On business services representation - the 3 x 3 x 3 Approach

Lam-Son Le
University of Wollongong, lle@uow.edu.au

Hoa Khanh Dam
University of Wollongong, hoa@uow.edu.au

Aditya K. Ghose
University of Wollongong, aditya@uow.edu.au

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On Business Services Representation – The 3 x 3 x 3 Approach

Lam-Son Lê, Hoa Khanh Dam and Aditya Ghose
School of Computer Science and Software Engineering
Faculty of Informatics, University of Wollongong
New South Wales 2522, Australia
Email: {lle, hoa, aditya}@uow.edu.au

Abstract

The increasing popularity and influence of service-oriented computing give rise to the need of representational and methodological supports for the development and management of business services. From an IT perspective, there is a proliferation of methods and languages for representing Web services. Unfortunately, there has not been much work in modeling high-level services from a business perspective. Modeling business services should arguably capture their inherent features, along with many other representational artifacts. We propose a novel approach for business services representation featuring a three-dimensional representational space of which dimensions stand for the service consumer, service provider and service context. We also discuss how the proposed representation approach provides methodological supports to the area of service orientation. Finally, we present in-progress work on the application of our approach.

Keywords

Service orientation, service description, service ecosystem, strategic service alignment

INTRODUCTION

In the last few years, service-oriented computing has become an emerging research topic in response to the shift from product-oriented economy to service-oriented economy. We now live in a growing services-based economy in which every product today has virtually a service component to it (Paulson, 2006). In this context, services are increasingly provided in different ways in order to meet growing customer demands. Business domains involving large and complex collection of loosely coupled services provided by autonomous enterprises are becoming increasingly prevalent (Singh and Huhns, 2005). Let us take a look at the operation of an international airport where there are multiple services on offer. There is a passenger transport service (taking people from one airport to another), which relies on the baggage handling service, a security screening service, a business class lounge service and so on. Each of those services can be offered in other business contexts. For instance, the baggage handling service can be independently used for cargo air-freighting, or the security screening service can be independently offered in other high security venues. Such interactions among and between independent services are what define a service ecosystem (Sawatani, 2007). The emergence of a ecosystem context can be seen in various places such as in the form of Shared Service Centres providing central, standardized services from different agencies or departments in the public sector (Janssen et al., 2004) or a Web service ecosystem on the Internet where Web services providers are interconnecting in their offerings in unforeseen ways (Barros et al., 2006).

When it comes to the description of business services, service providers and service consumers have typically been considered as service stakeholders. Perspectives of service stakeholders have significant impacts on how the services should be described. Properties of service providers and service consumers are incorporated in some existing work on service description such as (Scheithauer et al., 2009), (Cardoso et al., 2009), (O'Sullivan, 2007). The analysis of service stakeholders' viewpoint can enrich the representation of business services, particularly by giving it multi-perspective modeling concepts.

From an IT perspective, there is a proliferation of methods and languages for representing Web services. Unfortunately, there has not been much work in modeling high-level services from a business perspective. Business services have distinctive features that are not typically observed in Web services. Most notably, business services occur for a noticeable period of time, not spontaneously as Web services do. Business services may be performed in the context of a service ecosystem. Moreover, business services bring added values to businesses of both their providers and their consumers. It is necessary to understand the degree of strategic alignment of a service portfolio to support service re-alignment in the face of changing strategic landscapes. Good understanding of strategic service alignment helps identify service values and thus leads to better representation of business services. Furthermore, business services should be aligned with business strategies within an organization or between multiple organizations, and vice versa. Essentially, we need an approach to model business services that captures inherent features, along many other representational artifacts, of business services.

In the rest of this article, we shall (i) analyze the state-of-the-art of service description; (ii) propose a three-dimensional approach for modeling services; (iii) discuss methodological supports of the proposed service representation and; (iv) briefly mention in-progress work on the application of the proposed approach. Each of these topics will be presented in their own section.

REPRESENTATION OF SERVICES – WHAT ARE CURRENTLY MISSING?

