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SEMANTIC BUSINESS PROCESS PATTERN TO WEB SERVICE MAPPING: AN EXPERIMENTAL FRAMEWORK

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ABSTRACT

An organisation's competitiveness relies heavily on its business processes, and business processes nowadays are automated through Web Services to allow organisations to be more flexible in the face of change. However, bridging the gap between business process patterns and Web Services is an important yet challenging task and therefore this paper aims to describe an approach that facilitates the mapping of useful Web Services to business requirements via the adoption of business process patterns. This paper adopts a design research method for formulating and applying a new mapping framework for identifying the matching rules. To that end, two different repositories are mapped to one another: an ontology-based business process patterns repository and a Web Service software component repository. An important feature of this ontological matching is providing richer semantics, which enables fuller, more flexible automation of service provision and use, and support the construction of a more powerful mapping framework. Our mapping exercise has brought to light some vital differences between the definition of business process elements and Web Service constructs. Finally, the research demonstrates the need to focus future research efforts on understanding the importance of business process patterns as cornerstones of business process change, as well as identify directions for future research and practice.

KEYWORDS

Business process pattern, web services, ontology, design research and matching framework.

1. INTRODUCTION

Modern businesses constantly seek new ways to shorten the time to act on business opportunities and differentiate themselves from competitors (Gacitua-Decar and Pahl, 2009). Information technology (IT) is seen as a critical tool to increase the level of automation when incorporating new business requirements. Therefore, one of the key challenges in today's organisations is to ensure the alignment between the business requirements and the flexibility and responsiveness of IT systems to meet those requirements (Markovic and Karrenbrock 2007).

Business process patterns are used to capture general business domain requirements; they are models that are sufficiently general, adaptable, and worthy of imitation that various organisations can reuse (Graml et al. 2008). Patterns offer to (1) capture expert process design knowledge and greatly benefit the design of new enterprise services by guiding the definition of their scope and granularity, (2) identify process improvement options and serve as a basis for derivation of executable business processes, and (3) enable a better understanding of business processes, as patterns facilitate communication between business people and IT experts. However, identifying pattern instances in real and large documented business processes is a challenging task, requiring the analysis of the structure, semantics and behaviour associated with process descriptions.

A common theme in the recent literature on mapping business processes to Web Services is the search for an approach or a framework that allows a direct and easy to use matching process, which can be reused to facilitate organisational process redesign and support systems development. Web Services provide a suitable technical framework for making business processes accessible within enterprises and across enterprises (Kang et al. 2009).

In this work, we make a step forward by deriving executable processes out of business process patterns, i.e. mapping the elements of process patterns to the IT perspective (Web services) in an organisation. In particular, we apply semantic technologies to represent business process pattern elements and services at the IT level and design a conceptual framework for mapping these business requirements to their corresponding implementation in the IT system. Challenges are numerous, however we are focusing on proposing a solution dealing with structural and semantic aspects of the business process pattern-matching problem. The study follows a Design Science Research (DSR) approach for designing and evaluating the proposed framework. Evaluation is carried out using scenarios taken from fictionist Travel Agency and real world data source from the financial domains. Finally, this paper is structured as follows. Section 2 presents a review of previous work related with business process and Web Services leading to the research problem proposed in this paper, followed by highlighting the need for this study in Section 3. Section 4 presents our approach to solve the proposed problem. Section 5 demonstrates how the mapping rules can be applied using a running example. Section 6 provides a summary of the research and elucidates its implication suggesting future work.

2. BACKGROUND

Value-added processes have become more and more the driver for evolving any organisation. Hence the modelling of business processes is becoming increasingly popular. Both experts in the field of information technology and business engineering have concluded that a successful system starts with an understanding of the business processes of an organisation. Furthermore, conceptual modelling of business processes is deployed on a large scale to facilitate the development of software that supports the business processes and to permit the analysis and re-engineering or improvement of them. Literature researching process matching and discovery is discussed and presented in the following paragraphs.

Nadarjan and Burger (2007) suggested a limited lightweight conceptual mapping between Fundamental Business Process Modelling Language (FBPML) and OWL-S. This work resulted in: (1) a partial mapping of FBPML elements, e.g. Trigger exists in FBPML but not in OWL-S. The missing elements from OWL-S could lead to a severe implication from the business process point of view, and (2) full translation could not be achieved due to the lack of knowledge representation in OWL-S such as business rules not being supported yet (Nadarjan and Burger 2007). However, this work only provides a conceptual mapping of the FBPML notation to OWL-S without understanding the underlying meaning of the process model.

Hepp et al. (2005) proposed to combine Semantic Web services (SWS) and business process management and yield one consolidated technology, which is called Semantic Business Process Management (SBPM). This technology allows for the mediation of IT and business and supports the querying of the business process space using logical expressions that help in identifying activities relevant to the financial domain. This study found that: (1) current business process management inherits all the limitations that the traditional Web Services stack has, e.g. UDDI, which leads to an insufficient approach to discover Web Services automatically, and (2) current business process management is not founded on expressive, logic based representation techniques, hence failing to make the whole business process accessible to intelligent queries and machine reasoning.

In another study, a service semantic discovery process is proposed (Sriharee and Senivongse 2003) that uses an ontological-based approach to enhance the description of Web Services using behavioural information. This approach illustrates the applicability of behaviour related querying, which benefits from ontological inferencing, as an attempt to automate the service discovery and the matching process. This work, however, did not provide a ranking for the resulted query. Also it does not satisfy querying for a set of services that satisfy a particular behaviour. This work explored the querying of Semantic Web services without mapping/matching the results to organisational processes.

Markovic and Karrenbrock (2007) designed an approach to discover Semantic Web Services for process task implementation by mapping the process model from the business perspective to the Web services in an organisation. However, this approach focuses only on using business goals for process task annotation in business process models.

