A New Service-Based Approach for Enterprise Modeling

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Abstract. At present, there exist many modeling techniques for capturing business semantics from different perspectives: transactional, goal-oriented, aspect-oriented, value-oriented, etc. The results of these modeling techniques serve as natural input for the software system generation process. However, none of these current modeling proposals takes into account the service nature of most business organizations and/or the growing importance of service orientation in computing. In this paper we present a solution to this problem: a new business service-oriented modeling approach which extends the *i** framework. The proposed approach enables analysts to represent an organizational model as a composition of business services, where business services are the basic building blocks to encapsulate a set of business process models. In these models, actors participate in actor dependency networks through interfaces defined in a business service specification. Our proposal is illustrated by several real life examples.

Keywords. Organizational modeling, business services, service-oriented computing.

Un nuevo enfoque basado en servicios para modelar empresas

Resumen. Actualmente existen muchas técnicas de modelado para capturar la semántica de un negocio desde muy diferentes perspectivas: transaccional, orientada a metas, orientada a aspectos, orientada al valor, etc. Los resultados de estas técnicas de modelado son la entrada natural para el proceso de generación de sistemas de información. Sin embargo, ninguna de estas propuestas de modelado actuales representa la naturaleza orientada a servicios de muchas organizaciones, y tampoco reconocen el crecimiento de la orientación a servicios en computación. En este artículo se propone, como solución al problema planteado, un nuevo enfoque de modelo organizacional orientado a servicios de negocios, el cual extiende el framework de modelado *i**. El enfoque de modelado propuesto permite al analista representar un modelo organizacional como una composición de servicios de negocio, lo cuales son los elementos básicos que encapsulan un conjunto de modelos de procesos de negocio. En estos modelos propuestos, los actores participan en las redes de dependencias de actores a través de interfaces definidas en la especificación de cada servicio de negocio. La propuesta es ilustrada a través de ejemplos reales.

Palabras clave. Modelado organizacional, servicios de negocio, cómputo orientado a servicios.

1 Introduction

Today there is a proliferation in companies of the Information and Communications Technology (ICT) sector that are devoted to model organizational processes in order to obtain performance analysis and to propose new ways to better execute organizational activities, before defining a system or executing a workflow engine to automate business processes. All such companies use different methods and languages to represent the organizational context according to the objectives of each company.

However, none of the well-known modeling techniques and tools for enterprise modeling and management such as Business Process Modeling Notation (BPMN) is well-equipped to face the growing importance of service orientation within ICT. In this sense, service orientation has been considered as the most promising technology for information system programming in next years, and the ICT enterprises have dedicated resources to adopt Service-Oriented Computing (SOC) in their software development process. However, it is a reality that current modeling techniques do not support primitives that capture service orientation, and do not take account the growing relevance of

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service orientation in implementing ICT applications. As a consequence, additional (and costly) modeling and programming efforts are needed to adapt the organizational concepts (from a specific view of a given enterprise) to service-oriented software systems, because there are no direct mappings of conceptual primitives of business modeling techniques to implementation primitives of service-oriented software applications.

The objective of this paper is to present a new business modeling technique which considers business services as the main modeling concept. Therefore, the principal contribution of this paper is a definition of a new modeling and methodological approach to address the enterprise modeling activity using business services as building blocks for encapsulating organizational behaviors. Also, in order to support incorporating the service-oriented approach into a well-known and well-founded business modeling technique, extensions to the *i** framework [24] were proposed as an initial work of this research [11]. Combining the advantages of service orientation and the *i** modeling, we produce a well-founded approach to model enterprises, which enables analysts to manage the complexity of modeling in an incremental manner.

We illustrate our approach using a running example of services offered by a company specializing in car rental management. In order to demonstrate a practical use of the proposed approach, we present a traffic service case study and a study of a university job vacancy service.

The paper is structured as follows. Section 2 gives an overview of related works that use services at the organizational level. In Section 3, the *i** framework is presented as a support language for the business service approach. In Section 4, the proposed business service architecture is given. Section 5 describes the business service method. Section 6 presents validation of the proposed approach, and finally, Section 7 outlines conclusions and future work.

2 Current Use of Services at the Organizational Level

Service-Oriented Computing (SOC) is one of the fastest emerging paradigms in software development today. SOC relies on the Service-Oriented Architecture (SOA) which is a way of reorganizing software applications and infrastructure into a set of interacting services [22], [23]. Basic SOA defines interaction between software agents as an exchange of messages between service requesters (clients) and service providers.

In this sense, several definitions of services have been given according to a specific domain context where service is used as a representation mechanism. For example, the work of Baida [1] offers a comprehensive survey of service definitions in several application domains (business research, computer science, and information science). This paper also reviews state of the art in the use of services at the organizational level and presents some approaches that use services at the business level.

The use of services at the organizational level is the most significant emerging research field in service-oriented modeling. The focus of this phase consists of the definition of services offered by an enterprise. In contrast to service definition at the conceptual or implementation level, the definition of services at the organizational level does not necessarily imply the definition of a software system that gives support to organizational tasks. Therefore, in these modeling phases, the focus is on the definition of abstract functionalities provided (manually or automatically) by a supplier to potential customers. This specification, which reflects the current situation of an enterprise, must be the source for generating software services which give support to organizational activities. At the organizational modeling level one also finds scarcity of methods or mechanisms to model an enterprise following the service-oriented approach. Here we present relevant works in this area.

One of the few existing proposals concerns on demand business service architecture [7]. In this proposal, the authors explore the impact of service orientation at the business level. Services represent functionalities offered by an enterprise to its customers. It considers the definition of complex services composed of low-level services.