Services are often reasoned in connection with one another within an organization or between multiple organizations. Services should be considered as organization's assets in the sense that they need to be managed and operationalized effectively. Essentially, we need a framework for managing and operationalizing services. (Kohlborn et al., 2009a) proposed a framework for service portfolio management. This work, based on a thorough analysis and consolidation of existing, well-established portfolio management approaches, first raises the importance of such a framework and then conceptualizes the proposed framework. Other work in the literature is putting towards how services can be described. Description languages are dedicatedly defined for services at different perspectives (i.e. Web level, business level and universal point of view). Universal Service Description Language (USDL) (Cardoso et al., 2009) (SAP, 2009) is description language for an internet of services. In this language, services are described in three perspectives, namely business, operational and technical. There also exist standards for technical services such as Web Service Description Language (WSDL) (Christensen et al., 2001) and Semantics Markup for Web Services (OWL-S) (Martin et al., 2004). WSDL captures technical details of how Web services can be invoked over the Web. OWL-S provides an ontology for describing functionality of web services, how they can be used and how to interact with them. In our previous work, we propose a description language for business services called Business Service Description Language (Lê et al., 2010a). This language, specifically defined for the description of business services, has building blocks that capture who provides/consumes a service, what a service does (i.e. service capability), under what conditions a service can be executed (i.e. pre-condition), what effect a service has, what input/output the service requires/produces and some non-functional properties (e.g. schedules, obligations, penalties) of a service. This language is built based on existing work that investigates the description of service capabilities and service properties (O'Sullivan, 2007).

The aforementioned description languages have some shortcomings in common. They do not capture aspects that are more amenable to business services than Web services. (Booms et al., 1981) pointed out the inherent difference between services (which are intangible) and products (which are tangible). Taking into account this difference, (Cardoso et al., 2009) proposed a business perspective for services in the USDL. (Lê et al., 2010a) position BSDL in the space of describing business services from a purely business perspective with regard to strategic alignment. Unfortunately, both USDL and BSDL fail to capture service values, the incremental nature of the occurrence of business services because they are performed for noticeable a period of time (and not spontaneously) and the relationship between services to goal modeling (and in broader context, to strategy modeling). Languages like WSDL and OWL-S are engineered towards the technical aspects of Web services. They have building blocks that mainly represent the invocation (e.g. port, message) and execution (e.g. parameters, pre-condition, post-condition) of Web services. They make an implicit assumption that web services are not invoked by business entities and are executed almost spontaneously. As such, they address neither service values nor service-strategy correlations. They do not reflect the incremental nature of the occurrence of business services either.

As a summary, the state-of-the-art in service description fails to represent the following

- *Values* propositioned by a service to stakeholders involved, including service consumers and service providers. Value modeling differentiates intangible business services from web services and tangible products.
- *Strategic antecedents* in a service. Service providers and service consumers have strategies in providing and consuming a service, respectively.
- *Assumptions* that usually hold during the non-spontaneous occurrence of a business service. Assumptions include responsibilities of involved stakeholders, delivery schedules and penalties.
- *The context* in which business services occur.

The aforementioned representational aspects of business services can only be captured if we take into account perspectives of all stakeholders as well as the context in which services are performed. In the next section, we will look at the representation of business services from such a multi-perspective angle and propose a three-dimensional approach to represent business services.

THREE-DIMENSIONAL REPRESENTATION OF BUSINESS SERVICES

Business services usually involve multiple stakeholders. Typical stakeholders of a business service are service providers and service consumers. The providers and the consumers have different perspectives on a service they provide and consume, respectively. These two perspectives are the main sources of representational concepts for business services. The context where services are provided and consumed is another source of modeling concepts. The provider, the consumer and the context of services form a 3-dimensional representational space of business services as shown in Figure 1. Each representational dimension has an axis that features a total of 3 modeling concepts. A service representation can be regarded as a set of 3-dimensional points in this space. We will present each of these dimensions in details and explain how the dimensions can be put together in the representational space.

