# Transforming the Business Object Model in a Web Services Model: Evolutionary strategy

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*Abstract:* - This paper specifies how to define the technical and semantic link that allows transform a business object model in a set of Web services. The business object model represents the set of things, entities or resources that handles, generate or consume business processes. A Web services model describes the set of software services that make Web applications integrated and coherent; these applications are necessary to support the implementation of the business processes and contribute to achieving business goals. The proposed transformation strategy makes the specification of technical and semantic relationship between objects and Web services, from two complementary perspectives: (1) refining the organizational task to define technical details, that is, from the business processes level to the technologies level; and then, (2) verify this relationship and semantically validate it in reverse order, i.e., abstracting the support to the business work from the defined Web services. The described specification process is evolutionary as several repetitions of the refinement and abstraction effort is required to achieve a balanced and representative specification of the relationship between business processes and Web services.

*Key-Words:* - Web-services; Business model; Model transformation; Modeling strategies, business objects.

## 1 Introduction

In recent decades, the rapid and growing development of information technology and communication (ICT) has become a phenomenon of transformation in the way to operate and manage modern organizations, specifically, in their way of doing business. Thus, management strategies take advantage of these technologies not only for improving performance levels, productivity and profit, but also to mostly satisfy their customers [1]. This is one of the critical effects given by the globalization phenomenon, which is entirely based on the use of ICT to promote aperture and economic, social and cultural exchange between individuals, organizations and countries.

Within this context of technological dependence, organizations and companies today must have an organizational structure and technology infrastructure including Information Systems (IS) (ICT /IS), flexible enough to adjust quickly to changing demands, both in strategies and business objectives, like those arising from the development and upgrading of ICT technologies used by the business. In the first case, there is a downward transfer of the organizational change and adjustment needs that impacts ICT support technologies; in the second case, there is a transfer that leads to upward adjustment of business processes and activities, produced by changes in the ICT / IS infrastructure that supports it [2], [3].

Researches in this area are extensive and covers a wide range of organizational problems, ranging from technologies and systems governance to strategies definition to achieve better alignment of business interests and ICT. This work explores the

technical details that describe the link and the transformation between business models and technologies and systems [5], [6], [7], [8]. The two lower levels of Figure 1. Thus, this paper presents a transformation and maintenance strategy of technical and semantic correspondence between the business objects conceptual model and technologies model describing systems that use them.

Diverse studies are currently reported in the literature dealing with this technical-semantic conversion and vice versa issue, from different perspectives. For example, the initial work of Barrios and Nurcan [4] describes a strategy to define the requirements of information and automation systems from the business object model described in levels 2 and 3 in Figure 1. The work of Gmati et al. [8] proposes a strategy for measuring the degree of technical alignment between the elements represented in the business processes level and the information systems level of Figure 1. The problem of the business / ICT alignment, has also been described in some proposals that treat it from different perspectives ranging from the technical level of ICT support, which attempts to measure the degree of correspondence between databases, legacy technical objects from active systems and information requirements of an information system that supports a changing business process [12], to settle at higher management levels where strategic business objectives are defined seeking alignment with ICT strategies that supports it [4], [13]. Both perspectives come out of the context of this work, which is located at an intermediate level, seeking the conceptual correspondence between organizational task (business processes and consequently business objects) and the implementation of solutions that properly match this task (web services), through the definition of business services.

A business service is a business function that can be decomposed into other business services to provide a solution to the company or organization. The main idea is the reuse and composition of these services according to the changing needs of the organizational processes. Business services are implemented through service-oriented architecture (SOA); these are the result of an architectural approach for the organization of ICT resources. Thus, a Web services model or architecture (WSM) describes the set of integrated and consistent Web applications needed to support the business processes of a company in order to meet the stakeholder's needs. There is no simple recipe for implementing a business services correctly in an organization. There are contextual, cultural, policy and technology infrastructure variables, which are business challenges that the organization must face and consider. That is why today, architects persist in finding a method that handles the perfect combination of technology and best practices for specifying appropriate business services [9], [14]. Currently there is a wide range of best practices available for defining business services in the SOA context. These practices are more focused on the results that in the formalities or prescribed theories [14]. This paper presents a combined approach (*top-down-up*) to identify and specify the Web services required by an organization.