A contribution of this work is representation of services from the customer viewpoint; however, the paper lacks mechanisms to model the complex internal behavior needed to satisfy business services. Services are represented as *black boxes* where the internal details of each service implementation are not represented; therefore, in this approach there is no mechanism to represent the relationship between services and the goals that justify their creation. This makes such

technique difficult to apply to business model reengineering tasks which are mainly based on the operational aspects of business processes.

Another example of the use of services at the business level is the proposal of software-aided service bundling [1]. The main contribution of this research is the definition of an ontology (a formalized conceptual model) of services to develop software for service bundling. A service bundle consists of elementary services, where service providers can offer service bundles via Internet. The ontology describes services from a business value perspective. Therefore, services are described by exchange of economic values between suppliers and customers rather than by physical properties.

An industrial version of this proposal is *e3value* [16]. It was developed to put into practice the concept of service bundling. Practical cases were developed to demonstrate the advantages of this proposal [15].

This modeling technique has the same problem as the proposal of on demand business service architecture. Services are defined as *black boxes*, where the main focus is on the definition of a set of inputs and outputs of a service. This is done in order to match inputs and outputs of services to be composed.

One of the main consequences of a lack of mechanisms to describe the internal behavior of services (in *e3value* proposal) is that it is impossible to relate the services offered with the strategic objectives of an enterprise. Therefore, it could be difficult to define alternative services to better satisfy the goals of the enterprise.

Another example of using services at the business level is the proposal of Service-Oriented Modeling Framework (SOMF) [3]. In order to support service-oriented modeling activities, in this proposal a service is defined as a holistic entity that may encapsulate business requirements. A service is identified with a software component from a technological perspective. The main contribution of this work is modeling services as software entities which can be used to model activities.

Service modeling in this proposal is performed through a service-oriented conceptualization model. Such model helps to discover service concepts and define service and software components by establishing relationships between services and software components and defining service attributes. In this proposal, there is no mechanism to represent the relationship between services and the goals that justify their creation; this makes the proposed technique difficult to apply to address business model reengineering tasks which are mainly based on the operational aspects of business processes.

Another proposal of modeling services at the business level is the Sensoria Reference Modeling Language (SRML) [14] which defines the functionality of a service module. This proposal provides a formal model of a service or activity in terms of a configuration of interfaces (formal specifications) to the parties involved. The authors define a service as *service-overlay computer*, by which they mean the development of highly-distributed loosely-coupled applications over *global computers*.

The concepts of this proposal are related to description of services at the level of interaction between components. Therefore, in this proposal there are no mechanisms to represent the internal behavior of a service, and there are no relationships between services and the goals that justify the creation of services defined from a software system viewpoint.

Another proposal to explore the modeling of services at the business level is Service oriented architecture Modeling Language (SoaML) [21]. The authors define a service as the delivery of value to another party, enabled by one or more capabilities. A service is provided by a participant acting as the provider of the service to be used by others.

Due to its intended purpose, this approach does not include mechanisms to represent the internal behavior needed to implement a service, and therefore, there is no relationship between services and the goals that justify their creation.

Finally, it is important to mention that there exist other frameworks which use services to model an enterprise. For example, the ArchiMate language [18] is used to model an enterprise from business, application and technology perspectives. The term service is used to model the business perspective. The problem of this proposal is that it is focused on architectural modeling, which is different from our proposed approach.

It is important to point out that in all approaches mentioned previously there is a strong dependency between the concept of services and the concept of

business functionalities. However, this key aspect of service modeling has been historically neglected in literature. At present, there exists only a partial solution to the problem of representing services at the organizational level, in the same way as the services are perceived by final customers. This paper presents a solution to this problem. In our proposal, the goals are the mechanisms that allow analysts to match business functionalities and the user needs.

Table 1 presents a comparative summary of advantages and disadvantages of existing service-based approaches overviewed in this section. The features used to compare the related works are the following: a) service orientation, b) modeling of services at the business level, c) modeling of internal details of services, d) the relationship between services and goals, e) service refinement, f) service modeling from the customer viewpoint.

It is important to note that the proposed approach has relevant implications on current SOA approaches because most of them are designed at the implementation level. In this case, services are defined at a higher level of abstraction which could be the starting point for generating low level service-oriented mechanisms.

Table 1. Comparative summary of existing service-based approaches

Features / Prop.	a)	b)	c)	d)	e)	f)
Chervakov (2005)	x	x			x	x
Ziv (2006)	x	x			x	x
e3 value (2003)	x	x			x	x
SOMF (2008)	x	x				x
SMRL (2006)	x	x				
SOAML (2009)	x	x				x
Archimate(2004)	x	x				x
Our proposal(2008)	x	x	x	x	x	x

3 The *i** Framework as Support Language for the Business Service Approach

The *i** framework [24] is one of the most well-founded organizational modeling techniques in use today. The *i** framework supports the description of organizational networks made up of social actors which have freedom of action but depend on other actors to achieve their objectives and goals. It mainly focuses on: a) the representation of social and intentional relationships among the network of actors of an enterprise, and b) the representation of the internal behaviors required to satisfy actor dependencies.

As mentioned before, the objective of this research work is to provide a new approach to represent business services at the organizational level that solves current problems in this area. In such context, *i** framework was used in this work. The reason is that this language allows analysts to explicitly define the strategic relationship of actors to provide and request a service. Besides, the goal concept permits the existence of services based on enterprise goals.