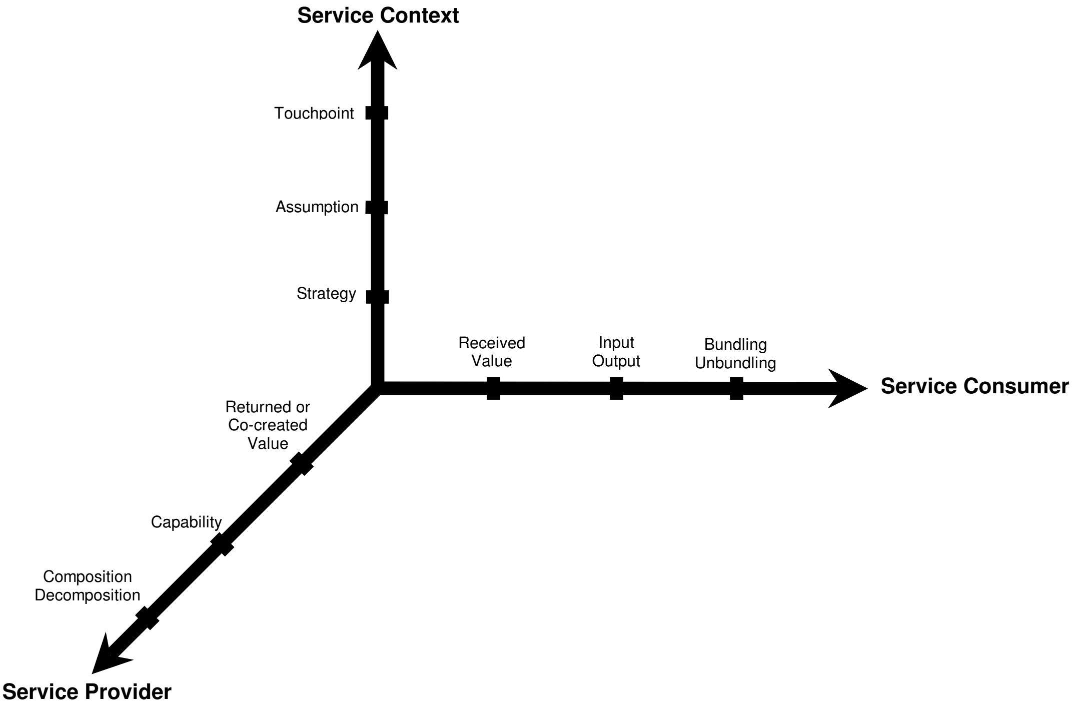

Figure 1: Three-dimensional representation of business services. The service provider, service consumer and service context each form a representational dimension.

The Representational Dimension of Service Consumer

As for the consumers, the concepts that matter are the service value, the service input/output and the manner in which services are packaged or unpackaged at their convenience. Service values capture the values added to consumer's business after she/he consumes a service. Services values are not tangible but they can be experienced or sensed. For example, a businessperson takes a charter flight from Melbourne to Brisbane in order to attend a scheduled meeting. One of the values the businessperson (as a service consumer) gains out of the flight (as a service) is to be able to attend the scheduled meeting in time. Another value the businessperson may appreciate is that she/he has comfortable room for preparing his meeting. This value may not be appreciated by a young passenger (as another service consumer) who is making holiday and enjoys sightseeing all the way between the two cities.

Unlike service values, service input and output are tangible (e.g. physical items) or perceivable (e.g. informational/computer items). For instance, online shopping as a service takes unique identifications of purchased items and payment confirmation as service inputs (both of which are informational objects) and delivers the purchased item (which is physical goods) to the buyer as service outputs.

Yet another modeling concept on the dimension of service consumer is service (un-)bundling. (Kohlborn et al., 2010) conceptualize an approach for service bundling suggesting that services can be consolidated into service bundles. Typical examples include the bundling of flight (as a service), accommodation (as another service) and car rental (as yet another service) to make a travel package that can be offered to travelers (as a service bundling) with some advantages over consuming these services separately (e.g. attracting costs, no need to work out the timing and location of individual bookings). In the opposite direction, service unbundling is the practice where a potentially-unbundled service can be untied so that service consumers can make their own choices in consuming certain parts of the unbundled service they really want to. For instance, as illustrated in Figure 2, an airlines company can unbundle their services of ordinary flights to make available the following service offerings to passengers who travel on budget: low-cost flights, speedy boarding, heavy luggage check-in and onboard meals. Note that pictograms of service (un-)bundling are drawn using dashed lines. The multi-point star symbols and dashed arrows running from service (un-)bundling to the stars stand for the service offerings of (un-)bundling to travelers – the main service consumer in this example. In general, the practices of bundling and unbundling services are driven by a pricing or marketing model.

The Representational Dimension of Service Provider

As for the service providers, the concepts that matter are the returned or co-created values, the service capabilities and service decomposition. In providing a service, providers of the service expect to get something in return. It could be returned values such as payments or acknowledgements. It could be values that are co-created by the consumers of the service. To give an example, let us consider house painting as a service. The painter will get paid (i.e. returned value) and learn some painting patterns while collaborating with the house owners in order to have the house painted in the way that most satisfies them. A co-created value in this example is that the painter will benefit from the painting patterns she/he learnt and will use them in her/his future businesses.