Figure 1 contains the organizational vision structured in three abstraction levels, on which this paper, is based. The highest level contains the strategies and objectives pursued by the organization or company; the middle level contains the business processes, which represents the set of processes, activities, actors, resources (objects) and business rules, which are organized and executed so that the objectives and the organization high level strategies are achieved in the best way. The third Level is the lowest and is related to technologies and information systems, their structure and degree of cooperation. It depends on the provided quality support received during the execution of the business processes from level two. At the middle level, business processes, modeled to the level of their activities are directly related to the resources or business objects that are produced, consumed or handled through the business object model (BOM). The BOM represents the different required, produced, processed or consumed resources by the business activities and provides a basis for directly identifying the services or functionalities required to implement in order to support the business. Thus, a business object is an entity or abstract or concrete element that is relevant to the business system or organization. For example, people, raw materials, equipment, financial resources, data related to an activity or product; suppliers and customers, bank accounts, human resources, are also treated as business objects. A Business Object Model (BOM) contains the entire set of elements or objects relevant to the business, describing, among others, their properties, behavior, structure and type, the set of possible values that may have their attributes in a given time, the variability with which these values may change over time, dependency ratios, aggregation or association between them [3]. In this paper, a business service is identified using various sources of information, such as BOM and business processes activity diagrams, which can identify services that primarily provide information services.

Prior knowledge related to functionality provided by existing systems are also used. Thus, an existing functionality with a high degree of use has a high priority for being enabled as a service business.

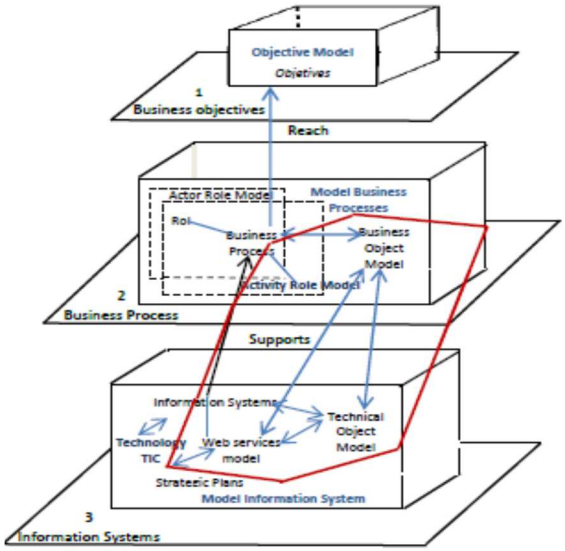


Figure 1. Organizational Vision

The aim of this paper is to present a strategy for specifying Web services (level 3 of information systems - ICT/IS) from the business object model and business processes model (level 2 business process - BP), both models are part of the business model shown in Figure 1. The strategy combines, in a simple and progressively way, the orientation paradigms for processes and business objects with the service oriented paradigm to manage bidirectional conversion complexity between the previously mentioned conceptual models. The strategy is specified as a method or guide for transformation between models so reuse and validation is facilitated.

This paper is organized as follows: Section 2 contains the basic concepts on which rests this research; the business vision and the models that comprise (objectives, processes, activities and business objects and information systems model) is described; This section ends with the description of Web services model principles, and main features. Section 3 describes the evolutionary strategy for discovery, specification and validation of Web services. Section 4 presents the conclusions and an outline of future work.

# 2 Basic concepts

## 2.1 The Business Model

A Business Model (BM) is understood as an organization or company global and integrated representation, through the representation of its objectives, processes, activities, actors, resources and supporting technologies, and especially through the specification of relations between them [2], [3].

Today it is considered that a BM is a vital decision-making and management level tool for the implementation of such decisions at the basic operational level related to the ICT /IS technologies that support the organization. In Figure 1 it's depicted a BM through three abstraction levels: the high level objectives and strategies of an organization (first level) which define the structure and allow the rest of the organizational levels; processes, activities and rules involved in achieving the objectives; actors responsible for implementation and the resources or business objects required, created, consumed or transformed by these business processes (second level); finally, at the last level, there are located information systems, Web services, databases, HW/ SW support and telecommunications devices that are the ICT infrastructure of the organization and support the execution of business processes, and thus is the level that supports the successful achievement of organizational objectives and strategies set by the high management representatives [3], [4].