Finally, the review of the business process – Web Service mapping literature highlights the existence of some critical points in existing approaches, as further explained in the following points:

1. Most of the previous work on service matching (Alaswad et al., 2009) considers finding a service match for another service regardless of the business process that models the underlying service. The focus in such approaches is on fine-grained level of service matching, instead of matching business requirements with a set of services.
2. Most approaches use Web Service ontology (WSMO and OWL-S) to represent business process models, rather than building a specific business process ontology (Markovic and Karrenbrock 2007; Nadarjan and Burger 2007). Existing approaches to process modelling lack an adequate specification of the semantics of the terminology of the underlying process models, which leads to inconsistent interpretations and usage of knowledge (Aldin and de Cesare, 2011). Previous work uses ontologies of Web Services without any reference to an ontology of business process, therefore it is more appropriate to start from a business process ontology to find software functionality that satisfies certain business requirements.

3. There is no single standard for modelling a business process; despite of the various modelling languages available (e.g., BPMN), different organisations will probably use various notations. Thus, if processes were dependent only on their graphical labels, this would lead to limitations in fully understanding the process elements. In addition, the ontologies produced previously provide semantic annotations for BPM languages without describing and presenting the knowledge of the domain presented (Hepp and Roman 2007). Most of these works are designed towards presenting a certain language, where they only deal with the semantic annotation of process models represented with the help of a certain modelling language (Thomas and Fellmann 2009). Furthermore, limited attention has been paid to domain models with limited integration between domain models and Web Service ontologies.
4. Looking back at the prominent problem facing the modern software industry due to consistent failure to meet expected functionality that satisfies quality requirements and low cost budget, the need for intricate traceability solutions is increased. There is limited work that looks into modelling business behaviour at a more generic level, as this can help in resolving the problem of traceability of business requirements to Web Services. (Anquetil et. al. 2008, Aversano et. al. 2010).

In this study, the authors are narrowing the gap between business process patterns and Semantic Web services and highlight the opportunity of utilising business process patterns in conjunction with Semantic Web technologies. In doing so, the authors are anticipating that the growth of potential Semantic Web service standards such as OWL-S could be strengthened and enriched by manipulating more mature business process patterns. Patterns can serve as blueprints defining common and reusable designs in specific business domains. The Web service ontology used to represent the scenario is based on OWL-S. On the above basis, the problem addressed by this paper can be restated in the following way:

1. Business process models will benefit from the generic view of business process patterns in a form that allows for the ontological/semantic representation of a general category of business process models.
2. Business process models lack machine-readable representations of their process space as a whole on a semantic level. Thus, business processes need a machine processable semantic representation using ontologies that allow querying their models via logical expressions. In management science, decision-making is a core discipline, and the main challenge for good decision-making is having access to all required information. This might sound like a triviality, but in fact it reveals that querying the business process and WSO is a very important task. As defined by (Hepp et al., 2005) a query is “a machine readable representation of a logical expression that defines a subset of all facts ("knowable" things might be more appropriate) in the universe of discourse (i.e. the process space) and is used as a request for returning all known facts that match this logical expression”.

3. RESEARCH METHODOLOGY

In this study, for the development of the mapping framework of useful Web Services to business requirements via the adoption of business process patterns, we applied the problem-centred approach of the design science research methodology (DSRM) presented by Peffers et al. (2008) in Figure 1.

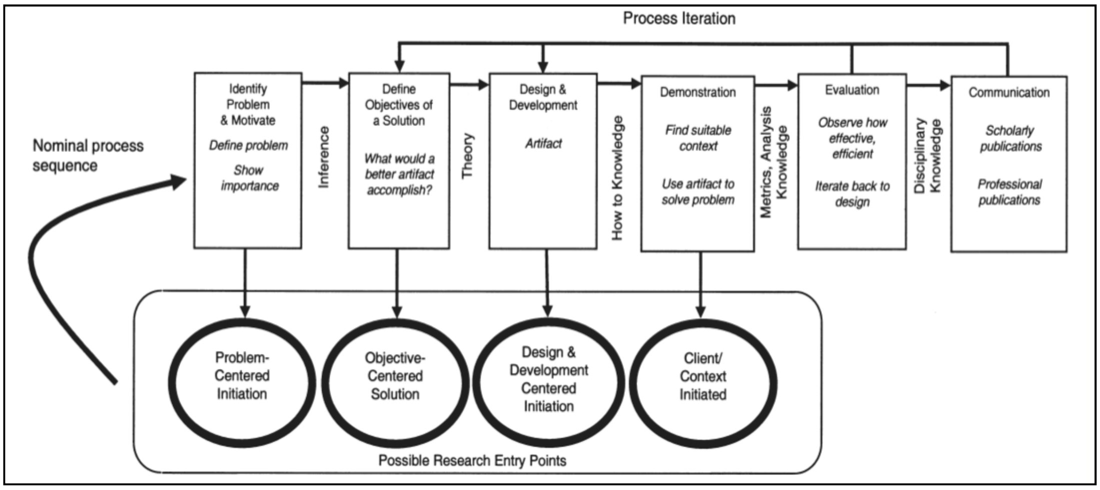

Figure 1. Design science research methodology (DSRM) by Peffers et al. (2008)

We draw on Peffers et al.'s (2008) six DSRM activities to come to rigorous and relevant research results as listed and defined in Table 1.