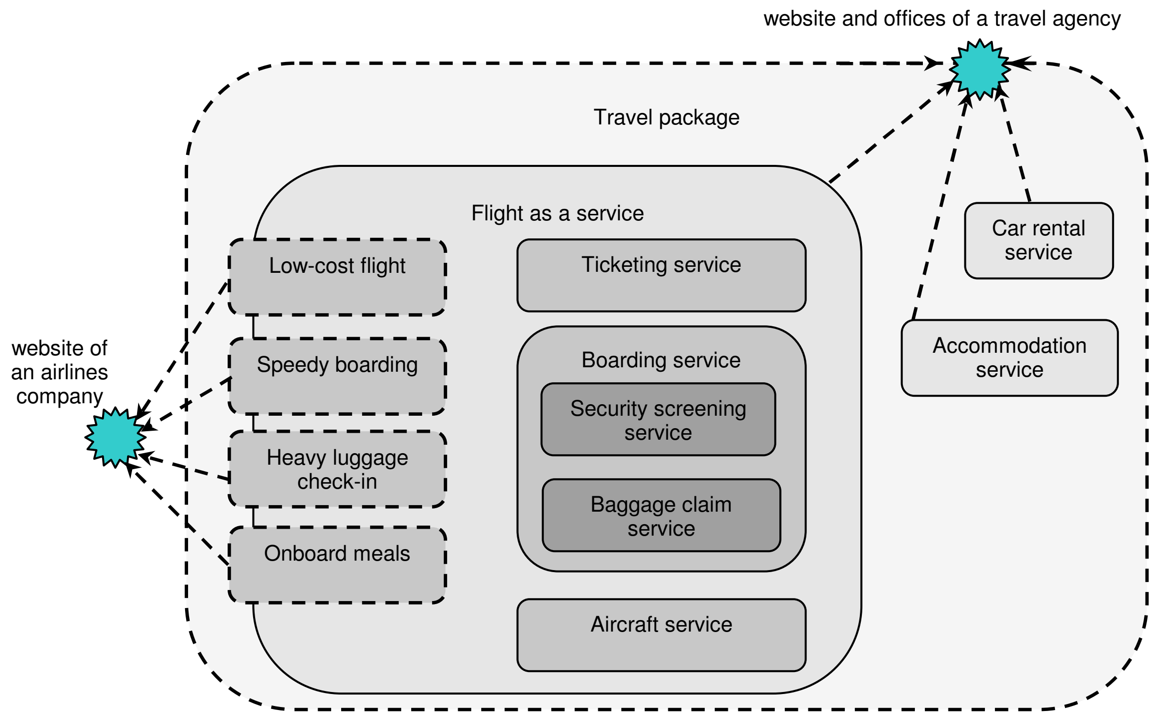

Figure 2: The `Flight` as a service can be decomposed into `Ticketing`, `Boarding` and `Aircraft` services. Unbundling this service yields `Low-cost flight`, `Speedy boarding`, `Heavy luggage check-in` and `Onboard meals`. Bundling `Flight` together with `Car rental` and `Accommodation` results in `Travel package`. The services `Security screening` and `Baggage` can be composed to realize the `Boarding service`. This service bundling and unbundling are made available to travelers through touchpoints.

Service capability is the modeling concept that permits reasoning on what a service does in order to deliver its values and provision its outputs. A service can have multiple capabilities. For instance, the `Flight` service is capable of taking passengers onboard and landing them at the destination airport as scheduled. This service is also capable of checking-in passenger's baggage and delivering it at a designated baggage claim. The concept of service capability takes its root from business modeling. (Homann, 2006) conceives the business as a network of capabilities. (Pohle, 2005) stresses that business components have capabilities. Service capability may not give imperative details of how service values and outputs can be achieved. Nevertheless, when it comes to service decomposition that will be discussed below, grouping service capabilities is the most natural way for service providers to design the decomposition of their service. In the literature, service capability is well addressed in existing service describing languages including the work done by (O'Sullivan, 2007), USDL and BSDL.

Service decomposition represents the manner in which a business service can be broken down for the ease of its design, operationalization or management. Let us reconsider the example of a flight as a service illustrated in Figure 2. In order to operationalize this service, its providers (i.e. an airlines company and airports) can decompose it into ticketing service (i.e. selling and advertising flight tickets) boarding service (i.e. boarding and landing facilities) and aircraft service (i.e. aircraft maintenance and flight attendance) These constituent services can be subcontracted to ticketing agents, airport departments and aircraft maintenance teams. Note that pictograms of (de-)composed services are drawn using solid lines in Figure 2. Other ways of decomposing business services include outsourcing, co-sourcing and delegation (Lê et al., 2010a). This decomposition may not be visible to the service consumers (e.g. passengers). On the other hand, some airport departments have facilities and resources for running security screening and baggage claim. They can compose these two services to offer a more cohesive service - the Boarding service that is consumed by the providers of the `Flight` service.