The Tropos and *i** framework have been used in several application areas including: organizational modeling [17], object-oriented system development [6], [12], agent system development [4], [2], non-functional requirements [8], etc. However, to accurately detect strengths and weaknesses of the *i** framework in practice, an empirical evaluation was performed [13]. This evaluation considered two main aspects of the *i** framework: a) modeling language (refinement, modularity, repeatability, complexity management, expressiveness, traceability, and reusability) and b) pragmatics of the modeling method (scalability and domain applicability).

As a result of empirical evaluation, it can be concluded that the *i** framework offers a well-founded language for describing organizations as a network of actors related through dependencies representing social behavior of actors in an enterprise. Compared with other intentional modeling languages, the *i** framework offers a well-defined set of concepts [20]. For example, KAOS [10] does not consider the concept of an actor in the definition of conceptual models which makes it difficult to represent the network of actors and dependences of services between actors. However, there are several issues that need to be solved to enable its practical application. In this work, we propose an extension of *i** framework in order to use it as a support language for our service-oriented business approach.

4 The Proposed Business Service Architecture

Research presented in this paper is based on a hypothesis that it is possible to focus the organizational modeling activity on values (services) offered by an enterprise to its customers. Here, we call them business services. Following this hypothesis, the proposed method provides mechanisms to guide the organizational modeling process based on the business service viewpoint. In this context, business services can be used as the basic granules of information that allow us to encapsulate a set of composite process models. The use of services as building blocks enables analysts to represent new business functionalities by composing models of existing services.

One of practical implications of this proposal is that the focus of the modeling activity is changed from the viewpoint of actors or process (of the traditional business modeling approaches) to the viewpoint of service. Our modeling process starts with considering an enterprise as a service provider and eliciting services which the enterprise offers to its end customers. As our approach is goal-oriented, any service exists because it can be seen as the translation of its corresponding goal. The following step consists of determining the way in which these mappings between business services and goals are fixed and specified at the enterprise level. Once the services have been elicited, we need to refine each service in the set of business processes needed to perform it. As a result of this new approach, the mechanisms for decomposition, refinement, and modularity are focused on services.

It is important to point out that our work is a part of a large research project where the following components are proposed: a) a modeling language that extends *i** modeling framework to support services, b) a three-tier architecture that captures relevant aspects of services: composition, variability, goals, actors, plans, behaviors, c) an elicitation technique to find current implementations of services offered and requested by the analyzed enterprise, where goals play a relevant role in the discovering process, d) a specific business modeling method to design or redesign an enterprise in accordance with the concept of business service, e) a formal definition (axioms) of the modeling primitives and diagrams of the service-oriented architecture. In the entire project, formal (axioms) and informal (diagrammatic) definitions are provided for business service components. In this paper we briefly mention the informal definition of the business service architecture and the service-oriented method as contributions of the business service approach.

In the following subsections, relevant components of the proposed architecture are pointed out: the concept of business service, the characteristics of the business service orientation, the architectural models and the business service components.

4.1 Our Definition of a Business Service

We have defined a business service as a functionality that an organizational entity (an enterprise, functional area, department, or organizational actor) offers to other entities in order to fulfill its goals [11]. To provide the functionality, the organizational unit publishes a fragment of a business process as an interface with the users of the service. The business service concept refers to the basic building blocks acting as containers in which the internal behaviors and social relationships of a business process are encapsulated.

Our service-oriented architecture provides a formal relation between an abstract representation of services and the set of processes that perform them. Service specification is a contract specifying the rules that determine collaboration of providers and requesters in order to achieve their objectives.

The proposed definition of a business service complies with the definition of services defined in business research in the sense based on organizational activities and customers. However, our definition is different from those provided by current research works because it emphasizes the social and intentional perspectives of services rather than the traditional transactional perspective.

A service can be seen as an explicit agreement among customers (who want to fulfill their goals by using the service) and providers (who want to fulfill their own goals by offering the service). Using the service, the customer extends her capabilities and a set of services provided by an external entity. Therefore, the customer delegates the responsibility to the provider to perform the activities of the service. Although the delegation of responsibilities among requesters and providers extends the capabilities of the requester, it can

also affect the latter who becomes vulnerable if the provider fails to deliver the service.

A business service plays the role of an interface between the provider and the requester. This indicates that all interactions among these actors must be contained in the definition of the service. It also indicates that the service is the only mechanism allowed to associate the enterprise and the customer. This characteristic enables analysts to encapsulate all business processes associated with the service in the abstract concept of service interface.

Business services were represented using an extension of the notation of the *i** framework. The concept of dependency provided by the *i** framework was modified to appropriately represent the social agreement between customers and providers. In extension to the *i** notation, the goal dependency must be linked with a business service placed on the boundary of the service provider. A business service is graphically represented as a parallelogram located on the boundary of the business actor. In the graphical representation (Fig. 1), the service has been placed on the boundary of the provider actor to indicate that the business service is the only interface between providers and requesters. The

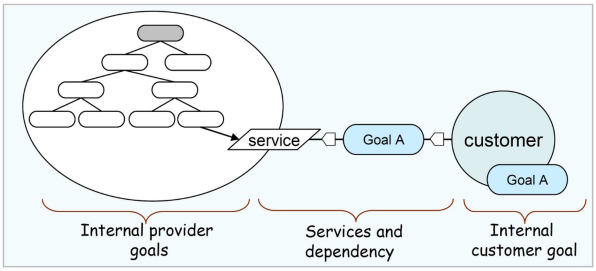

Fig. 1. Business Service Notation

arrows of the dependency must always be directed toward the service provider. Each actor can provide 0...n services, and each service can be requested by 0...1 end consumers. This implicit cardinality indicates that an organizational actor is not obligated to offer services; however, if a service is offered, then there must be at least one potential consumer.