Table 1. DSRM activities application

DSRM activity	Research Application
Identify problem and motivate	This activity starts by understanding the problem in the field to suggest a type of solution that forms a proposal to be developed further in the remaining of the research. This research is concerned with the problem of recovering mapping links between the business requirements of business process patterns and Web services. The existence of the problem was identified from existing literature and previous research projects.
Define objectives of a solution	After clarifying the problem, a utility theory, which aims at suggesting a meta-design for the above problem is defined in this activity. This has been achieved by conducting further study on the problem and the solution spaces, synthesising various types of standards. This research is developing a conceptual framework for mapping business process patterns to Web services. This allows a direct and easy to use matching process, which can be reused to facilitate organisational process redesign and support systems development.
Design and development	Design and Development activity is when the main artefact of the research is created. In the realm of this research a mapping framework is created.
Demonstration	The development and demonstration activities of the mapping framework go through iterations aimed at evolving and improving it. In each iteration the framework was applied to process data and evaluate the outcome. The evaluation formed the basis for the design phase of the following iteration.
Evaluation	The aim of evaluation activity is to demonstrate the utility and practical adequacy of mapping framework by applying it to two more scenarios and evaluating the quality of the resulting models.
Communication	This activity refers to publishing scholarly papers and demonstrating the importance of the solved problem to the research community. Research on this study to be published in academic papers.

Design science research is aimed at solving practical and theoretical issues, by creating and evaluating IT artefacts that are intended to solve identified organisational problems (March and Smith, 1995, Hevner et al. 2004, Peffers et al. 2008). Artefacts represent the final result of a design process, which can be characterised as constructs, model, methods, or instantiations (March and Smith, 1995) as presented in Figure 2.

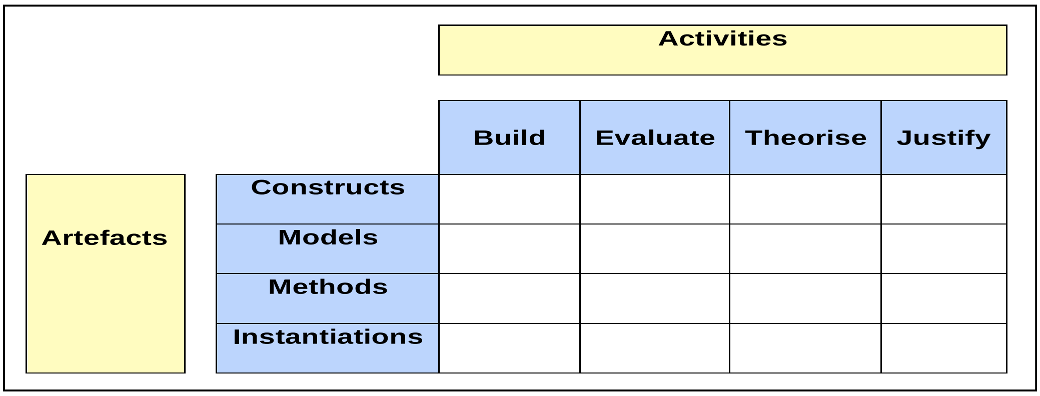

Figure 2. Design and Natural Science Framework (March & Smith, 1995)

Three design iterations are used to deliver the final artefact as illustrated in Figure 3 adopted from (Alfaries 2010). In each iteration the artefact refinement process is formed as a mini Design Research cycle of build and evaluate, following Vashnavi & Kuhler's (2004) design cycle steps.

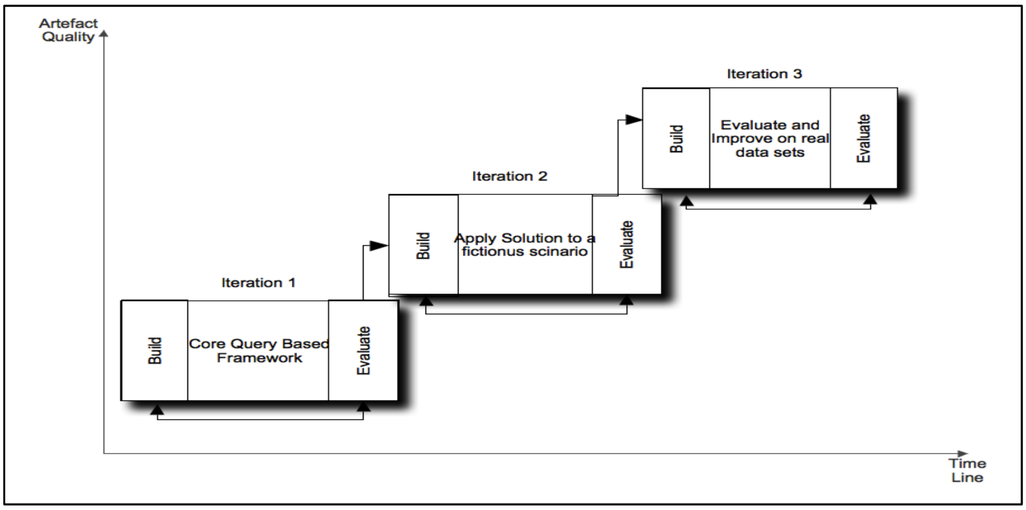

Figure 3. Design Research Iteration (adopted from Alfaries 2010)

With regards to the hypothesis about existing mapping approach explained earlier and in order to provide an effective solution to the business problem, suitable data sources are required. Thus, data for this study is acquired from: (1) fictitious scenario of Travel Agency. This scenario presents the process of organising a travel trip for a customer, and (2) multiple legacy systems (retail banking, insurance and mortgages) from the financial services domain. The sourcing of such domains, and the context from which they were derived, are of particular importance. Both in directing the research and serving the research aim. Similarities are found in the way processes are performed in the different scenarios under investigation. Variation in the type of organisations and systems utilised provides the required level of external validity across multiple domains, enabling some general conclusions to be drawn from the mapping framework and the discovered mapping rules.