Whilst the concept of (de-)composition looks similar to that of (un-)bundling, they actually come from different perspectives: the service provider's perspective and the service consumer's perspective, respectively. The concepts of service composition and decomposition give a white-box view to a business service whereas the concepts of service bundling and bundling provide a black-box view. The former is useful for designing and operationalizing business services and the latter is helpful for consuming services effectively. For a given business service, the way that it is (de-)composed can be independent of how it is (un-)bundled. In most cases, it is not necessary for the service consumers to be aware of how the service they are consuming is decomposed or composed with others. In addition, service (de-)composition and service (un-)bundling have different objectives. The former aims at achieving a "good" design of services whereas the latter is usually driven by a pricing or marketing model. Traditional merits of software modularization such as low coupling and high cohesion (Stevens et al., 1974) also apply in the case of service (de-)composition.

The Representational Dimension of Service Context

The dimension of service context features strategy, assumption and touchpoint. We can bear on the analysis of how business services are designed, operationalized and consumed by bringing goals to the representation of services. For instance, the businessperson who takes a charter flight from Melbourne to Brisbane has three goals: a) To get to Brisbane before the meeting she/he attends; b) To spend no more than 8 hours on travelling; c) To have a pleasant trip. These goals make him take a flight although he may have other choices such as driving. The airlines company that operates this charter flight has a goal of winning travelers who are in need of fast and reliable transportation means from other competitors (e.g. rental car companies). In fact, goals can be considered as one kind of business strategy. We can broaden this principle to cover other kinds of strategy, including business plan and optimization objective (Wang and Ghose, 2006). Modeling strategy in service context allows us to catch business intent behind and to align services with this business intent, which would lead to the representation of service capabilities, service values and co-created values.

Service assumption addresses the expectations on both the service provider and the service consumers. The service providers are expected to operationalize the service they are providing according to service capabilities specified. The expectation can be elaborated into schedules and penalties. For example, a pizza maker is expected to deliver a hot pizza to his client in 15 minutes after payment is made. If she or he delivers the pizza in 30 minutes, she/he has to refund his client 50% of the payment she/he received. On the other hand, the client is expected to be present at the counter or at his place at the time of pizza delivery. We consider expectations of service providers and consumers, schedules and penalties all as service assumptions. Assumptions normally hold but may be violated in some situations. Assumptions should be regulated by third-party stakeholders who can objectively judge the situations where they do not hold, independently of the interpretation of service providers and service consumers. Assumptions such as schedules and associated penalties may represent on-going behavioral aspects of a business service – the representational concepts that matter during the occurrence of a business service. This is a distinctive feature of the representation of business services in the sense that the course of occurrence of business services, unlike that of Web services, is observable and thus should be explicitly captured. An alternative approach of capturing responsibilities, schedules and penalties is to separate them from the functional aspects of services and regard them as non-functional properties. However, as the border between functional and non-functional properties typically blurs and depends on the interpretation of service stakeholders, this separation is quite subjective and is difficult to formulate.

Service touchpoint is the place where service interactions happen (Bitner, 1990). Through touchpoints, the service is experienced and perceived with all the senses. In a service ecosystem, a provider can deliver services across multiple touchpoints such as the Internet, self-service technologies or face-to-face communication. As an example, many pizza restaurants (e.g. Pizza Hut) now allow their customers to order over the phone, the Internet, or the traditional in-store service desks. A service can be made available at multiple touchpoints, as exemplified in the pizza example. On the ether hand, a single touch point can host multiple business services. For instance, as illustrated in Figure 2, travelers can rent cars, reserve hotels or book flight tickets all at a travel agency office. Service providers can develop new business services and deploy them at a well-known existing touchpoint in hope that the services can quickly reach their potential consumers. To this end, touchpoints having great interaction bandwidth eventually give birth to new business services.

Representational Space of Business Services – The 3 x 3 x 3 Approach

Figure 3 illustrates the representational space of a business service. In our approach, a service representation can be interpreted as the set of points in the 3-dimensional space formed by service provider, service consumer and service context. There are a total of nine main points (illustrated by small circles with thick lines and enumerated as P1, P2…P9) in this space. They all lie on a geometric plane. Table 1 gives intuitive meanings conveyed by these points.

