A Web Services-Based Business Interactions Manager to Support Electronic Commerce Applications

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ABSTRACT

Electronic commerce applications (e-commerce) need connecting technologies to support the external, agreed-upon or flexible business processes. This requires a specification of these types of business processes with a business interactions and connection-oriented perspective in order to compose them from the existing assets of the enterprise, partners, and suppliers. This work advocates a conceptualization of the business interactions perspective (of a business modeling) as an approach to specify: (1) the business processes as abstract (virtual) entities implemented as dynamic connections among actual entities that are the business functions and objects (as implemented in the inter-organizational information systems), and (2) the requirements for a connecting technology, that is Web services, to make it an enabler of two categories of e-commerce interactions: B2C and B2B.

The approach consists of: (1) abstracting, specifying (in terms of activities), and categorizing the business interactions into enterprise, customers, suppliers, and partners' interactions, (2) insulating the core business activities from the interaction activities to make these two types of activities independent, (3) dedicating to the interaction activities a specific artifact termed business interactions manager (BIM), (3) specifying the functionality of the BIM. This specification aims at overcoming the limitations of the current technologies, especially the de facto connecting technology, that is Web services, in order to specify a Web services-based BIM as a backbone of Web services-oriented architecture (WSOA), and (4) implementing a specific instance of the Web services-based BIM for each category of e-commerce with regard to the business specifics.

The paper proposes guidance for deploying WSOA enabler of e-commerce through steady instantiations of the Web services-based BIM.

Key Words

E-Commerce; Business Modeling; Business Process; Business Interactions; BIM; Requirements for Connecting Technology; Web Services; WSOA.

1. 1. INTRODUCTION

Developing e-commerce requires a design process based on a layered architecture that allows composition of crossing businesses processes by interacting loosely coupled components implemented in disparate, heterogeneous information systems. That is, a three-level architecture where the business interactions are central to the business processes and information systems.

This work emphasizes a business interactions perspective[1], of a business modeling, as a framework to define and specify the components of the aforementioned architecture, namely (1) the crossing business processes, and (2) the requirements of the connecting technologies that implement business interactions among components implemented in the information systems.

The concepts of business process, business interactions, and information system are critical for e-commerce. Indeed, the crossing business processes are specified as flow of messages among involved, connected components of the information systems (IS).

There are many attempts to define and specify the concept of business process [17][5][22]. We extend these definitions to a business interactions and connection-oriented perspective, and consider a business process as "an abstract (virtual) entity that is implemented by interacting actual entities that are the business functions and business objects as implemented in the enterprise's IS (EIS), partners' IS (PIS), suppliers' IS (SIS), services providers (ASP), or even customers' IS (CIS)". That is, a business process is a dynamic composition process that requires well-specified, dynamic, cost-effective, timely business interactions among business functions and business objects. This requires first unlocking the heterogeneous and independent implementations of the business functions and business objects to make them visible and accessible, then connecting them, which is the responsibility of the connecting technology.

This issue has been seen as an integration issue [15][1][29].

Currently Web services are becoming a simple service-oriented architecture (SOA) where applications are offered as services both within and across the enterprise [7] with lower development costs [14][6][l9]. The Web services underlying standards allow interfacing, publishing, and binding loosely coupled services available on the Web. In addition, Web services can: (i) easily live with distributed object-computing middleware such as CORBA, DCOM, and EJB [4], (ii) make legacy databases and applications, and even traditional enterprise application integration (EAI) messaging look like Web services [20], (iii) integrate semantic Web [26], and (iv) implement business transactions [21]. This makes Web services technology the *de facto* Internet integration standard [2][4].

However, we still need a framework to overcome the current

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[1] Other related perspectives in Zackman model [28] are: business functions, business objects, network, people, time, and motivation. With respect to e-commerce, Zwass in [30] considers five perspectives that are commerce, collaboration, communication, connection, and computation.

limitations of this technology in order to make it a truly enabler of e-commerce solutions.

The proposed framework consists of:

1. Conceptualizing the business interactions, i.e. abstracting, specifying, modeling the activities, and categorizing them. In fact, business interactions differ in many aspects, namely: (i) the situations including for instance, buying, and selling, (ii) the space and scope, (iii) the nature, i.e. dynamic or fixed, (iv) the time, i.e. synchronous or asynchronous, (v) the intensity: 1:1, 1:N or N:M, (vi) the frequency and volume, and (vii) the nature of exchanged knowledge.

2. Insulating the core business activities from the business interactions activities to make the implementations of these two types of activities independent. This independence is meant to dedicate to the business interactions activities a specific artifact we call business interactions manager (BIM). This separation of concerns avoids affecting implementations of the business functions and objects whenever a technology is introduced.

3. Specifying the BIM functionality to overcome the current limitations of Web services technology to allow (i) a semantic specification (interfacing) of the components (business functions and objects) as services to unlock them, (ii) publishing their interfaces to be reused, (iii) planning the flow of the business processes, (iv) discovering the required services, (v) selecting the services, (vi) connecting (statically or dynamically) any application to the services, (vii) ultimately, connecting services to each other with respect to WSOA, and (viii) dynamically composing the services into new e-commerce applications.

4. Instantiating the BIM for each category e-commerce applications with regard to the business specifics.

The next section presents a conceptualization of the business interactions. Section 3 specifies the BIM. Section 4 details the implementation of the BIM towards a Web services-based BIM. Section 5 shows how the Web services-based BIM enables e-commerce applications. Section 6 presents guidance to deploy e-commerce applications. Section 7 presents some related work. Finally, a conclusion section summarizes the results and presents further research issues.

