fundamental conceptual modeling languages in OMiLAB” In: D. Karagiannis, H. Mayr, J. Mylopoulos (eds.) “Domain-Specific Conceptual Modeling”, Springer, Cham, 2016.
- [3] R. J. Wieringa, “Design Science Methodology for Information Systems and Software Engineering,” Springer, 2014
- [4] BEE-UP Modelling Tool Download, Available at: <http://austria.omilab.org/psm/content/bee-up/download?view=download>
- [5] RDF4J Framework Download, Available at: <http://rdf4j.org/>
- [6] Alpha Vantage API, Available at: <https://www.alphavantage.co/support/#api-key>
- [7] Currencylayer API, Available at: <https://currencylayer.com/>
- [8] Clickatell API, Available at: <https://www.clickatell.com/developers/platform/>
- [9] PHP EasyRDF Library, Available at: <http://www.easyrdf.org/>
- [10] SPARQL Query Language, Available at: <https://www.w3.org/2001/sw/wiki/SPARQL>
- [11] D. Karagiannis, R. A. Buchmann, and M. Walch, "How can diagrammatic conceptual modelling support knowledge management?", in Proceedings of the 25th European Conference on Information Systems, AIS, Guimarães, Portugal, pp. 1568-1583, June, 2017, Available at: https://aisel.aisnet.org/ecis2017_rp/101
- [12] O. Corcho, M. Fernandez-Lopez and A. Gomez-Perez, “Methodologies, tools and languages for building ontologies. Where is their meeting point?”, Data and Knowledge Engineering, Elsevier, vol. 46, no. 1, 2003, pp. 41-64.
- [13] M. Henneberger, A. Katzmarzik, S. Muller, F. M. Pleie, “Sourcing and automation decisions in financial value chains,” in Proceedings of the European Conference on Information Systems 2009, AIS, Available at: <https://aisel.aisnet.org/ecis2009/384>
- [14] M. Lacity, L. Willcocks, “Robotic process automation at Telefonica O2,” MIS Quarterly Executive, AIS, vol. 15, no. 1, article 4, 2016, Available at: <https://aisel.aisnet.org/misqe/vol15/iss1/4>
- [15] UiPath, Available at: <https://www.uipath.com/>
- [16] J. Carlisle, “Semantic modeling using theta-roles: a natural language processing-based approach to conceptual representation,” in Proceedings Americas Conference on Information Systems, AIS, 2010, Available at: <https://aisel.aisnet.org/amcis2010/437>
- [17] R. A. Buchmann, D. Karagiannis, “A semantic approach to deploying product-service systems”, “International Journal of Information System Modeling and Design”, IGI Publishing, pp. 19, 2017, Available at: <https://www.igi-global.com/article/a-semantic-approach-to-deploying-product-service-systems/197431>
- [18] U. Frank, “Multi-perspective enterprise modeling (MEMO) – Conceptual Framework and Modeling Languages,” in Proceedings of Hawaii International Conference on Computer Science 35, IEEE, 2002, pp. 1258-1267.