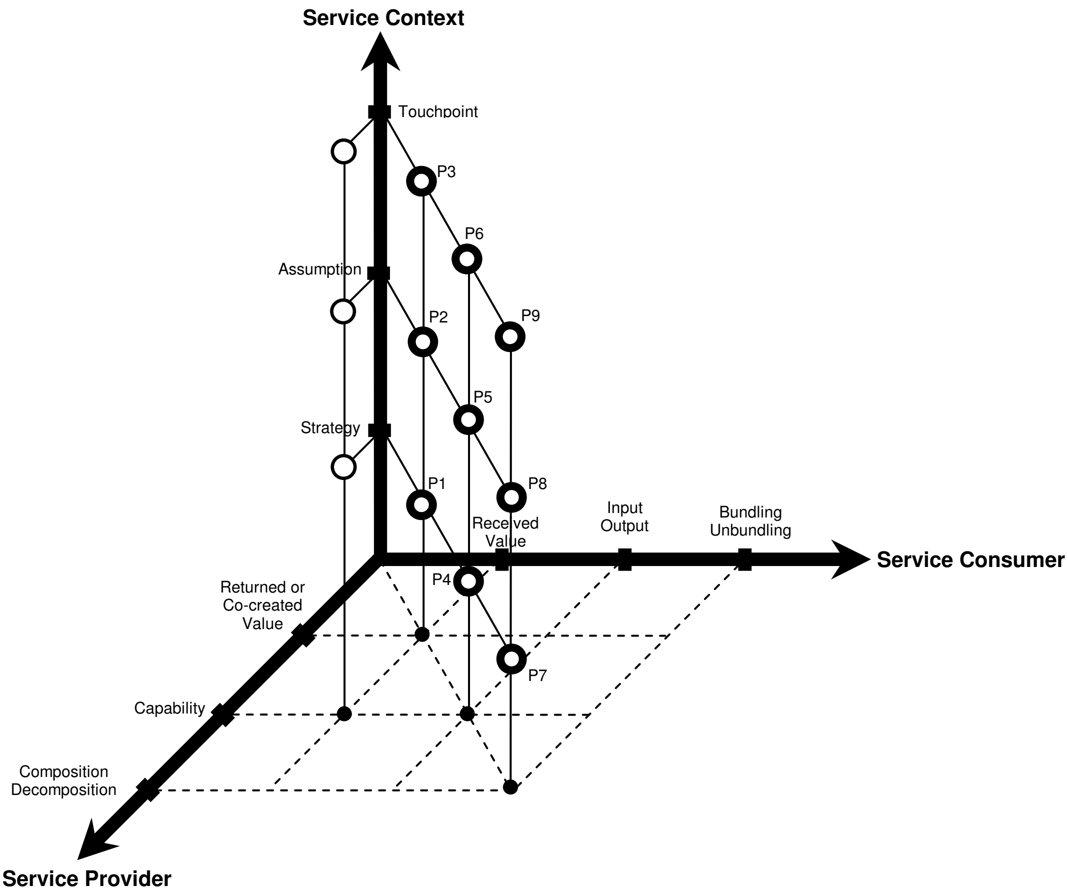

Figure 3: The representational space of business services has a total of 27 representational points (3 x 3 x 3). For the sake of simplicity, only 12 points (out of 27) are illustrated in this figure.

Other points in this representational space could be interpreted in a similar way. For the sake of simplicity, we show only three points of this kind in Figure 3. They are illustrated by small circles having thin lines in this figure. Theoretically, the representational space has a total of 27 points. For this reason, we give our three-dimensional service representation a shorter name – the 3 x 3 x 3 approach. Note that this three-dimensional representational space specifically addresses all issues identified at the end of the previous section, namely the failures of capturing values, strategic antecedents, service assumptions and service context in modeling business services.

Table 1. Intuitive meanings of the main nine points in the representational space of the 3 x 3 x 3 approach

Point	Intuitive Meaning
P1	Strategies relate values, co-created values and returned values of business services.
P2	Assumptions can be assigned to co-created values and returned values of business services.
P3	Touchpoints help judge values, co-created values and returned values of business services.
P4	Strategies help identify capabilities and input/output of business services.
P5	Assumptions can be put on capabilities and input/output of business services.
P6	Touchpoints help define capabilities and input/output of business services.
P7	Strategy give hint on how business services are (un-)bundled and (de-)composed.
P8	Assumptions can be put on the ways business services are (un-)bundled and (de-)composed.
P9	Touchpoints help identify potential (un-)bundling and (de-)composition of business services.