In our approach, services have a direct influence on the fulfillment of the goals of customers and providers. This makes our proposal different from current research works based on describing services as transactional activities or services as business value generators.

4.2 Characteristics of Business Service Orientation

Here we discuss how the business service-oriented approach presented in this paper complies with the following set of principles of service orientation. **Business services are autonomous.** All business activities needed to satisfy services reside within an explicit boundary.

Business services share a formal contract. A business service can be considered as a contract between the provider and the requester.

Business services are loosely coupled. The set of dependencies among requesters and providers which make up the service must be limited in order to comply with the service contract.

Business services abstract underlying logic. The business logic beyond the abstract service definition must be invisible to the outside world.

Business services are composable. One of the main objectives of this work is to provide a solution to the scalability issues in *i**.

Business services are reusable. Regardless of whether immediate reuse opportunities exist, services are designed to support potential reuse.

Business services are discoverable. An enterprise must make fragments of its business process public in order to allow its customer to use a specific business service.

4.3 The Three-Tier Architectural Models

The business service architecture is composed of three complementary models representing what an enterprise offers to its environment and what this enterprise obtains in return.

Global Model. In the proposed method, the organizational modeling process starts with the definition of a high level view of services offered and used by an enterprise. A global model permits the representation of business services and the actors playing the role of the requester and the provider.

Extensions to *i** framework conceptual primitives are used in this model. Fig. 2 shows a fragment of the detailed view of the business service global model for the running example. In this case, the goals of the services offered by the enterprise (flight reservation, car reservation, hotel

reservation and integrated travel planning business services) were mapped to the strategic interests of the enterprise. In this stage, services are categorized into basic services (a basic service is decomposed into processes without further service decomposition) and composite business services (a composite service aggregates multiple business services) which are composed using the variability model [9].

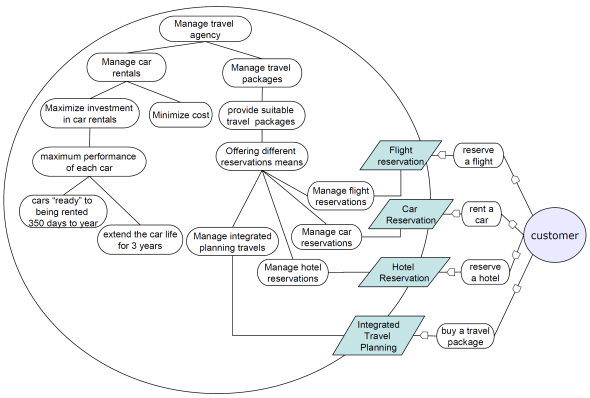

Fig. 2. Fragment of the detailed view of the global model for the running example

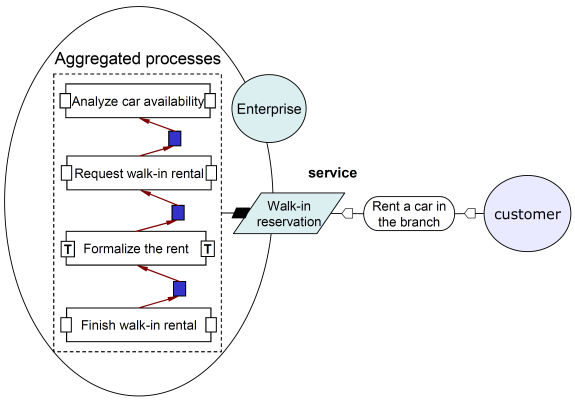

Fig. 3. Example of the process model for the running example

Process Model. Once business services have been elicited, they must be decomposed into a set of concrete processes that perform them. To do this, we use a process model that represents functional abstractions of a business process for a specific service. The process model provides mechanisms required to describe the flow of multiple processes. Extensions to *i** conceptual primitives are used in this model. Fig. 3 shows an example of a simplified view of the process model for a walk-in rental car case study. In this model, milestones indicate the execution order as follows: to request a walk-in rental, it is necessary to analyze car availability first. To formalize car rental, a request is needed, and finally, to finish the business service, it should be formalized in a previous time. The current process model is focused on indicating the processes that are part of a business service.

Protocol Model. Finally, the semantics of the interactions and transactions of each business process is represented in an isolated diagram using the *i** conceptual constructs. This model provides a description of the set of structured and associated activities that produce a specific result or product for a business service. This model is represented using the redefinition of the *i** modeling primitives. Fig. 4 presents an example of the protocol model for the running example. It is important to point out that the definition of business interactions enables analysts to represent an enterprise as a service requester. In this model, the enterprise depends on the customer to obtain her personal data, and the customer depends on the car rental company to obtain acceptance or rejection of her request to rent a car. In our case study, the analyzed enterprise uses an external business service provided by a bank entity to validate the credit of the customer who requested a walk-in rental.