2. 2. BUSINESS INTERACTIONS

A Business model represents a business from different perspectives at different levels of abstraction. This work emphasizes the business interactions perspective with respect to the business process definition and specification.

2.1 The Business Process-Oriented Approach to Conceptualize the Business Interactions

The work organization structures the enterprise into functional areas. Each functional area is responsible for some business functions. For example, the functional area marketing and sales is responsible for business functions such as sales order processing, and customer relationship and support. Business functions are implemented in the EIS system that also keeps track of the business objects. The business processes, we are concerned with, cross the functional areas and the boundaries of the organization. They may be (i) agreed-upon with partners or suppliers (e.g. virtual enterprises that share knowledge), (ii) more flexible (e.g. supply chain where the enterprise extends its processes), and (iii) supported by pre-existing, local, heterogeneous information systems. Unlike the business functions, which are actual entities implemented in the EIS, the business processes are abstract (virtual) entities that are composed by interacting business functions provided by the enterprise, partners, and suppliers (e.g. B2B) in order to respond to a business events or a customer's demand (e.g. B2C).That is, one can view a business process as a set of dynamically interconnected business functions through business interactions[2] . Each business interaction has two connected business functions as endpoints. Each business function accesses some business objects (Figure 1). However, the business interactions differ in many aspects. Therefore, one needs to conceptualize them in order to specify them, with respect to a business perspective, before addressing the technological perspectives.

2.2 Business Interactions Specification

2.2.1 Definition

The concept of interactions has been used by several disciplines such as linguistics, work organization, distributed agents, software engineering, knowledge management, and Web component. A business perspective definition that we adapt from the above disciplines considers business interactions, with business process vision, a "set of action-reactions of causal, reciprocal business functions while synchronously or asynchronously exchanging messages (views of business objects) or sharing a representation (states of business objects) in different situations". These business functions are provided by autonomous, independent, local or external functional areas. The main aim of the business interactions is to compose business processes with respect to an e-commerce solution.

2.2.2 Specification

The business interactions are characterized by: (a) business process. That is, the business interactions constitute a main building block that facilitates the specification, the composition, and the implementation of the business processes, (b) connected business functions, which are implemented in the different functional areas' IS. They play the role of endpoints of the business interactions, (c) exchanged messages: business functions may interact by exchanging messages. Each business function defines the messages it accepts and those it may return, (d) shared representation: business functions may also share the states of some business objects. Some business functions re-act to the change in these states, (e) space: business interactions may connect local as well as distributed, remote business functions, (f) time: action-reactions of the business functions are synchronous or asynchronous, (g) dynamics: business interactions specified with respect to flexible business processes are dynamic relationships among business functions provided by autonomous functional areas, and (h) situations of business interactions: these are various answers to the question 'why do business functions interact?' With respect to e-business, business functions interact to dynamically compose crossing business processes, and manage their related knowledge. Each distinct situation requires a specific connecting technology. Therefore, one needs to categorize the business interactions in order to specify the requirements of that connecting technology.

2.3 Categorization of the Interactions

The business interactions differ in many aspects. First, they differ

[2] Business interactions are generally implemented by organizational or technological artifacts to offset semantic, linguistic, and technological breakups.

according to the types of the business functions' providers. Second, the business interactions in a goal-driven business differ from those of an event-driven business. The latter are more dynamic and intensive than the former. Third, the business interactions involving business functions provided for an external use are dependent on the effectiveness of local ones. For instance, B2B interactions cannot be approached if EAI is not working properly. Last but not least, the business interactions differ with respect to their enabling technology. For, instances, CORBA, EJB, or DCOM are suitable for connecting internal business functions; XML/EDI or ebXML may be suitable for a long term fixed relationships; and Web services are suitable for dynamic relationships. This needs a categorization of business interactions as shown in Figure 1, which distinguishes each of the following categories:

1. Internal business interactions:

- Business interactions (BI) connecting business functions (BF) provided by enterprise' functional areas (FA) to each other (e.g. those involved in local integration such as EAI (noted EAI1, i.e. high level EAI)).
- Business interactions connecting business functions to each other, i.e. the business functions provided by the same local functional area (e.g. for local business processes to an internal functional area (noted EAI2, i.e. middle level EAI)).
- Business interactions connecting activities of the same business function that is made up of activities (noted EAI3, i.e. low level EAI).
- Business interactions connecting business functions to access business objects (BO)(e.g. local API such as ODBC or JDBC).

2. External business interactions:

- Business interactions connecting business functions provided by a local functional area to business functions provided by a supplier (e.g. agreed-upon business processes, or virtual enterprise (noted B2B1, i.e. B2B of type 1, including functional B2B)).
- Business interactions connecting business functions provided by a local functional area to business functions provided by a partner or services provider (noted B2B2, i.e. B2B of type 2 including logistics B2B).
- Business interactions connecting consumers to business functions provided by and internal functional area (shown as B2C, including all categories of consumers).