TOWARDS A METHODOLOGY FOR SERVICE ORIENTATION

In the previous section, we have described a three-dimensional approach to represent business services. When it comes to methodology in service-oriented computing, services should be treated as the first citizen (Chang and Kim, 2007), in the same manner that objects are regarded in object-oriented methods (Booch, 1993) (likewise, component in component-based development (Atkinson et al., 2002), (D'souza and Wills, 1999)). In this section, we discuss how our 3 x 3 x 3 representation approach can support service-oriented methodologies. We consider the following three phases in the development of service-oriented systems: service identification, service specification, and service operationalization.

Service Identification

One of the tasks of service analysis and design is to identify service candidates. The importance of service identification is amplified when the target system is a service ecosystem which consists of a large number of services. Existing work such as (Dhanesha et al., 2009) (Scheithauer et al., 2009) tend to focus on proposing techniques for describing and decomposing business services and fail to address the importance of how these services can be identified at the first place. (Kohlborn et al., 2009b) analyzed the state-of-the-art in service-oriented methods and concluded that a comprehensive approach to the identification and analysis of both business and supporting software services was missing. They then proposed a consolidated approach for the identification and derivation of both software and business services. Since services are the fundamental entities in service-oriented systems, we believe that a critical requirement for a service analysis and design methodology is to assist the developers in identifying services that constitute the system. We look at the phase of service identification from the angle of correlation between strategies and services.

A service ecosystem can be considered as an organization of services. Therefore, we adopt an organizational view of the world and encourage a designer to think of building service-based systems as a process of organizational design. An organization has a certain number of participants playing different roles. For instance, the airport organization has several roles played by different people including administration, security guard, air-traffic controller, passenger, etc. Different roles in an organization interact with each other to achieve their own strategy and also to contribute toward the overall high-level strategy of the organization.

Therefore, we believe that a natural step to service identification is to start from identifying roles, their strategy and their relationships. Roles allow for a combination of both top-down and bottom-up design. They are identified by a top-down process of strategy modeling. At the same time, they provide a bottom-up mechanism for determining service types and their responsibilities. In the example of an airport organization, we can start by listing high-level business strategies in this organization. Examples of such strategies include transporting passengers from one airport to another, handling baggage, security screening, providing lounges, maintaining aircrafts and so on. These can provide a basis for refinement into a more extended list of strategies/goals that can then be grouped into roles. The strategy refinement process can be conducting using techniques of asking the questions of “how” and “why” as proposed in goal-oriented requirements engineering (Lamsweerde, 2001).

The next step is to identify various roles participating in the operation of an airport by grouping related strategies. For instance, there is a role responsible for transportation, a role for managing the airport facilities, a role for handling baggage, a role for dealing with security, etc. A role can be responsible for a number of related strategies. Service participants are then formed by grouping these roles in which a service participant can play one or more roles. For instance, a service participant is responsible for passenger transportation, one for baggage handling, one for security screening, and one for providing business lounge service. Grouping roles into service participants is an important decision during the process of service analysis and design. There are potentially different options which can then be evaluated using the classical criteria of coupling and cohesion. These two criteria are crucial in service oriented architectures since they should enable business participants to work together more cohesively using services without getting overly coupled.

After identifying service participants within a service ecosystem, a further step is to examine the interactions between service participants at various touchpoints. Such interactions form a service context in which touchpoints, assumptions and strategies are defined. Finally, a service participant will be designed to be capable of playing each role in the interaction, and providing the services necessary means to fulfill the responsibilities of that role. Therefore, roles can also serve as an indication for defining the values and capabilities which a service participant offers. In fact, we need to flesh out what capabilities are necessary for a service to fulfill its responsibilities as outlined in the roles it play.

Service Specification

Representing business services from perspectives of the ecosystem context, the strategic alignment, the provider/consumer deepens the specification of services in the sense that it captures modeling aspects that otherwise are considered as methodological issues. The more modeling aspects captured in the service representation, the more straightforwardly a service-oriented methodology can be developed. This is a direct methodological support of the 3 x 3 x 3 representation approach. Specifically, the separation of service consumer's perspective and service provider's perspective reduces complexity of a service-oriented design. More specifically, the separation of service (de-)composition and (un-)bundling would lower the degree of service coupling in the same fashion the principle of information hiding does to object-oriented analysis and design (Booch, 1993). Likewise, capturing service values independently of modeling service capabilities has the same advantage.