Table 2. Presents the development of the Query based mapping framework over each iteration

	Purpose	**Source(s) used**	**Why**
Iteration 1	Iteration 1 aims to uncover the form and structure of our Query based mapping framework.	No data is used. Framework designed based on what is needed to solve existing matching limitation.	• The effectiveness of building the mapping framework is analysed. • The effectiveness of discovering mapping rules is evaluated, specifically adherence to DR principles.
Iteration 2	The second iteration aims to recover the mapping links between the business requirements of business process patterns and Web services and refine existing ones by using the query based mapping framework from Iteration 1 on fictionist scenarios.	Fictitious scenario of Travel Agency. This scenario presents the process of organising a travel trip for a customer	• Apply the ontology of business processes to provide a more accurate representation of the process models. • Uses Semantic Web services (SWS) to automate the process of finding Web services that implement business process patterns. By describing a Web service using OWL-S, which enables adding a semantic layer to Web services. • Utilise DL query to identify the mapping rules. • Apply the method across new legacy functionality in order to demonstrate generality of mapping rules.
Iteration 3	The motivation of Iteration 3 is to evolve the Third/Final version of the Query based mapping framework by re-applying the mapping rules to the Financial Services domains. Moreover this iteration assesses the ability of the framework to work on real data sources to produce more real world mapping rules.	Three software systems will be used. These are financial systems for retail banking, insurance and mortgages. These systems are developed to be generic; therefore they should provide a good source for the defining the mapping rules.	• Continue discovering new mapping rules from empirical data (e.g., legacy systems). • Continually test the existing mapping rules from the factious scenarios against the finding rules of the financial domains. • Evaluate the benefit of both the framework and the discovered mapping rules.

4. QUERY BASED MAPPING FRAMEWORK

Ontological business process patterns will be used to identify business requirements in a query-based framework that will lead to the discovery of matching Web services. This section describes the work preformed in iteration one on the Web service ontology and how it integrates with the business process patterns using a query based mapping framework.

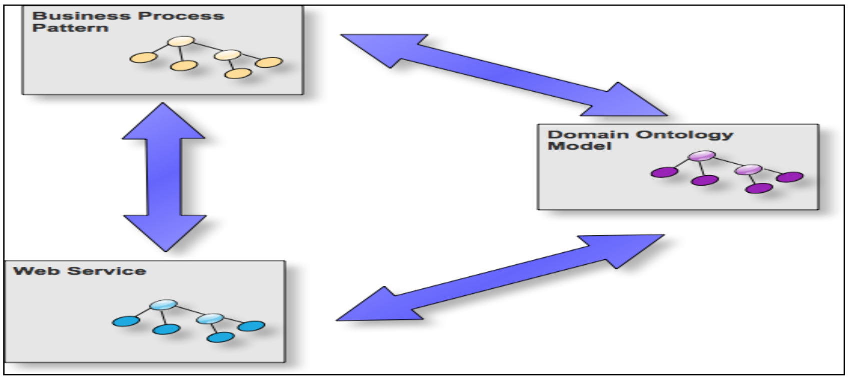

Figure 4. Top Level Conceptual Framework

The framework consists of semantic components that represent the business requirements through the business process pattern component and the software functionality through the Web service component as illustrated in Figure 4. The first component represents the generic business process patterns ontology, the second component represents the Web service behavioural description ontology, and the third component is the domain ontology, which can be used to provide semantic descriptions of the underlying domain. This domain ontology will serve as a linking ontology between the other two components, by describing the domain concepts.

For this iteration and in order to arrive at a sound ontology mapping approach we have proceeded in the following way:

1. Business process patterns are discovered by recognising commonalities in the processes of different organisations or domains. Modelling business process patterns cam help to more accurately identify the individual process elements, as they exist in an organisation. These real-world models are then represented in the Web Ontology Language (OWL) in order to allow for automatic inferencing of generalised process patterns. Interested readers can refer to Aldin et al. (2009) for a more complete explanation of the method that was developed for the modelling of process patterns. A process pattern represents generic organisational behaviour and therefore intrinsically refers to one or more functional requirements. A domain expert can use the business process pattern ontology to query the ontology for a specific pattern that satisfies certain criteria (business requirements) using process elements such as inputs, outputs, events, participants and activities.
2. The domain expert can query the Web Service ontology to find a matching service using service inputs and outputs. Then the domain expert can use the result of the query to match the business requirements to the service functionality identifying a software match for the given business requirement identified in step 1.
3. Identify the mapping rules using DL-Query to map existing business process patterns (functional requirements) to the Web services ontology. Although the business process patterns include activities, events, participants, input and output resources, services, products and goals, the only elements that are clearly mapped in this study are participants, input and output resources. For the rest of the elements Web services do not

provide clear definitions. The Semantic Web community has highlighted that high quality ontologies are crucial for the construction and integration of many applications and their evolution depends on powerful reasoning tools. Thus, in this study DLs provide ideal candidates to provide powerful reasoning capability over well-defined semantics expressed in OWL. The research in semantics is still under way to show the efficiency of reasoning by DL systems over the expressive power of ontologies (Baader et.al. 2010). This paper demonstrates that the reasoning capabilities provided by DL queries can be used to provide stable automated bridges to narrow the gap between business process patterns and their mapping to Web services.

5. MAIN STAGES AND MAPPING RULES

In this section, the authors aim to focus on iteration two to uncover the form and structure of the mapping rules by applying the Query based mapping framework to a fictitious scenario of Travel Agency. This scenario presents the process of organising a travel trip for a customer. The scenario begins with a Travel Agency receiving a travel reservation request, including airline and travel dates, from a customer. To give an illustrative example, let's imagine that the travel agency takes the customer booking information into account, several tasks must be processed by the agency starting with search and evaluation of travel information based on a customer travel specification request. Having found the customer's requested information, the booking activities can take place to book the desired flight. The successful booking the itinerary is then issued and the process stops with a successful reservation.