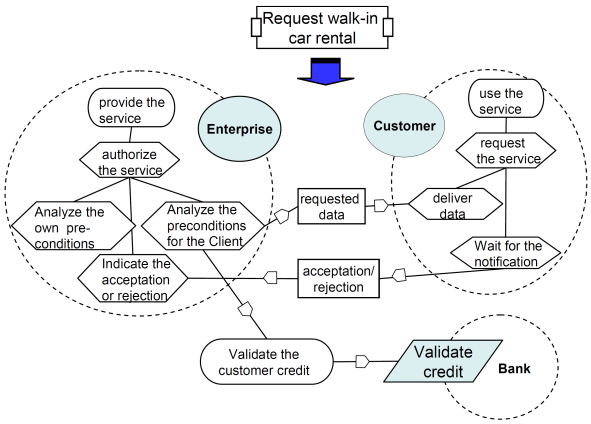

Fig. 4. Interaction needed for requesting a walk-in car rental (protocol model)

The proposed approach enables analysts to reuse the definition of protocols by isolating the description of the processes in separate diagrams. In this way, the process model represents a view of the processes needed to satisfy a service but without giving details of its implementation. Each business process is detailed through a business protocol model. This model is represented using the *i** notation.

The main idea of this approach is to promote the granularity of the service definition by isolating the organizational behavior of each business service in a separate business description.

The meta-model that represents these elements of the business service proposal for the *i** framework is presented in Fig. 5. The proposed meta-model establishes that business services are the mechanism to fulfill the business goals. Business services are composed of business processes which can be defined as transactional or non-transactional business processes.

Business services and business processes are both represented by using the proposed extension to the *i** modeling primitives. Finally, the meta-model indicates that business interactions, which are the low-level specification of a business service, need to be represented with *i** modeling primitives. This protocol model represents the organizational behavior needed to perform a business process.

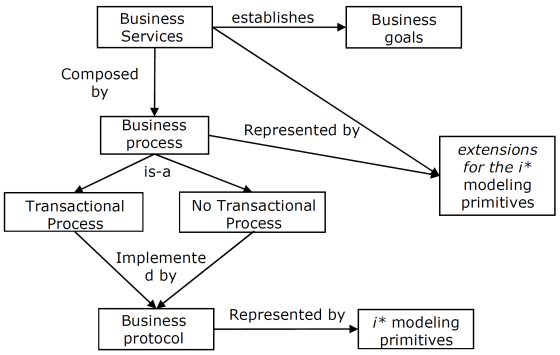

Fig. 5. The meta-model of the service-oriented architecture

The business architecture permits representation of the following key aspects: a) services offered by an enterprise, b) providers (enterprises) and requesters (final customer) involved in a service, c) communication between providers and requesters, d) reasons for the enterprise to offer a service and reasons for the customer to request it, e) values interchanged by the execution of the service and the reason for transferring these values, f)reasons for the values being interchanged among the service participants.

4.4 Service-Oriented Components

In order to make application of the service-oriented architecture possible, several aspects were considered in this work. The set of service components includes actors, business services, service offering and supporting, service requesting, service visibility, and service delegation rules. A complete description can be found in [11]. Each of these components, which influence the definition of the service architecture, is explained in the following paragraphs using real life examples.

Actors. Our service-oriented approach considers an actor composite structure in order to represent the hierarchical relationships between actors. Fig. 6 shows the composite actor structure for the car rental example, where the subordinated relationship enables analysts to represent the capability of an actor to assign responsibilities to its subordinates. A business actor is graphically represented as a circle with the name of the actor, as defined in the original *i** framework definition.

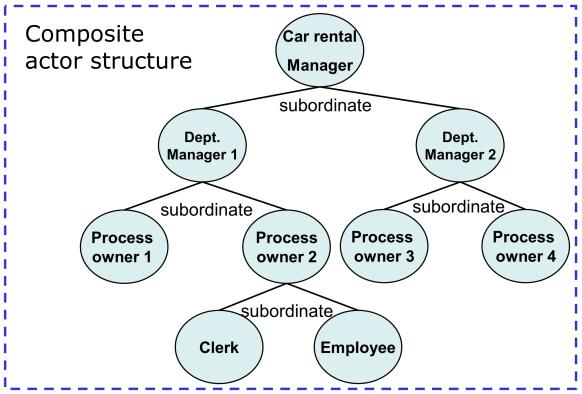

Fig. 6. The composite actor structure

Business services. A business service is a self-contained, stateless business functionality that is offered to potential customers through a well-defined interface. Business services were represented using an extension of the *i** framework notation. In this proposal, two types of business

services are distinguished: basic and composite business services. Fig. 7 shows a real life example of basic (walk-in reservation) and composite (integrated travel planning) services.

Service offering and supporting. Services of this kind are requested by a number of external customers that use the service interface to interact with the service provider. Customers interact with business services in a manner prescribed by the restrictions imposed by the enterprise that offers the corresponding service or by external entities that regulate the service. Fig. 8 shows an example of supporting business services associated with the offered walk-in rental service.

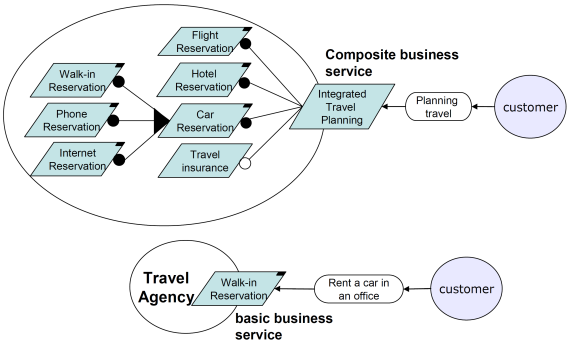

Fig. 7. Example of composite and basic service

Service requesting. In order to provide the functionality associated with business services, an enterprise must offer certain fragments of its business processes as an interface with potential customers. One of the fragments that need to be offered is the mechanism for requesting a service. Fig. 8 shows an example of supporting business services associated with the offered walk-in rental service.