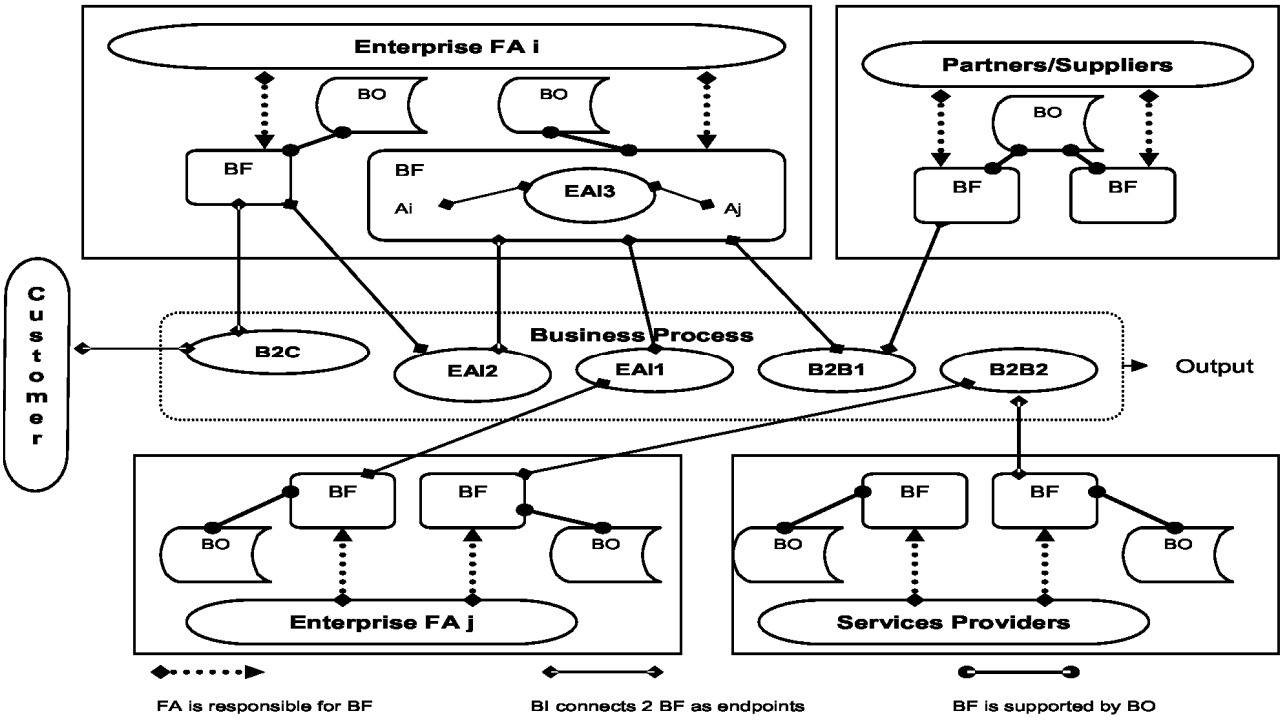

Figure 1. Business processes, business functions, business objects, and categories of business interactions.

2.4 Model of Business Interactions Activities

Each category of business interactions needs connecting business functions to implement the following model of activities (protocol) assuming that business functions can publish themselves, discover and select each other. These activities are: (a1) business function BF_1 *request*s business function BF_2, (a2) BF_2 *receives* the request from BF_1, (a3) BF_2 *interpret*s the request (semantics required), (a4) BF_2 *re-acts* to the request according to its interpretation, (a5) BF_2 *responds* to BF_1, (a6) BF_1 *receives* the response from BF_2, (a7) BF_1 *interprets* the response (e.g. ontology), (a8) BF_1 *re-acts* to the response of BF_2 according to the interpretation (semantics required).

While re-acting, a connected BF may: (i) generate a response to the requesting BF, (ii) generate a request to another BF, or (iii) change the state of a shared representation.

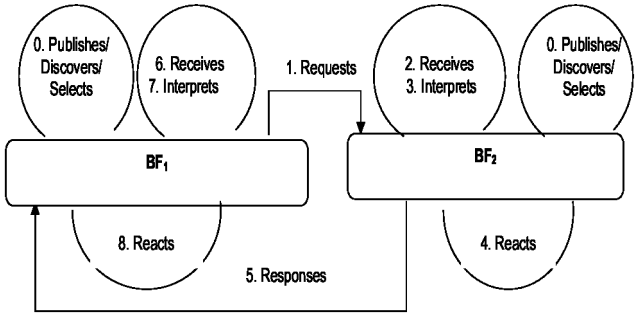

Figure 2. A model of business interactions activities.

This representation of the activities in business interactions helps in using the paradigm of separation of concerns to insulate the business activities from the interactions activities. This insulation aims mainly at: (i) making the business functions implementations independent from the connecting technologies in order to leverage them; and to avoid affecting them whenever a connecting technology is upgraded, and (ii) lightening the workload of the business functions, the interactions activities will have a specific artifact dedicated to them.

2.5 Insulation of the Interactions Activities by a Specialization of the Interaction Activities

The aforementioned model of activities involved in business interactions (Figure 2) allows a specialization of these activities into business functions related activities, and business interactions related activities. Pure business functions related activities are *acting* and *re-acting*. These activities are the core business activities, i.e. business logic, business rules, and data access. They are implemented in the IS. The rest of activities concerns rather with connection activities than business activities. Therefore, we will dedicate to these activities a specific artifact that is the business interaction managers (BIM) as shown in Figure 3. The BIM functionality are summarized in Table 1.

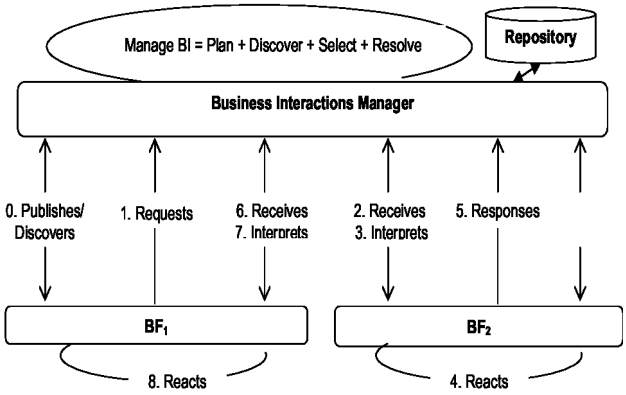

Figure 3. The functionality of the BIM.