This section describes the main steps of our framework for mapping business process patterns to Web services as demonstrated using the above travel scenario to illustrate the application of the mapping rule framework.

In the **First Stage** a generic pattern aimed at making a booking is presented in Figure 5. The model is a pattern due to its level of generality in the sense that it can be further specialised for bookings of any nature (i.e., not just travel). This pattern can be implemented to clarify the steps required to perform a booking within an organisation. Figure 5 represents the Make Booking business process pattern, which is being considered for the travel agency scenario.

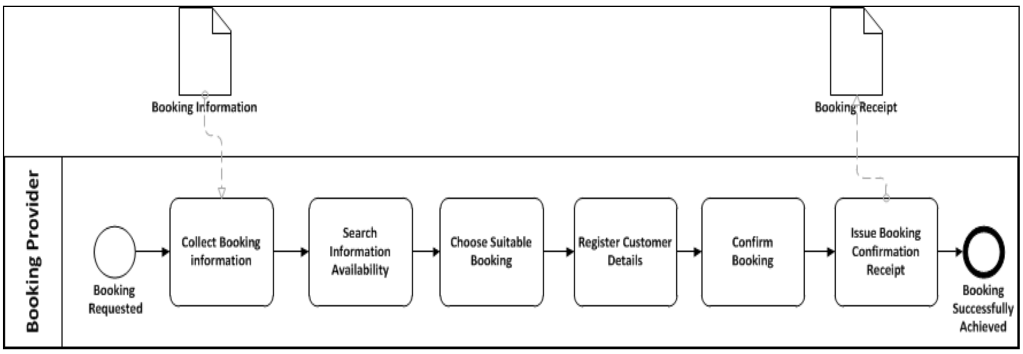

Figure 5. Make Booking business process pattern

This pattern is created ontologically using the business process ontology (BPO) presented in Figure 6 (for further reading see (Aldin and de Cesare, 2011)). The BPO was initially represented informally in UML (Figure 6) and then converted to OWL in Protégé 4.0. The models were then represented in OWL based on the ontology in Figure 6 and subsequently generalised to patterns at various levels of abstraction and classified as described in the Figure 5. Process pattern discovery was carried out by identifying commonalities based on a mix of the core process elements of the BPO (Aldin et al., 2009 b).

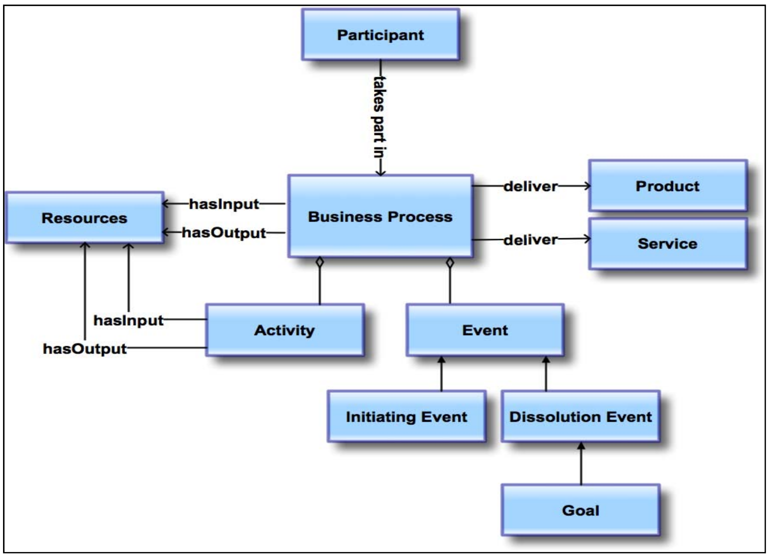

Figure 6. Business Process Ontology

This pattern is represented ontologically using Protégé as illustrated in Figure 7. This business process pattern is initiated by an event (***BP Initiating Event*** – BookingRequested), which is triggered by ***BP Participants*** (BookingProvider) that take part in the business process. The process follows a series of steps (***Activities*** - CollectBookingInformation, SearchInformationAvailability, ChooseSuitableBooking, RegisterCustomerDetails, ConfirmBooking and IssueBookingConfirmationReceipts), then terminated as a consequence of a final (dissolution) event (***BP Goal Event*** – BookingSuccessfullyAchieved).

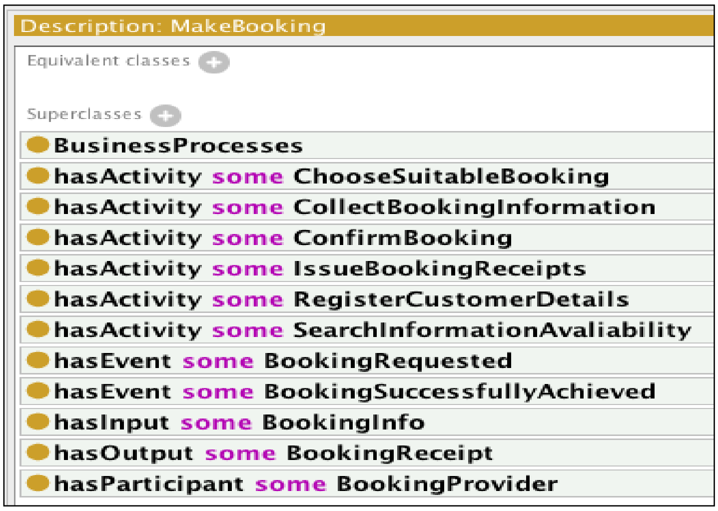

Figure 7. Snapshot of the MakeBooking business process pattern in Protégé

The **Second Stage** is uses Semantic Web services (SWS) to automate the process of finding Web services that implement business process patterns. Hence assisting the business domain expert to implement the desired business functionality. By describing a Web service using OWL-S, which enables adding a semantic layer to Web services. The SWS domain ontologies provide the semantics of business data, processes and services. Ontology allows logic-based reasoning by machines – a necessary step in automating the process of service discovery and composition.