## 2.2 Web Services model

The service concept is inherited from the business world, where a service is something that a provider offers in order to meet the needs of consumers, each service is provided through a service contract [13]. In technology, services are software systems that allow sharing data and functionality across applications over a network, they must allow the composition, be autonomous, and not having state and been able to be found [9]. Additionally, a service has an interface that describes the service contract offered, usually Web APIs that can be accessed over a network (mainly Internet) and executed on the system that hosts them.

A Web service uses the Internet and the World Wide Web, is implemented using a service-oriented architecture (SOA) and more recently REST (REpresentational State Transfer), a style that provides a new option for the use of Web Services. REST attempt to emulate the HTTP protocol or similar protocols by restricting the interface to establish a known set of standard operations (e.g. GET, PUT), this style focuses more on interacting with stateful resources that with messages and operations. SOA meanwhile, uses a standard set of software technologies for data exchange between applications such as SOAP (Simple Object Access Protocol), WSDL (Web Services Description

Language) and UDDI (Universal Description Discovery and Integration) [10] [14], [15]. SOA facilitates the development of highly scalable systems, enabling organizations to achieve one of its main objectives in relation to ICT, as is the continuing evolution through the evolution of their services.

Web services are a way to implement distributed information systems that can be developed in a variety of languages to be used in different types of computer networks allowing that the services can be interconnected or can be consumed by other applications, the success of this interoperability is achieved through the adoption of open protocols and standards.

One advantage of the services is reuse. A service can be shared or used by other services in order to compose more complex services. There are two mechanisms to compose services: 1) orchestration: where a service called director plans and directs other services, this director invokes the sequence of services to produce the desired effect; 2) choreography: where services interact and cooperate without the help of a director [13]. Each Web business service corresponds to a business functionality. This functionality must be well defined, be self-contained and have small or not link. The software organization as services allows expose to consumers the functionality, increasing the visibility and adding value to the business.

A key aspect to consider in the selection and specification of services is to define the appropriate level of granularity. The granularity is a relative measure of the extent that a service, from the point of view of required functionality to satisfy a need [11]. A fine grain service targets small units of functionality or small amounts of data exchange. Therefore, to build complex business processes, companies would have to organize large amounts of these services to effectively automate a process: difficult and complex activity. On the other hand, a gross -grained service, involves larger or more complex functionality into a single interface, reducing the number of service requests needed to perform a task, but in contrast, it is possible to return excessive amounts of data, as well as being difficult to use again, or change to meet new requirements.

The set of Web services that support the business processes of an organization it is called Web Application Architecture. This architecture supports (information processing services) to the processes of an organization, its specification is called Web Services Model (WSM). This model describes the Web services composition hierarchy, which handles at its base the lowest level services for the objects management and, at higher levels of the hierarchy a set of complex services or gross grained services is located. Finally, at the top of the hierarchy the set of services that make up the applications and give direct support to business processes are specified, as shown in Figure 2.

The WSM specifies the set of services, relationships and interfaces. The services that make up this model, according to its granularity and responsibility are classified as:

- Object Management Services: They are fine grained services, responsible for transformation or management (create, observe, transform) of business objects.
- Business services: They are gross grained services that support one or more business processes. Consist of a set of services that are invoked in a specific sequence to satisfy a business requirement. In terms of SOA, these services are composed of a series of operations, services, which are executed in sequence according to certain business rules. These services consist of one or more object management services, business services defined in previous interactions or reusing services (wrap) using some legacy functionality.
- Business applications: They are the grossest grained services that define the set of services that support business processes. They are built by composing a set of business services.

## 2.3 Correspondence between levels and submodels of a BM

As shown in Figure 1, the of Business Process (BP) model of Level two, is composed, among other submodels, of the business objects model (BOM), which represents the set of resources that are created, manipulated, transformed and consumed during the execution of business processes. This BOM model has its equivalent in the third level, which represents the set of technical business objects models (TBOM). The technical objects model in the third level, specify the business objects that are persistent and are required by the information systems to support the execution of business processes and decision-making throughout the organization. In addition, this technical TBOM model may include other objects that are representative of data related to the internal or external actors, and other entities of the context in which the organization operates.