Table 1. Specialization of the business interactions activities

Activity Type	Activities	Observation	Support
Business Activities	Act-React	Core business activities that concern with business logic, business rule, and data access	***supported by EIS/PIS/ASP***
Business Interactions Activities	Publish	Publish business activities to be discovered	***BIM***
	Discover	Find partners/business activities	
	Plan	Orchestrating the flow of a composed business processes	
	Select	Select a business activity among many similar ones (semantics required)	
	Resolve	Resolve dependencies by selecting and integrating a new business activity when the exiting one fails	
	Request	Transmission activities	
	Receive Interpret	Reception activities Coding/encoding activities in order to interpret and understand the request/response	
	Response Code/Decode	Transmission activities Code and decode the exchanged messages to be interpretable (semantics required)	
	Crypt/Decrypt	Crypt and decrypt secure exchanged messages	

3. BUSINESS INTERACTIONS MANAGER

The BIM is the central component of the e-commerce architecture. It supports the business processes by implementing the interactions activities, and managing the knowledge related to the shared and exchanged information (e.g. business processes, functions, or objects). The BIM aims mainly at making the implementations of the business functions independent from any connecting technology in order to: (i) decide the right connecting technology for each category of e-commerce, (ii) steadily wire towards e-commerce architecture based on a service-oriented architecture (SOA) by readily plugging-in the BIM functionality without affecting the implementations of the current business functions, (iii) leverage these implementations, (iv) lighten the workload of the business functions, and (v) manage the enterprise knowledge with the BIM which plays the role of a knowledge manager. The BIM is responsible for:

- Connection activities.
- Publishing business functions and generating their required proxies (e.g. stub and skeleton). Indeed, the business functions are responsible only for the core business activities.

- Discovering published business functions taking into account the newly published ones.
- Providing a repository to keep track of the semantics (e.g. ontologies such as in [26]) of: (i) the profile of each business function (e.g. capability, provider, non-functional parameters), (ii) the business function model, i.e. the required details of the business function (e.g. black box, gray box, or glass box), (iii) the business function grounding, i.e. separation of the interface from the implementation details, (iv) the past and current compositions of the business processes, and (v) the business objects that are the representation products/services, or the exchanged documents.
- Managing dynamic interactions including: (i) planning the business processes in terms of a flow of business functions, (ii) selecting the required business functions (multiple business functions may satisfy the functional and non-functional requirements), (iii) composing the business processes; which is defined as a virtual entity, (iv) replacing the current implementations of the business functions by new ones more adapted to the business process, and (vi) resolving the dependencies in case of failure of any involved business function.
- Providing common e-business common services including e-commerce services (e.g. digital payment).

4. IMPLEMENTATION OF THE BIM: TOWARDS WSOA ENABER OF E-C

The business interactions perspective is used as an approach to deploy WSOA architecture to support e-commerce applications.

4.1 Add-Value of Business Interactions Perspective to SOA

The conceptualization of the business interactions, i.e. (i) specification, (ii) categorization, (iii) model of activities, and (iv) insulation of the core business activities from the connection activities will allow:

- A separation of concerns between the core business activities and the business interactions activities. The connecting activities are handled by the BIM. Whereas, the business functions are responsible for providing core business activities.
- Well-specified interfaces of the business functions independently of their implementations. The separation of concerns simplifies the specification of such interfaces' definitions.
- An effective loose coupling of the heterogeneous business functions. The interfaces of the business functions (insulated and independent from their implementations) are described in a standard extensible markup language that can be understood by any business function's implementation (e.g. XML, OWL).
- On-demand composition (or reengineering) of the business processes. The BIM helps in planning their flow, discovering, and selecting partners' business functions. The BIM can also help in simulating a business process by adding/removing business functions to/from it.
- Fine/coarse-granularity of the business functions. The categorization of the business interactions, described above, allows first an implementation of the business functions and the business objects access operations as fine-grained services. The set of connected, business functions are presented as coarse-grained services, i.e. a unified interface used by B2C and B2B applications.

4.2 Approach to Implement WSOA for E-C

The conceptualization of a business as a set of dynamic business interactions provides a twofold framework for:

1. A steady, readily implementation of SOA based on a well-specified connecting technology. SOA aims mainly at achieving communication among loosely coupled interacting business functions [12]. The connections are the business interactions implemented in the BIM.
2. The specification of the BIM functionality provides a framework to specify the requirements of the Web services.

An implementation of WSOA requires first an implementation and a publication of the semantically specified business functions as services, and then a connection with Web services technology.

4.2.1 Implementing the Business Activities as Services

SAO architecture requires a service to be self-contained, self-described service, provided with a well-defined, standardized interface to be transparently accessible.

- A local business activity of a business function, such as business logic, business rule, or a data operation (insert, update, delete, or retrieve) on a business object can be readily interfaced and implemented as a fine-grained Web service. For instance, [3] and [11] provide approaches to identify and design Web services. While tools (e.g. Axis, Glue) generate Web services.
- Locally connected business functions (or even agreed-upon, running business processes) can be wrapped and interfaced as coarse-grained services provided that they are well-specified in terms of: (i) flow of explicit, semantically, interfaced business functions, (ii) commonly understandable input/output messages, and (iii) pre-conditions and post-conditions.