A repository of Web services is ontologically developed based on OWL-S and this repository is referred to as Web Service Ontology (WSO). This work considers only the service model part and its related constructs for the purpose of describing the flight booking Web Services scenario as illustrated in Figure 8.

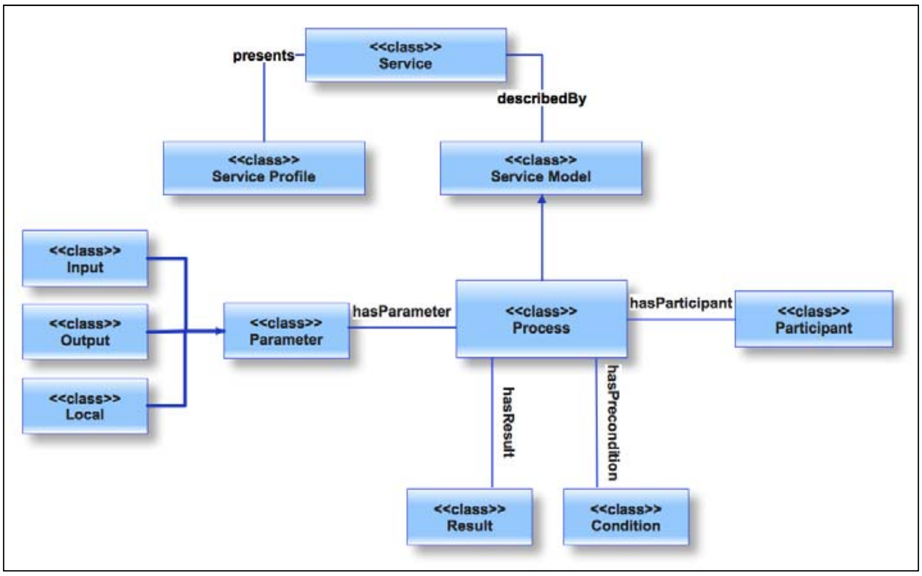

Figure 8. Top Level Web Service Ontology (WSO) Model

Building upon the top level WSO, one instance of a ‘FlightBookingService’ is created for a Service class as illustrated in Figure 9. Each instance of FlightBookingService presents a Service Profile ‘FlightBookingProfile’ and described by a Service Model ‘FlightBookingModel’. An instance ‘ABCFlightBookingProcess’ is created as an Instance of ‘FlightBookingProcess’. In this example, ABCFlightBookingProcess is a process that takes ArrivalAirport and DepartureAirport as Inputs and returns ReservationID and SeatNo as Outputs.

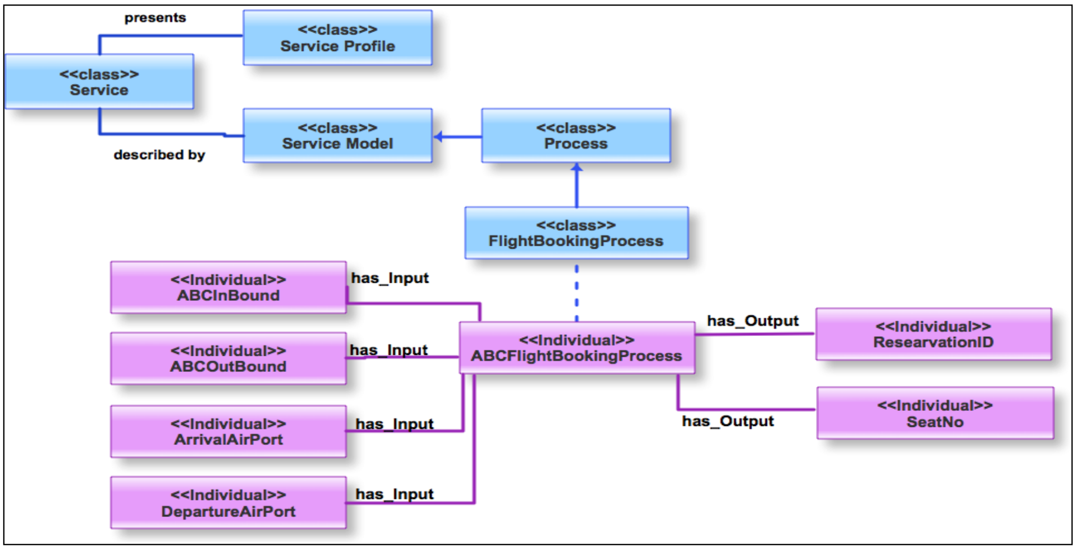

Figure 9. Domain Ontology for Flight Booking Service

Figure 10 illustrates a snapshot of Protégé development of a FlightBookingProcess defined using property restrictions. The process takes ArrivalAirport and DepartureAirport as Inputs and produces ReservationID and SeatNo as Outputs.