Service visibility. An advantage of modularity is the possibility of using mechanisms to control visibility between the service requester and the service provider. Two different kinds of visibility aspects are considered in this work: actor and service visibility. Fig. 6 shows an example of service visibility, of services and processes of other subordinated actors. For example, a car rental manager has visibility of all services of all actors.

Service delegation rules. Based on the hierarchical model defined in the composite actor structure, an actor responsible for a business service can delegate it to its subordinated actors based on the hierarchical model defined in the composite actor structure. Fig. 6 shows an example of a service delegation rule, where a car rental manager actor can delegate the responsibility to perform a service to her subordinated actors.

Business processes. The main idea of the proposed service approach is the reification of abstract representation of services into concrete business processes. A model that provides an abstract representation of business processes is proposed (business process model) as an extension of the *i** framework. Fig. 9 shows an example of the processes needed for requesting a walk-in rental service.

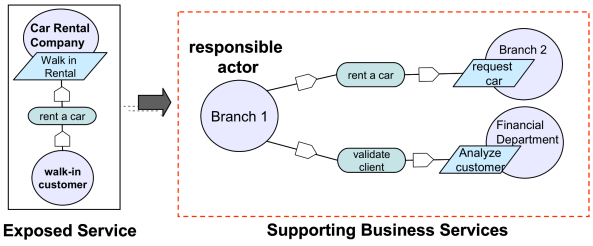

Fig. 8. Example of supporting business services

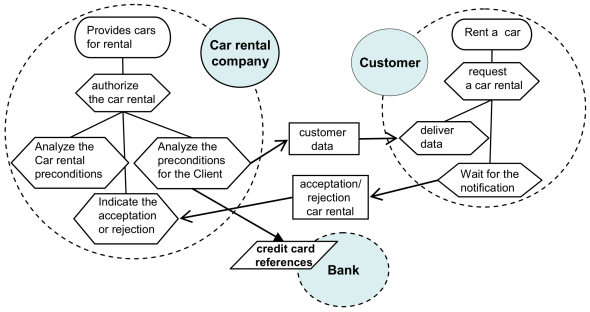

Fig. 9. The requesting process for a walk-in car rental service

5 The Business Service Method

The main objective of the proposed service-oriented method is to produce a description of the current way in which an enterprise offers/uses services in order to fulfill its current needs. The objective of the method is to create a simple view of the services used and offered by an enterprise. The details about the reification of

business services into business processes are also represented in this modeling approach [11]. The idea of this work is to represent a current enterprise situation based on a service-oriented architecture. To do this, four aspects need to be represented: a) what: a definition of the scope of services, i.e., determining what the service actually is, b) who: a definition of external actors that drive the service, c) why: identification of the reasons to offer services, and finally, d) how: representation of the details about the processes that implement services.

To give an appropriate solution to these aspects, a three-step method is proposed to enable analysts to produce service-oriented business models (Fig. 10).

The first step is to represent the current enterprise situation which consists in a service global model definition. The objective of this phase is to define a model that represents the business services offered and used by an enterprise to fulfill its current goals. Once the external business services have been represented in the service global model, the delegation structure for each business service must be identified and represented using the composite actor structure.

The second step of the method consists in creating a business process model for each elicited business service. The objective of this phase is to identify and represent business processes that make up each one of the business services.

The last step in the representation of the current enterprise situation is the definition of a business protocol model for each business process defined in the previous steps. Once the process model has been represented at a high abstraction level using the business process model, the behavior of each one of the processes that compose the business service must be identified and represented. A protocol model, which uses the reviewed version of the *i** modeling language [11], is generated for each process as a result of this step. The proposed approach provides support necessary for managing the complexity of the modeling activity, allowing analysts to represent each fragment of a business service in isolated diagrams.

As an additional step of the method (not represented in Fig. 10), once the current enterprise situation has been defined, it is possible to use the generated diagrams to produce a description of alternative solutions for offering/implementing business services in order to satisfy the desired goals of the enterprise. The objective of this modeling stage is to generate new descriptions of business services that enable the enterprise to adapt to new external conditions. To do this, softgoals need to be used to evaluate new services according to the quality factors desired in the enterprise.

The architectural models presented in this research work are proposed in order to represent

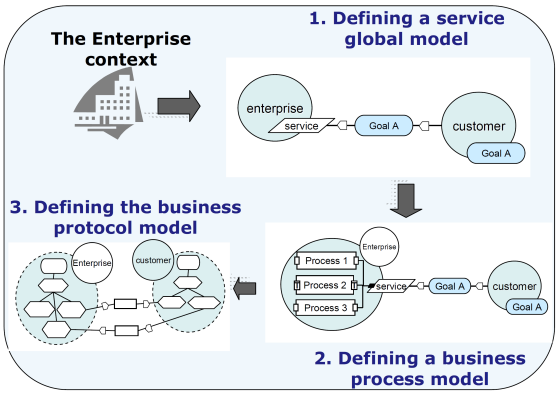

Fig. 10. Business service overview

the four key aspects relevant to business modeling (what, who, why and how). A global model is an appropriate means to represent the what, who and why aspects. A process model gives a high level view of the processes that compose each service (what and how). Finally, a protocol model offers a detailed view of the implementation details of each business process (how).

An advantage of the service-oriented method proposed in this work is the explicit capability of the method to align the goals with service refinement levels. Also, it is possible to align high level goals that justify the creation of services offered to customers and very specific goals of the protocol model that justify the activities of actors.