Figure 2 shows the model concepts used on third level of the BM, the information systems. This model extends the information systems model presented in [4], incorporating the new entity required for implementing Web services, called Web services model (WSM). The proposed strategy allows identifying the services that make the WSM establishing a coherent and consistent correspondence between concepts in Figure 1.

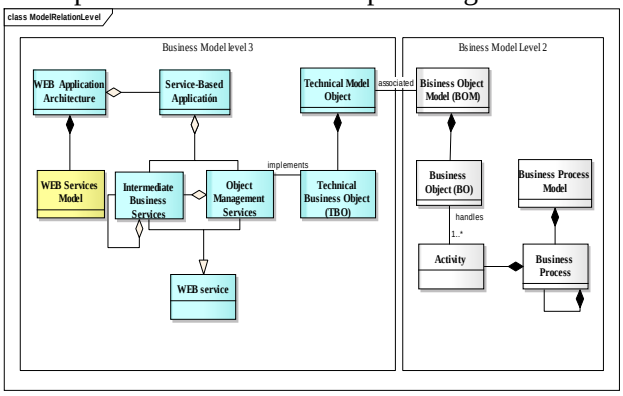


Figure 2: Correspondence between the concepts of business processes and information systems

# 3 Evolving strategy for transforming business objects into web services of a WSM

The transformation strategy recommends a sequence of steps to perform consistently over time to gradually transform the Business Object Model (BOM) in a Web Services Model (WSM), considering the TBOM concepts of the third level from figure 2. The proposed strategy sets out a series of activities to discover and specify the Web services required by the processes of an organization.

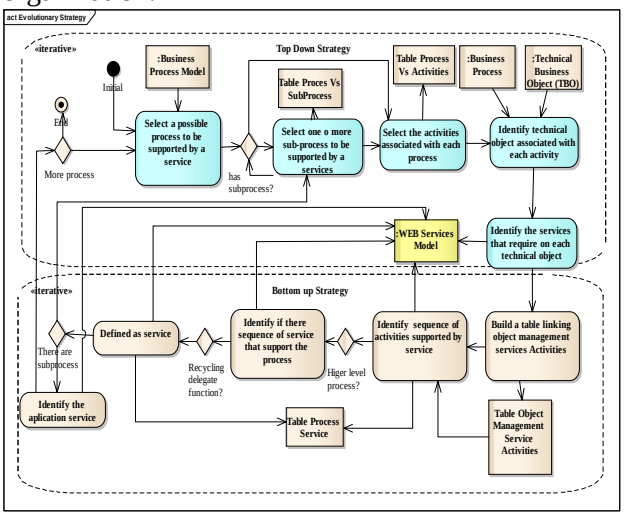


Figure 3: Activities diagram of transformation strategy

The strategy consists of two phases, the identification phase of the processes to be supported by services, known as Top-dow strategy and service specification phase, called bottom-up. Figure 3 shows the sequence of activities defined in the transformation strategy.

## 3.1 Top-Down Application of Strategy

The strategy begins with the Business Process Model and using a top-down approach, begins with the process model, descending over the models describing the sub-processes, up to level of activities. In this path it will be identified the processes or sub-processes whose characteristics (business objects management, previous experience indicates that can be supported by some service, areas that are supported by automated systems, among others) may be candidates to be supported by services.

Upon reaching the activity level, the identification and specification process of the lower level services, called object management services starts.

## 3.2 Bottom-up Implementation of strategy

Identified all the services associated with technical objects and using a bottom-up approach it's proceeded to identify the business services. Finally, the highest level services, application services processes are defined, linking these services with the business logic. Each service is specified by its interface, it will be described the operation that the service will provide, the data input and output that service will provide. Implicit criteria in this process of discovery and specification will be detailed in the following sub-sections, Figure 4 shows the processes to run for the identification of services.

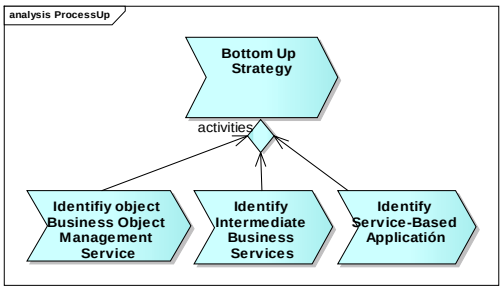


Figure 4: Processes for identifying services.