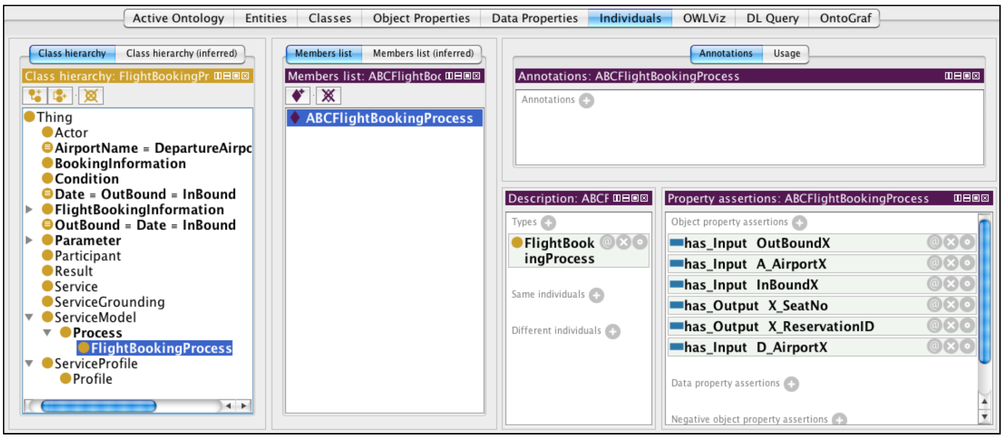

Figure 10. Web Services ontology for a FlightBookingProcess

Now the business data is described using a shared Travel Domain Ontology. This ontology is linked to the business process pattern ontology and WSO to describe the domain concepts used by both ontologies such as SeatNo and ArrivalAirport. The vocabulary described by the travel domain ontology defines domain concepts related to the Travel Booking industry. The Travel Domain Ontology built for this example is a fictitious ontology to meet the simple requirements of the given scenario and to avoid matching failure due to syntactic differences and to verify that the terms used by both business process patterns ontology and WSO are drawn from the same vocabulary. Even if the vocabularies are different the mapping process can still find matching services as long as various terms are suitably related by their ontologies. Figure 11 (travel pattern ontology and WSO) shows the integration between the three ontologies that will lead to identifying the mapping rules between the business process pattern ontology and WSO.

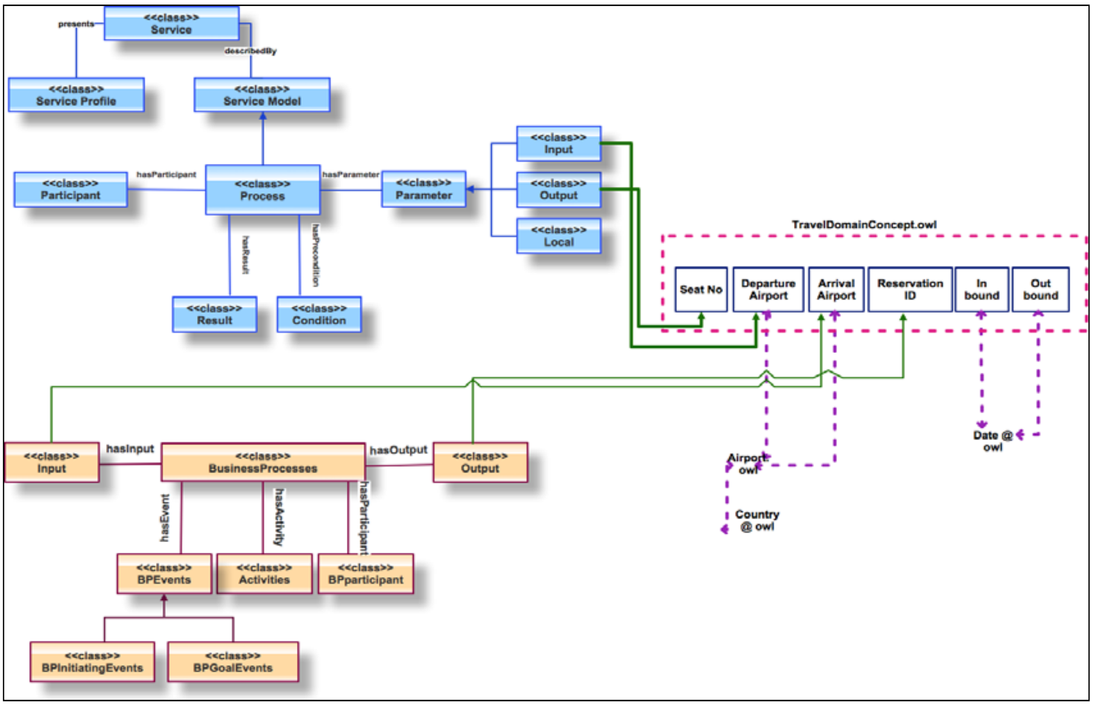

Figure 11. The integration between the three ontologies (Business process pattern ontology, WSO and Domain Travel Ontology)

The **Third Stage** is to use DL query to identify the mapping rules that map the Make Booking business process pattern to suitable Web Services. The following DL queries are aimed at validating the automation of the mapping of the business process patterns ontology to Web Services ontology, therefore, automatically finding an appropriate software functionality that can be mapped to business process pattern ontology.

Query 1:

Aim	**DL Query for WSO**	**DL Query for Business process pattern ontology**
Find a business process and a Web Service that uses InBound as an input	`Process and has-Input some InBound`	Business Process and hasInput Some InBound
DL Query Result	`ABCFlightBookingProcess`	STAFlightBookingBP
Reflections	The `ABCFlightBookingProcess` is a matching service for the Business process that has Input some InBound.	The business process that has Input some InBound is the STAFlightBooking business process.
Overall conclusion	This implies that using the above queries we can automatically find a matching service for the business process by mapping the business process ontology inputs to WSO inputs.	