4.2.2 Implementing the BIM with Web Services

Currently Web services technology is becoming the most attractive even if it is not mature enough to implement all the BIM activities. Table 2 and Figure 4 (the symbol ~ in the figure denotes 'is roughly implemented by') show the BIM activities (depicted in Table 1 and Figure 3) that are currently implemented by Web services standards (bolded in Figure 4), and those activities that still constitute issues [3] (bolded question marks in Table 2), especially the semantics of the services that truly allows dynamic composition of the business processes [16][27][26][9].

However, when standards fitting these issues will be matured enough and Web services integrated with semantic web to become semantic Web services, this connecting technology will truly enable e-commerce as developed in the next section. Indeed, Web services technology presents the following desired capabilities:

[3]These issues are beyond the scope of this paper. They are presented here to get a comprehensive framework.

- Its basic standards such as the basic standards (XML, SOAP, WSDL, and UDDI), the security standards (e.g. WSS, EPAL, XACML, XKMS, X-BULK, and XML-enc), the process description standards (WSFL, BPML, BPEL4WS, WSCI, XPDL and ebXML), and others related to semantics (RDF, DAML-S, OWL-S) will allow: (i) semantically specifying (interfacing) the components (business functions and objects) as Web services to unlock them, (ii) publishing their interfaces in a registry to be reused, (iii) planning the flow of the business processes, (iv) discovering the required Web services, (v) selecting the Web services, (vi) connecting (statically or dynamically) any application to Web services, (vii) ultimately, connecting Web services to each other with respect to WSOA, and (viii) dynamically composing the Web services into new agreed-upon or flexible business processes with respect to e-business solution including e-commerce in order to respond to business conditions change and events.
- Its readiness to live with other technologies, namely traditional as well as distributed object-computing middleware (CORBA, DCOM, RMI, EJB) [4].
- Its readiness to make legacy databases and applications, and even traditional enterprise application integration (EAI) messaging look like Web services [20].
- Its readiness to implement business transactions [21].
- Its capability to be integrated with the semantic Web [26].

Table 2. BIM functionality enabled by current Web services technologies and standards

BIM activities	Web services underlying standards
Publish	UDDI + WSDL
Discover	UDDI + WSDL + (WS-Inspection standard)
Plan	? (to a less extent BPEL4WS)
Select	? (to a less extent WS-Inspection standard)
Resolve	?
Request	SOAP standard
Receive	
Interpret	+
Response	
Code/Decode	XML and related standards such as DTD, XSD, XST, XLANG
Crypt/Decrypt	? (to a less extent Web service security standard)

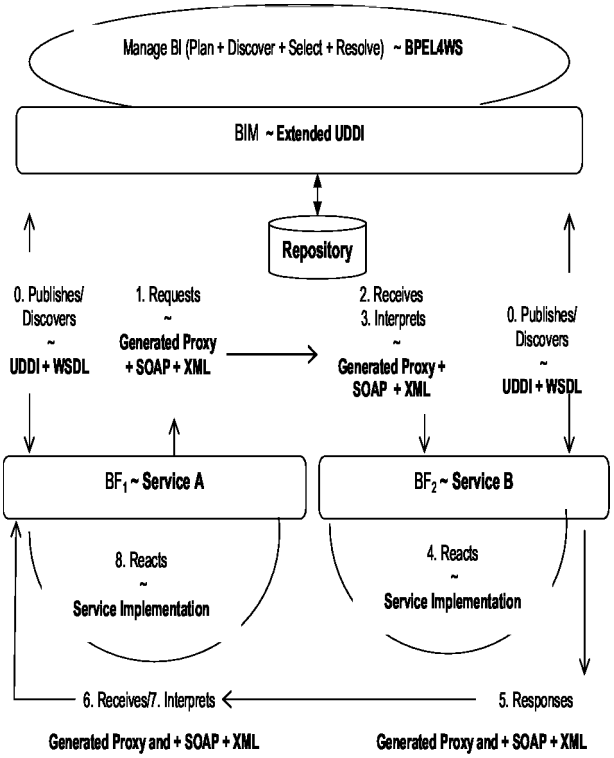

Figure 4. Implementation of the BIM with Web Services.

5. WEB SERVICES-BASED BIM FOR E-C

E-commerce emphasizes collaborative interactions beyond simple communications or transactions [23][30]. The implementation of functionality of the BIM with Web services technology will enable the categories of the business interactions including B2C and B2B as summarized in Table 3. Each category is an instance of the BIM as shown in Figure 5.

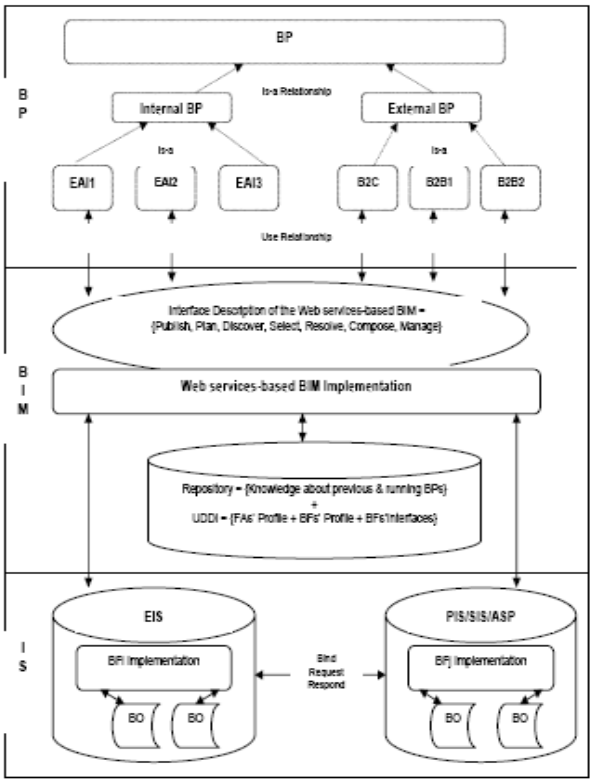

Figure 5. WSOA for B2C and B2B.