The top-down/bottom-up process is repeated as often as necessary, at each iteration is refined and/or extended the existing model. The strategy ends when all business applications based on Web services (definition of logical workflow), that the organization needs to support all business processes, are identified.

Figure 4 shows the flow diagram, the UML Business notation [15] is used. In this diagram can be identified: 1) the input that strategy requires,

which are Business Processes Models (BPM) and Business Objects Models (BOM); 2) The output, which is the Web Services Model (WSM).

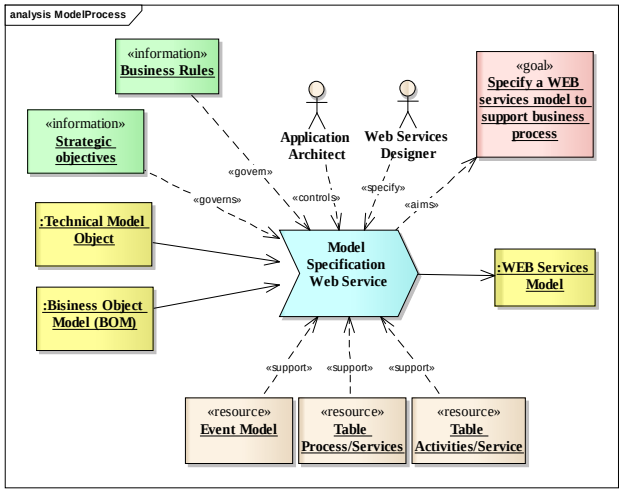


Figure 5: Processes Diagram for specifying Web Services

### 3.3 Processes to identify services

Process: Identify Business Object Management Services

It is used to identify the services responsible for managing (watch, create, consume, transform) business objects. These are services that are reused by higher-level services, requiring to manipulate technicians' objects. It begins with the selection of the activities associated with the processes or sub processes that can be supported by ICT.

The activities diagrams serve to identify the technical objects and the actions that each activity performs on these objects. With this information, is built a matrix relating technical Objects vs. activities, along with the actions taken (change state, notify, search state, among others). Once they are identified, it is proceeded to specify the interface of each service. These are the fine-grained services and are located at the base of the services hierarchy.

Process: Identify Intermediate Business Services

There are identified the services required to support the business processes or sub processes identified as candidates to be supported by services when the top-down strategy was applied. If a hierarchy of sub processes is identified, it is possible that a hierarchy of services is generated, where the lowest level intermediate services are specified composing some objects management services. Then, using an iterative process, if necessary, intermediate business services of gross grain (higher level) are identified and are specified from the composition of lower level services (intermediate business services and object management services). Also, if there exists any legacy applications, those functionalities that are highly used by these processes are identified. With this information, it is proceeded to identify and specify the business services; then they are incorporated into the services hierarchy, from lowest-level service to the highest level of the hierarchy gross grained (composition).

To identify business services, there are used the sub processes diagrams, activity diagrams from business process model of the second level of Figure 1 and the object management services.

Specifically, the strategy is to select between candidates' processes a sub process. If there is a processes hierarchy the lower level, and together with the activity diagram associated with it and object management services. Some sequence of services to support this process is identified, for example, a process for approving applications consists of the services for changing the status of an application and notify to the applicant. If there is a sequence, it is identified as a possible service. Having analyzed a set of processes that are related to each other (using services of common objects), it is observed if there are sequences of similar services including, if so, these sequence services become business services.

This process is applied iteratively analyzing, if any, higher levels processes. In these iterations, activity diagrams are replaced by sub processes diagrams of lower levels. A fundamental principle to consider for identifying services is the reuse; it must be careful when applying, because it must be ensured that services of gross grained will not affect the flexibility and scalability of the architecture. This requires adapting to changes in the objectives, rules and processes that occur over time. It is also possible to identify services that have no justification for reuse, but they have justification because it easily allow incorporating changes in an organization.

In this process it's necessary to build a matrix of relationship between objects management services. vs. sun processes, this matrix identifies the object management services sequences, determining which are repeated sequences, which services are used in different sequence. The sequences that are repeated and whose low-level services are not used in other sequences become intermediate service, thus more gross-grained services.