In the global model, the objective is to align the goals of customers with business services and then to associate the enterprise objective with the offered business services (Fig. 11). In this stage, the goals that support the services are pointed out. In the process model, the objective is to align the service goals with process goals by abstraction and refinement. The idea of this stage is to make it explicit how the high level goals are refined into more concrete goals for each business process participating in business services.

Finally, in the protocol model, the process goals are aligned with the goals of the actors that are

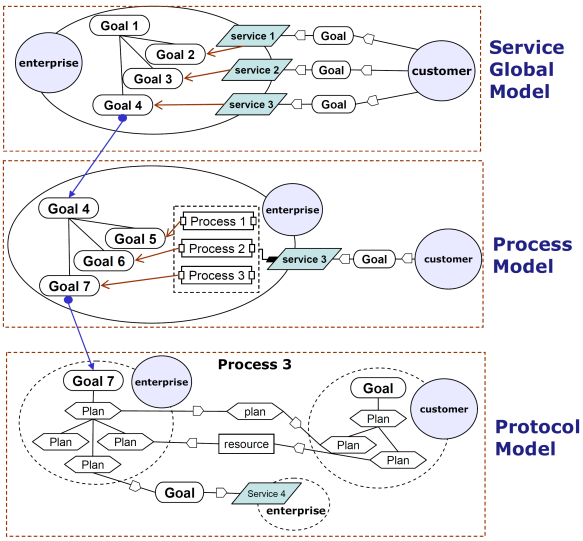

Fig. 11. Strategy for aligning service, process and interaction goals

involved in performing business processes. This approach enables analysts to trace a specific goal through service decomposition; it also permits justifying each business activity by the elicited enterprise goals.

There are several potential challenges in the procedure of aligning goals of services, processes and protocols. The biggest one is that usually no detailed goals are produced by managers when each service or business process is implemented in the enterprise. Most of the processes are then executed without a complete definition of the goals that support the process definition. However, we consider that this situation can be different if managers can detect advantages in the goal definition for normal operation of business. One of the clear advantages of aligning goals is that it is possible to construct a dashboard that enables managers to detect the level of fulfillment of the goals at various levels of service definition. In the example given, if several goals of the process model have been delayed, it is expected to have processes delayed, and as a consequence, services execution delayed.

Another challenge of goal alignment is the possibility of having different abstraction levels in goal definition. In this case, it may be complicated to find a match between two goals that reflect the same aspect but at different definition levels.

We consider that although exhaustive goal analyses are needed to accomplish the proposed method, the result of the process is a consistent business model.

6 Validation of the Proposed Approach

The proposed approach was validated through several real case studies in the domain of traffic service and also in modeling of services offered by a university. In these case studies, the proposed approach was used in practice by analysts to represent a particular enterprise (Government Agency and University) as a service provider. The goal of validation is to focus the organizational modeling activity on the values (services) offered by the enterprise to their customers. It is important to point out that the objective of the evaluation was to determine if analysts with knowledge of *i** can effectively use the proposed business service approach. The analysis of aspects related to the evaluation, such as training time, errors detected in the modeling phase, quality of the generated models, are out of the scope of this paper.

The first part of evaluation was to define the case studies, secondly, the case studies were modeled by analysts, and finally, we obtained the result service models for the enterprise. In what follows we define the case studies of traffic and scholar services and also present the resulting models of the application of our approach by analysts.

Traffic services case study. This case study considers a set of free services offered by a traffic department of a local government in Mexico. The objective of the case study is to model a traffic department using the service-oriented approach to model business processes. Five services were detected as the main activity of the traffic department: citizen assistance, payment of tickets, payment of car rights, requests of a driver license and of car recovery. In this case, the service to request a driver license (driver license process) was completely developed. Fig. 12 presents a fragment of the categorization of the driver license service process which was decomposed into several sub-services. This decomposition model considers a feature model in order to represent all possible variations to compose services. This case study involves a definition of the main sub-services

needed to accomplish the service to request a driver license.

This case study was developed for analysts with an in-depth knowledge of *i** and the service-oriented method.

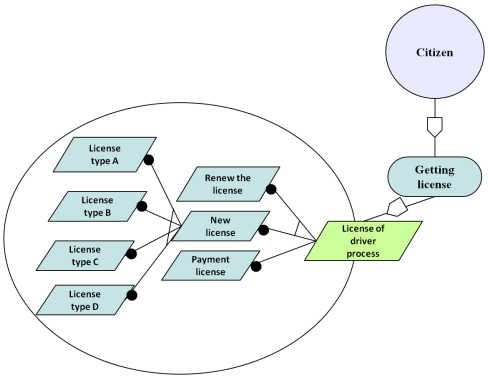

Fig. 12. A fragment of the categorization of the driver license service process

Scholar services case study. This case study considers modeling of services of a public university in Mexico. The services associated to students and professors of the university were modeled with the objective to generate an information system to support these services. The process consisted in modeling services and associating these with the strategic objectives of the university. Once the services were elicited, case models and their corresponding scenarios were generated from business services. Fig. 13 presents the resulting global model corresponding to the services offered by the Job Placement Department of the university to three actors: entities and dependencies, academics, institutions and companies.

Fig. 14 shows the decomposition of the service that offers job placement of students, and Fig. 15 shows the decomposition of job vacancies.

The service-oriented organizational model was developed by analysts with a medium knowledge of the service-oriented model and the final software product was implemented by programmers without knowledge of the service-oriented approach.

At the final stage of the case study, an information system was implemented that is currently in operation at the university [1].