5.1 Web Services-Based BIM Enabler of B2C

The implementation of the functionality of the BIM, as a key component of WSOA will make business functions that are connected (interfaced) to customers, readily accessible through PDA, office devices, and mobile devices in addition to Web browsers. These business functions include, for instance: product/service evaluation, cataloging, order placement, order payment, order shipment, order tracking, and returns. Web services (especially semantic Web services) tools will reduce the product evaluation by publishing a more semantic description (e.g. OWL) of the products and services. From the enterprise perspective, the enterprise can manage its customers with CRM implemented as coarse-grained Web services to present better services and reliability.

5.2 Web Services-Based BIM Enabler of B2B

As mentioned before there are two types of B2B: B2B1 with suppliers and B2B2 with partners and services providers. B2B1 include product sourcing, product information and collection, purchase and procurement, tracking, billing, and supplier management. B2B2 include product development, collaborative supply, demand planning, and logistics. For large organizations, this has been achieved based on EDI specifications. Web services are used in B2B to:

- Allow effective dynamics. Indeed, EDI specifications assume a long term fixed and well-specified interactions (e.g. agreedupon format) deployed through proprietary networks (e.g. VAN). Web services connecting technology is based on the contract of type "take or leave", which gives more freedom and dynamics to businesses to choose transparent services accessed through the protocols of the Internet [4].
- Make transparent time and space, which overcomes the limitations of the traditional commerce.
- Fix the problem of the difference in semantics of the exchanged information, business functions, and business processes by using ontologies.
- The exchanged messages are no longer fixed as imposed by EDI specifications. They are open messages.
- Reduce the cost of entry into B2B for enterprise of any size, type, and nature (e.g. small and medium businesses). Indeed, EDI deployment and maintenance is very costly, which deprives small and to a less extent medium businesses to play the right role in the economics arena.

Table 3. Web services technologies enabling Interactions

	Value added by Web services technology
B2C	• Applications involved in B2C are better interfaced (in WSDL) to be accessible through different means, i.e. office devices, PDA, mobile devices, and browsers. • BIM searches and tracks facilities are exposed as Web services. • BIM allows dynamic binding facility allows business applications or services to bind to services at run-time. • BIM facilities assist in the inspection and selection of cost-effective services and connection. • Use of external as well as internal CRM applications accessible from anywhere through Internet.
B2B	• BIM, exposed as Web services, is accessible over the Intranet and Extranet for any designer willing to compose or to reengineer a business process. • BIM allows flexible or agreed-upon BP. • Dynamic businesses are really autonomous in their business interactions by dynamically discovering and selecting their partners through the BIM. • Dynamic binding facility allows applications or services to bind to services at run-time via the BIM. • BIM allows inspection and selection of efficient services and cost-effective connections. • Free message format using XML. Messages format not fixed and standardized. They are open messages. • EDI/VAN is no longer required, which facilitates the entry into B2B to small and medium enterprise. • Web services can live with the already integrated applications with a distributed computing middleware (e.g. CORBA).

5.3 Example of Web Services-Based BIM Enabler of B2B

Figure 6 illustrates an example of a B2B process 'purchase', composed of some business functions: 'quotation', 'order' and 'tracking', 'perfect delivery', and 'billing'. These business functions are actually implemented in the manufacturer's IS and supplier's IS, which are likely running on heterogeneous platforms. The business process is supported by the Web services-based BIM as follows:

Step1. The Web services-based BIM provides an interface to help the buyer in planning his/her 'purchase' business process.

Step2. The buyer, assisted by the Web services-based BIM, plans his/her business process in terms of flow of business functions (e.g. 'quote', 'order', 'track', 'perfect delivery', and 'payment').

Step3: The Web services-based BIM registers the planned business process 'purchase' in the repository for reuse.

Step4: The buyer executes the business process 'purchase'.

Prior to the above process, the following tasks must be achieved:

Task1. The Web services-based BIM provides tools to interface the business functions (e.g. wrapping tools for legacy business functions, generation tools for Java classes). The interface is described in terms of operations, message in, message out, pre-condition, and post-condition. A simple example is, for the operations 'quotation': (a) message in: list of items (id and

description), (b) message out list of quotes (id, quote), and (c) pre-condition: item id does exist, and (d) post condition: item quoted.

Task2. The Web services-based BIM provides tools to generate WSDL from the interfaces. The generated WSDL are stored in the repository.

Task3. Web services-based BIM can also provide some common e-commerce services such as 'electronic payment', 'auction', or 'reverse-auction'.