Query 2:

Aim	WSO DL Query	DL Query for Business process pattern ontology
Find a business process and a Web Service that uses Arrival and/or departure Airports as an inputs	`Process and has-Input some (ArrivalAirport or DepartureAirport)`	Business Process and hasInput Some (ArrivalAirport or DepartureAirport)
DL Query Result	`ABCFlightBookingProcess`	STAFlightBookingBP
Reflections	The `ABCFlightBookingProcess` is a matching service for the Business process that has Input some (ArrivalAirport or DepartureAirport)	The business process that has Input some (ArrivalAirport or DepartureAirport) is the STAFlightBooking business process.
Overall conclusion	This implies that using the above queries we can automatically find a matching service for the business process by mapping the business process ontology inputs to WSO inputs.	

Query 3:

Aim	WSO DL Query	DL Query for Business process pattern ontology
Find a business process and a Web Service that has specific participants	`Process and hasParticipants some ABCParticipants`	`Business Process and hasParticipant Some BookingProvider`
DL Query Result	`ABCFlightBookingProcess`	`STAFlightBookingBP`
Reflections	The ABC Flight Booking Process is a matching service for the business process that has `ABCParticipants` as a service provider.	The business process that has participants some booking provider is the `STAFlightBooking` business process.
Overall conclusion	This implies that using the above queries we can automatically find a matching service for the business process by mapping the business process pattern ontology participant to Web Services ontology participant.	

Mapping Rules and findings of iteration two:

1. Business process pattern inputs can be mapped directly to Web Service inputs.
2. Business process pattern outputs can be mapped directly to Web Service outputs.
3. A process in the business process pattern ontology can be mapped directly to an atomic process in the Web Service ontology.
4. Business process participants can map directly to Web Service participants.

Understanding the Query based mapping framework was necessary in order to describe and clarify the structure of the underlying phases, steps and techniques used to semantically discover the mapping rules and the consumable resources required for the process. Upon reflection, it can be stated that both the learning and the knowledge gained from doing the previous iterations, helped to progress and evolve the study findings.

Several observations were made from the mapping between the business process pattern ontology and Web services ontology in iteration two:

1. Matching has been only partially achieved using inputs, outputs and participants of a business process pattern and Web services. Due to the fact that exact matching for all

business process elements cannot be achieved, as OWL-S does not support representation of business process events, rules and activities. This leads to the inability of representing some types of business process patterns in OWL-S.
2. Applying semantic matching to the discovery of relevant business process patterns can quickly identify the corresponding Web service.
3. Although identifying the rules may appear to be a time consuming and complex task, the resulting solution can be highly useful for stakeholders in both the business and the IT domains who are searching for appropriate Web services to achieve an agile and efficient business process pattern that reduces the time and cost involved in developing new business processes in the existing dynamic business environment.

Therefore, these issues provide feedback to the design of the next iteration (Iteration Three) in order to increase the emerge benefit of Query based framework and its discovered mapping rules.

Finally, this research is still in progress, and the third iteration is still ongoing. The motivation of doing Iteration 3 is to evolve the Third/Final version of the Query based mapping framework by re-applying the mapping rules to the Financial Services domains. Moreover, this iteration assesses the ability of the framework to work on real data sources to produce more real world mapping rules. Three software systems will be used. These are financial systems for retail banking, insurance and mortgages. These systems are developed to be generic; therefore they should provide a good source for the defining the mapping rules. Further aims include:

- Continue discovering new mapping rules from empirical data (e.g., legacy systems).
- Continually test the existing mapping rules from the factious scenarios against the finding rules of the financial domains.
- Evaluate the benefit of both the framework and the discovered mapping rules.

6. CONCLUSION

Patterns at a business process level are abstractions of common and reusable designs to operate businesses. Business process patterns can capture expert process design knowledge and greatly benefit the design of new enterprise services by guiding the definition of their scope and granularity. Designing the adequate scope and granularity of services is critical for their effective reuse. Thus, in this paper we have presented a conceptual framework for mapping business process patterns and Web Services. We have introduced the necessary stages and described their interactions. Furthermore we have presented the travel example that details how and when these stages are used. Also, in this work the use of Design Research is directly associated with the expected result, which is to create the Query based framework for mapping business requirement in the business process patterns to Web Services. In this framework an iterative process of design was used to ensure continuous improvement in the designed artefacts. Each iteration feeds back knowledge gained through construction and developing into the design of the following iterations

The research described is concerned with the problem of recovering mapping links between the business requirements of business process patterns and Web services. The approach introduced exploits both syntactic and semantic analysis. This obviously includes more complex analyses. In particular, business requirements and Web services components require further exploration and definition.

The main reason to use business process patterns in this research is that business process patterns are frequently used and accepted business process designs (often associated to a particular industry domain); it makes sense to reuse this domain expert knowledge as guidelines to design new enterprise services. Web Services would benefit from the acceptance of business process patterns across the industry domain, increasing the chances of being reused in future developments. However, the complexity and size of real processes makes it difficult to identify business process patterns in existing process models from organisations. The time expended during the analysis can be high and errors can be frequent. Moreover, business process patterns - as independent abstractions of specific process models - might not be exactly replicated in an actual process. Rather, partial, inexact and often less abstract business process pattern instances take place.

However, the approach presented in this paper has several noteworthy characteristics. First, it matches business process pattern ontology to Web service ontology. Second, it compares functional requirements. Third it assigns a Web service to a business process pattern, which helps to reduce the cost of designing and developing a Web services from scratch, Finally, this mapping exercise has bought to light some vital differences between the definition of business process elements and Web services constructs.

In conclusion, the solution offered in this research addresses the traceability problem in software development by providing a link between business process pattern requirements and software solutions that meet the business requirements.

Narrowing the gap between business process patterns and Web services has opened a window of opportunity for the more established BPM methods to be utilised by the evolving Web technologies. It is hoped that the growth of potential Semantic Web standards such as OWL-S could be strengthened and enriched by manipulating more mature technologies such as BPM methods.

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