The sequences that are repeated but using services that are used by other sequences are constructed from the composition of fine-grained services.

This process is repeated iteratively with the higher levels sub processes, services. vs. sub processes matrices are constructed, common patterns (invocation of the same business services or objects management) are identified in different sub processes and business services at the highest level, gross grained are specified.

It is important to know if an already identified possible business service is multiple use or not. It can be said that the best services are the most reusable, yet it is not true in some cases. Having just fine-grained services, leads to tremendous overhead and inefficiency. Obviously if there is a small collection of gross grained services that can be used in multiple scenarios it is a better choice; however, solving the problem of granularity in WSM is critical, and according to it will depend the success of an architecture. The more can be taken advantage of a service for multiple processes, the more useful it is. If it is possible to include a service within several different processes, it must be asked whether or not has the right level of granularity.

Additionally, it is possible to identify some services that are only used by a process (no reuse). But if these services may experience permanent changes in requirements must be considered as possible candidates, there are situations where agility instead of reuse is the driving force for services design. The fact that a service is subject to changing requirements drives the design of the service rather than their reusability.

On the other hand, an important element to consider if there are already developed or legacy applications, is to meet the 80/20 rule which states that 20% of the existing functionality in any given system is used 80% of the time. This makes that this 20% of functionality will become candidates for service. If it can be identified those features of the existing systems with 20% of heaviest use, they can be enabled as business services providing a greater return on investment to the organization. These features can generally correspond to an already identified service, if so it will be necessary to identify the function to be reused and avoid duplicating their specification.

Process: Identify service-based applications

The set of applications required to support business processes are identified. To identify the required applications, the business services consumed by each process are identified. This requires a relationship matrix for Intermediate Business Services vs. process. There are identified which services are consumed by a single process and services that are consumed by different processes.

Services consumed by a single process will be part of the functionality required by the business application. Each service group will form a business application. In those services that support different process, the granulated should be reviewed, to ensure that changes in objectives or rules in any of the processes can be incorporated easily, without affecting the processes sharing this service. Figure 6 shows how, through the strategy is gradually building the Web Services Model (WMS).

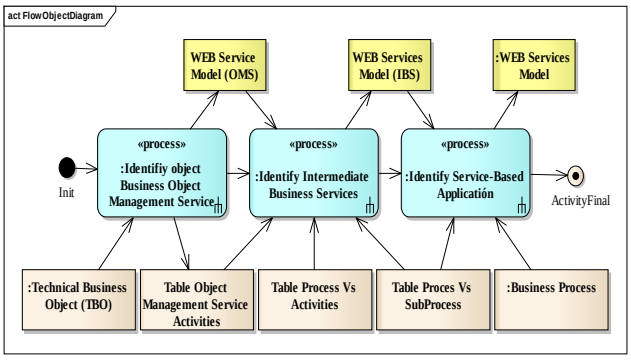


Figure 6: Flowchart of objects during the execution of the strategy

After the bottom-up strategy is finished, there are selected another processes to implement again the

top-down / bottom up strategy. In each iteration arrays that have been generated are updated, and if necessary the identified services are also updated.

# 4 Conclusions

With this technological research based on the definition, repetition, validation, improvement and adjustment of different alternatives for the specification of Web services from the business process model, an evolutionary strategy is proposed to define models of web services from business models. These development have validated the strategy contributes to the definition of an application based services, following the concepts shown in Figure 2. Likewise confirms that the identification of a correct granulated services, allows a balance between the numbers of calls between services and reuse, allowing to define a scalable architecture and flexible services to suit changing goals and processes.

Since technical objects represent business objects, it can be said that proposed WSM is flexible and easily adapted to have implicit connection with the BOM of second level in business processes. BOM contains the data, information and business resources that manage the members of the organization for the implementation of its activities, making adjustments as required to perform on the WSM because of changes in working or operating in the organization, they can be quickly specified, developed and integrated into the operating ICT infrastructure in an organization, without major difficulties.

This strategy is part of a set of strategies for transformation between levels of the business model, which have been working and refining. Future works will focus on formalizing the method (product, process and actors models) for transforming conceptual business process models (level 2) in information systems models (level 3). The definition of a tool that supports the selection process of transformation and validation strategies will be part of future work.

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