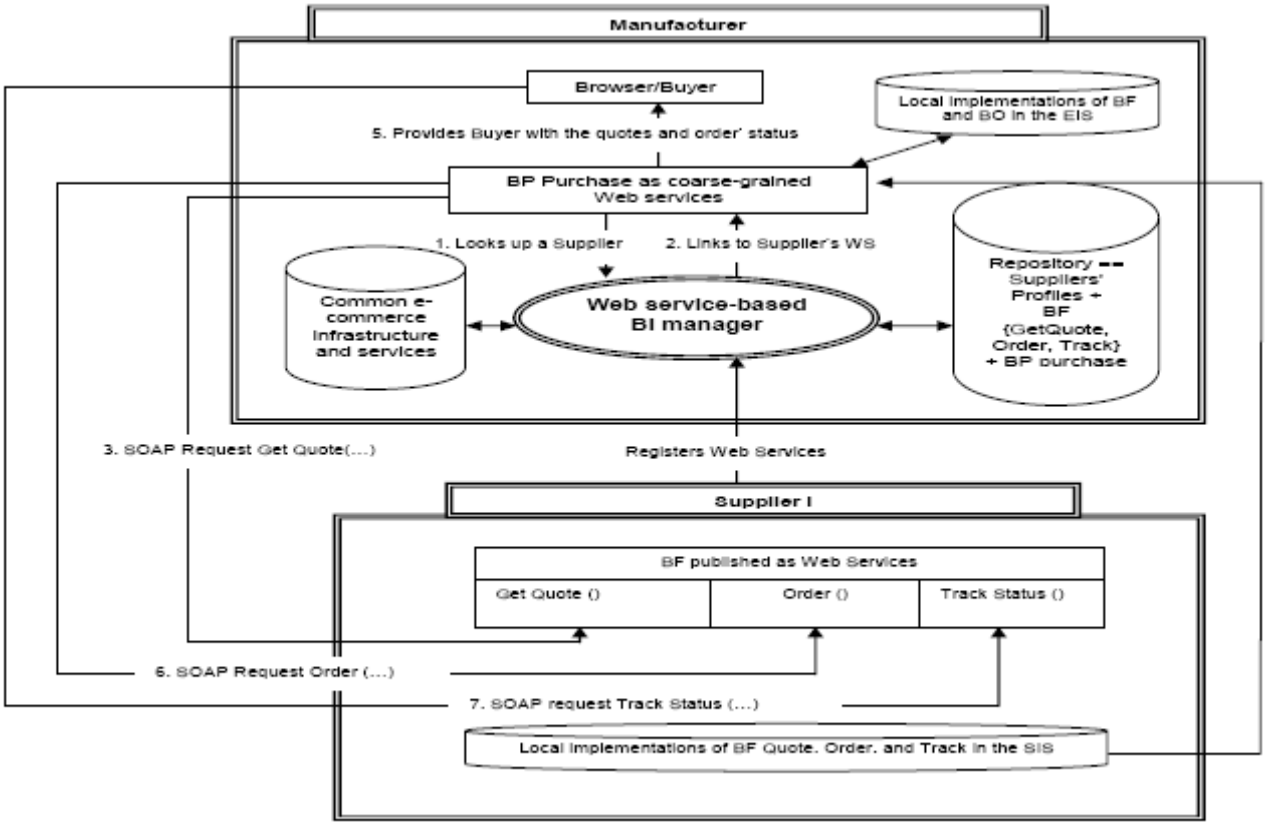

Figure 6. Example of a B2B application enabled by Web services-based BIM.

6. GUIDANCE TO DEPLOY WSOA TO E-C

The implementation of the functionality of the BIM, as a key component of SOA, with matured Web services technology will certainly add value to the enterprise architecture. Yet, the deployment of such a technology is still hindered by some methodological and technical issues (shown in Table 2 and Figure 4). Methodological issues deal with vision, frameworks, and methods (including models, approaches and tools). While technical issues (question mark in Table 2) are, for instance, related to security, availability, transaction, synchronization, and performance. This section presents guidance towards a method to deploy the architecture depicted in Figure 5 towards a WSOA architecture enabler of e-commerce. The guidelines are presented from business perspective to IT perspective.

6.1 Required Business Perspective of WSOA

A business model abstracts the business to make clear (and distinguish) business orientation from technology orientation.

Each abstract level has its own semantics and language. Current approaches for deploying e-commerce with Web services are more IT than business oriented. Focusing on IT rather than the business itself will not allow an abstraction and a robust specification of the requirements of BIM for each category of e-commerce with respect to business specifics. Indeed, an IT perspective always gets analysts confused as technologies are not mature enough and rapidly evolving. Therefore, it is very hard and time-consuming to build consistent SOA starting from the lowest abstract level, a technology-oriented level that is the EIS where the varied and redundant components have complex semantics. Certainly, these components will be leveraged, interfaced, and (re)used but after having specified the requirements and designed the architecture.

Unlike the IT perspective, a business perspective allows answering critical questions related to the business events, business processes, business objects, business functions, business interactions, and the relationships between them. That is, the focus must be on the specification of these building blocks, at a very high abstraction level, independently of their implementing technology.

6.2 An Approach to Deploy WSOA Based on the Requirements for a BIM

Deploying WSOA architecture is a huge project and a real challenge. Moreover, there is a lack of consistent methods (including a process with steps, models and tools) to deploy such architecture. In such situations, analysts must prioritize the deployment. Therefore, starting from internal incremental to external integration is a must. One cannot efficiently use the features of a technology, including Web services, for adding value to external applications such as B2B applications without having

EAI integration been working properly. Therefore, a general approach, based on the three-level architecture depicted in Figure 5, consists of:

Level 1: the information System

Step 1: Specifying the business objects in term of schema

Step 2: Specifying each business function (preferably in XML or OWL) in terms of:

- Interface, i.e. list of the business activities. For each core business activity:
  - Business activity name
  - Input messages and output messages specified in terms of parts (description of the business objects)
  - Pre-conditions, post conditions
  - Shared representation (e.g. a business object or any artifact for asynchronous connection)
- Accessible business objects, namely the pieces of data (a business object may play the role of a shared representation)

There is a relationship of the business functions to the business objects. Well-specified business objects may lead to a specification of almost all the business functions [3], and vice versa [11][22].