[1] Universidad Veracruzana (http://www.uv.mx/bolsadetrabajo/)

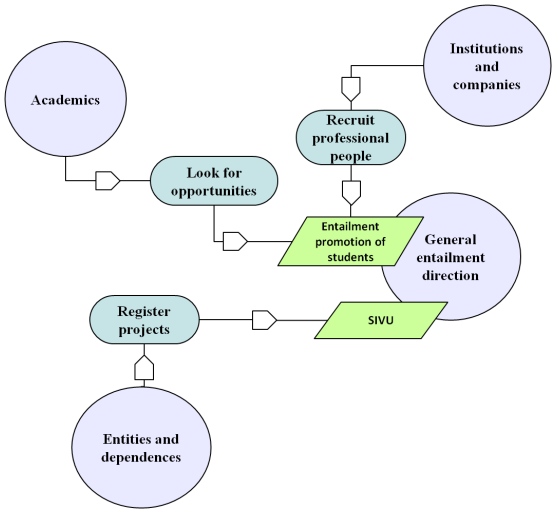

Fig. 13. A fragment of the global model corresponding to the services offered by the Job Placement Department

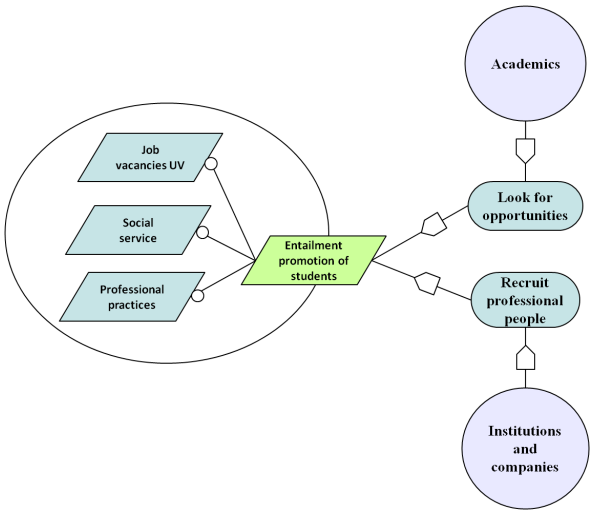

Fig. 14. Decomposition of the student job placement service

It is important to point out that the proposed approach was also validated by other authors whose research is related to extending the business service approach to modeling different applications domains. This is the case of the works of Becerra and Franch [5] where the business service approach was used to model architectural design, and more specifically, to fill the gap between the requirement description and architecture design and assessment. In this work,

extensions were made to incorporate architectural aspects in developing information systems that correctly satisfy the user needs.

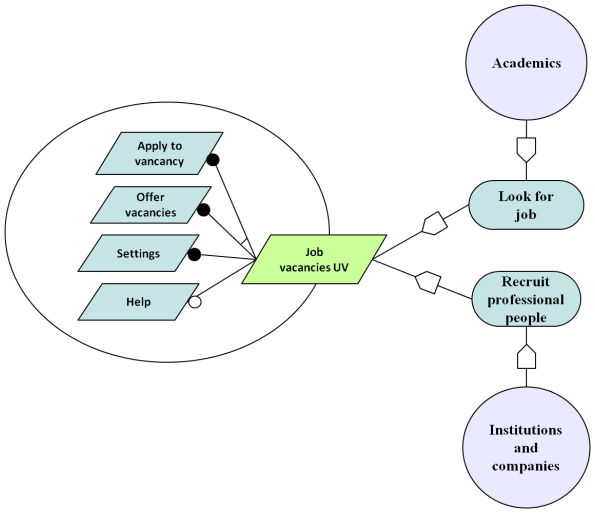

Fig. 15. Decomposition for the composite job vacancies business service

The use of the proposed approach in practice revealed some strengths and also weak points that need to be addressed to improve the approach. The main strength of the proposed approach is that it is possible to better manage the complexity of the modeling activity by starting with a high level view of services that an enterprise offers to a potential customer. Also, the business service approach is more suitable to be explained to a novel analyst in organizational modeling. The main weak point of the proposal is that it needs software application support that enables analysts to validate each model of the proposed architecture.

7 Conclusions and Future Work

As a solution to the lack of appropriated mechanisms to reduce current mismatch between business models and service-oriented designs and implementations, we proposed a service-oriented organizational model. In this model, services represent the functionalities that an enterprise offers to potential customers. Business services are the building blocks for three-tier business architecture: business services, business processes and business interactions. The organizational modeling process starts with a definition of a high level view of services offered and used by an enterprise. Later, each business service is refined into more concrete process models, according to the proposed business service method. Finally, business interactions are represented using the revised version of the modeling concepts of the *i** framework.

The proposed service-oriented architecture introduces new *i**-based modeling diagrams and analysis needed to represent services at the organizational level. We also presented a service-oriented method to elicit the organizational setting using service orientation; this method is a relevant contribution of this work. Some real case studies were developed to model a particular enterprise context. The initial results indicate that the proposed approach is useful to represent a high level view of services offered to potential customers. The analysts who participated in the case study found our approach appropriate to manage the complexity of modeling large enterprise. However, changes are needed to improve the model scalability. Currently, the model does not scale well due to graphical notation.

Finally, as a future work, we will focus on creating a method to model information technologies involved in the implementation of business processes at the business level. These technologies may include initial modeling using our proposal as a starting point followed by aligning services, processes and technologies at the business level. The objective of such integration is to make important decisions before implementation phases, avoiding problems in selecting technology to implement a business process in later phases of software development. A first approach of the method implementation was published [19].

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