Service Operationalization

As discussed in the previous section, touchpoints having great interaction bandwidth can lead to the operationalization of new business services because the service providers see benefit in deploying their services at this interaction hub. This is another methodological support of our representation approach. By including touchpoints in the representation of business services (see Table 1), we can model the way services are deployed and operationalized, analogously to the deployment of software components is represented in Unified Modeling Language (OMG, 2010).

This phase also determines how a business service can be realized by service providers. The realization could be done by consuming the services of other stakeholders or by using their own business processes. The first step usually involves determining the internal structure of a service provider in terms of an assembly of parts representing other service providers. The next step is to model the business process that take place between such service providers to realize the service capabilities represented. In this sense, business process models can also be used to specify service composition and orchestration.

APPLICATION

In this section, we briefly present our on-going work on a case-study in which we have been partially applying the proposed service representation approach. The case-study is about an agency that is about to provide business services under the government body of an Australian state. They proposed a total of 29 services and documented them using their own ad-hoc template. We studied this document and populated all documented services using the 3 x 3 x 3 representational approach presented in this paper and the BSDL language we previously defined (Lê et al., 2010a).

Lessons learnt in this application

Although the case-study in this application has not been completed, we were able to learn the following while applying our 3 x 3 x 3 approach.

- Some fields in the document can be straightforwardly populated. For example, what are documented as service items in the catalog were directly mapped to service capabilities. However, the document contains inconsistent and potentially ambiguous fields. As an example, we came across a field that means service capability for some entries in the document but is closer to service assumption for others. The population of these fields was done flexibly.
- We found an interesting way to extract what is described as service measurements to service assumptions, including delivery schedules and obligations. We came up with initial representation of this service catalog after having harmonized all these noises.

- The initially-populated model was incomplete. For instance, it is unclear how the services documented in this catalog can be (un-)bundled or (de-)composed. We augmented this representation by decomposing a total of 9 services and populated the constituent services at the same level of details as we did to the decomposed services. The decomposition of these services was made by grouping their service capabilities, services assumptions in a way that maximizes the cohesion of constituent services.

On-going work is being carried out on this case-study with the aim to obtain a fully-populated service representation of the service catalog and to help the agency identify additional business services that would be of their interest.

CONCLUSION

The increasing popularity and influence of service-oriented computing give rise to the need of representational and methodological supports for the development and management of business services. Business services have distinctive features that are not typically observed in Web services. Most notably, business services occur for a noticeable period of time, not spontaneously as Web services do. Business services may be performed in the context of a service ecosystem. Moreover, business services bring added values to businesses of their stakeholders, including service providers and service consumers. Furthermore, business services are aligned with business strategy within an organization or between multiple organizations, and vice versa. Modeling business services should arguably capture these inherent features, along many other representational artifacts. Motivated by this problem, and after having identified this gap in the state-of-the-art, we propose a novel approach in modeling business services. The approach defines three-dimensional representational space whose each dimension features three modeling concepts. The three dimensions in this approach stand for the service consumer, service provider and service context. We name this the 3 x 3 x 3 approach, recalling that there are up to 27 representational points in the representational space of business services. We also discuss how a service-oriented development methodology can leverage this representational approach. The approach (not the methodology) has been applied in a case-study that requires detailed representation of a catalog of business services managed by an agency. We populated a total of 29 services using the proposed approach from documents provided by the agency with some augmentation and correction.

We consider the following future work directions i) formalizing semantics of modeling concepts in the representational dimensions; ii) developing verification techniques for service decomposition; iii) having service representation visualized in a toolkit; iv) seeking for big-scale applicability of the 3 x 3 x 3 approach. In the first direction, we aim to formally define denotational semantics (Allison, 1987) for modeling artifacts and ways they are combined in the representational space. In the second direction, work is currently underway on developing machinery that checks whether inputs/outputs of and assumptions on decomposed services fully meet those of the decomposed one. In the third direction, we will implement the visualization of business services in a toolkit that we have been developing for strategy modeling and strategic service alignment (Lê et al., 2010b). In the fourth direction, we aim to complete our on-going work presented in the previous section. To further validate the application of our approach, we look for potentially new case-studies that could be sourced from industrial partners that get involved in the multi-partner project funding this research.

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