Level 2: the BIM

Step 1: Categorizing business interactions into:

- Internal business interactions (EAI1, EAI2, and EAI3)
- External business interactions (B2C, B2B1, and B2B2)

Step 2: Specifying the business interactions in terms:

- Activities, intensity, volume, and situations
- Connected business functions, exchanged messages, shared representation, space, time, dynamics, intensity, and situations (e.g. EAI1, EAI2, EAI3, B2C, B2B1, and B2B2).

Step 3: Deciding how to develop Web services to implement the instance of the BIM. That is, in-sourcing or out-sourcing?

- In-sourcing. When Web services are locally developed, analysts and developers must understand Web services as a contract between a provider and a consumer. That is, developers must consider the service as: (i) a connected business function, (ii) a service interface, i.e. the business function interface, and (iii) how to use this interface. Analysts and developers must be consistent in approaching development of Web services.
- Out-sourcing. Many services will be provided on some type of free-for-use basis. This is the essence of SOA architecture, which will be economical for organization of any size. SAO architecture is not limited to large organizations. In fact, this architecture will represent a real opportunity for small and medium organizations. Moreover, in SOA architecture, the distinction between internal and external service is transparent.

Level 3: the e-commerce applications

Step 1: Deciding the type of the e-commerce applications and involved business processes.

Step 2: Instantiating the Web-services-based BIM to specify its functionality for each category of e-commerce applications. Indeed, the business interactions are not the same for each category of e-commerce applications. The BIM presents an interface for each category of e-commerce application. However, not all the categories will use the same interface. For instance, the inner business interactions that connect the activities of the same business function (EAI3) or the business functions of the same functional area (EAI2) need not to be composed (unless we reengineer everything). In the same manner the BIM interfaces presented to B2C applications are different from those presented to B2B applications.

7. RELATED WORK

Business interactions have been seen as integration issues where various ways have been approached, namely: (1) a data-oriented integration, (2) an distributed object computing middleware such as COBRA [29], DCOM, or EJB, (3) a component based solution [1][23][10]. Currently, Web services are considered for business transactions [24][11][7][21][13]. Table 4 summarizes current implementations of the BIM to support different categories of business interactions.

Table 4. Current implementations of the business interactions

	Category of BI	**Current implementing technology**	**Example**
Category	**Subcategory (as noted in Figure 1)**		
1. Internal business interactions	EAI1	EAI, ERP, CORBA, DCOM, RMI, EJB	SAP
	EAI2	CORBA, DCOM, RMI, EJB	SAP
	EAI3	Function call, Inheritance, RPC	Programs including libraries and functions
	Business function to business object	SQL, ODBC, JDBC	DBMS
2. External business interactions	B2B1	B2Bi, EDI, VAN, Internet ebXML, RosettaNet, OBI, and to a less extent CORBA	Supply Chain Management (SCM), e-procurement
	B2B2	B2Bi, EDI, VAN, Internet ebXML, RosettaNet and to a less extent CORBA	e-services, e-cash
	B2C	Web browsers, Web servers, Internet	Storefronts, CRM

In addition to the confusion about these integration technologies and terminology [15], the current connecting technologies have some limitations namely: (i) the insulation of the business activities from the interacting activities is not clear, (ii) the used building block (if any) are too fine-grained (e.g. object), (iii) the integrated business processes are rigid and not flexible. Connection of the EIS/PIS/SIS/ASP is tightly coupled; the integration is static and hard-wired because essentially of the fixed format of the exchanged data structures, and (iv) the semantics of the building blocks, endpoints, and exchanged data is not considered. This makes the composition of the crossing, flexible business processes, namely e-commerce processes hard and costly.

With respect to e-commerce, especially B2B, due to its rapid growth and complexity, the integration standards are ebXML and RosettaNet. In [8], the authors survey and compare B2B e-commerce frameworks. In the last years, the concept of SOA [12][25], especially Web services have emerged. Chen et al. [6] analyzed the implications and impacts of the Web services to the e-commerce research and practices. Hogg et al. in [13] demonstrated that Web services are a good architectural style to obtain significant costs saving from the reuse of the existing components. Lu et al. in [18] proposed to make on-demand business process integration based on intelligent Web services. The WSMF framework [9] is as a conceptual model for developing and describing Web services, and their compositions. The Web services-based framework for business solutions integration [14] consists of a set of IT artifacts developed as Web services to address various aspects of an e-business integration solution. In our solution, the set of IT artifacts are embedded into the Web services-based BIM.

8. CONCLUSION

We have shown that a business interactions perspective, of a business modeling, provides a framework to define the crossing business processes involved in e-commerce, and to specify the requirements for Web services technology towards Web Services-based SOA architecture enabler of e-commerce.

First, we defined the business processes as virtual entities that are dynamically composed by interactions among the actual entities that are the business function and objects as implemented in the EIS, partners' IS, suppliers' IS, and services providers.

Then, we used the business interactions perspective to separate the concerns between the business activities and the connection activities in order to make these two types of activities independent; and to dedicate to the latter a specific BIM.

We specified the BIM to constitute a set of requirements for the connecting technologies, namely Web services.

We have sketched out an approach to steady implement instances of the Web services-based BIM for each category of e-commerce with respect to the business specifics.

This approach is based on a three level architecture where the Web services-based BIM is central to the business processes involved in e-commerce and the information system. That is, the Web services-based BIM complements and makes the information system a truly backbone of the business, which is a critical for the survival of the businesses willing to cost effectively and dynamically composing external business processes.

The integration of business interactions perspective with IT based frameworks and semantic Web will extend this work for a comprehensive, multiple abstraction levels WSOA enabler of e-commerce, and ultimately e-business.

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