VEGITO: A Virtual Enterprise Generator for B2C e-commerce

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Abstract. Web services have been used to respond to the new emerging requirements. Web services promise the dynamic creation of loosely coupled information systems and flexible business applications. Nowadays, a growing number of commercial enterprises are redefining their business processes under this technology. The platform and language independence of the web services programming interfaces enable the seamless integration of heterogeneous Web based-systems. In this work, we propose a Web service-based virtual enterprise generator for B2C e-commerce. The main contribution of this work consists in a Web-based system namely VEGITO which builds and generates B2C Web portal through a GUI set. Under our proposal, we believe that small organizations can automate many of their business processes for B2C e-commerce without making large investments in software development and deployment.

1 Introduction

With the rapidly spread of the Internet and E-Business, Web Service, a new web application pattern, has been used to respond to the new emerging requirements. Web services paradigm promise the dynamic integration of loosely coupled information systems leading to more flexible business applications [1]. A Web service is a service that is accessible by means of messages sent using standard web protocols, notations and naming conventions, including the XML Protocol [2]. Web services area is broadly used for Supply Chain Management, Enterprise Application Integration, and B2B and B2C e-commerce. In this context, B2C e-commerce involves electronic retailing or e-tailing. E-tailing involves online retail sales. E-tailing makes it easier for a manufacturer to sell directly to a customer, cutting out the need for an intermediary (retailer). With B2C transactions there is no need for retailers and therefore, no need for a physical store from which to distribute products. An electronic or Web storefront refers to a single enterprise Web site where products and

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services are sold. Customers can browse online catalogs or electronic storefronts when it best suits them. Taking this into account, we have developed a Web system for developing Internet portals for B2C e-commerce named VEGITO (VEGITO stands for Virtual Enterprise Generator of the Instituto Tecnologico de Orizaba). VEGITO implements Web sites to search and purchase products and services of the enterprises registered by using Web services technology. By using VEGITO, small organizations can automate many of their business processes without making large investments in software development and deployment. Furthermore, virtual enterprises generated by VEGITO solve interoperability and integration problems not attended yet by Web portals for B2C e-commerce.

The rest of this paper is structured as follows. In the next section we describe the functionality of VEGITO, its architecture and components. Also, we propose a case of study to show how VEGITO can be applied in a real world scenario. Finally, we review the related work in this area and we emphasize the contributions of our work.

2 VEGITO Architecture

VEGITO stands for Virtual Enterprise Generator from Instituto Tecnologico de Ori-zaba. In Fig. 1, the general architecture of VEGITO is depicted.

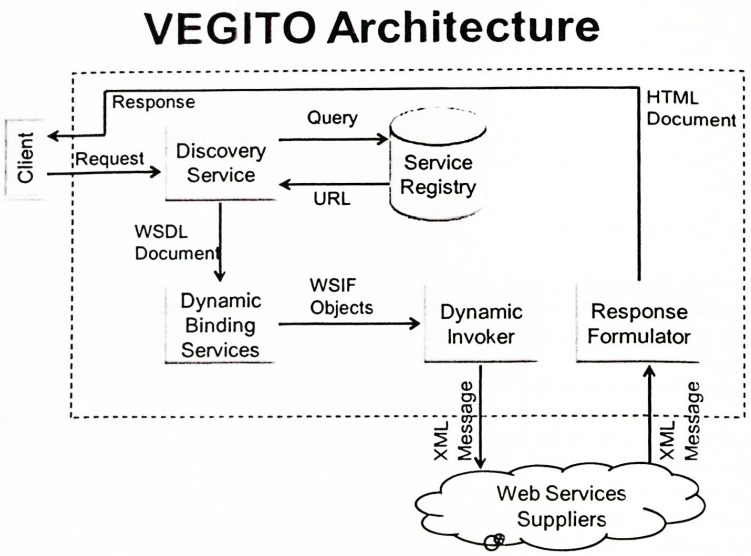

Fig. 1 Main internals of VEGITO

In Fig1, each component has a defined function explained as follows:

Service Registry is the mechanism for registering and publishing information about business processes, products and services among B2C e-commerce partners and to update and adapt them. In this sense, we used a private UDDI node [3] for describing services, discovering businesses, and integrating business services. In our private UDDI node, commercial enterprises, services and products both are classified and registered. For the classification of business processes, products and services in the registry, we use broadly accepted ontologies like NAICS, UNSPSC and RosettaNet. NAICS is a standard classification system for North American Industry; UNSPSC provides an open, global multi-sector standard for efficient, accurate classification of products and services and; RosettaNet defines the technical and business dictionaries.

Discovery Service is a component used to discover business processes implementations. This component discovers Web services like authentication, payments, and shipping at run time from a B2C e-commerce scenario. These Web services can be obtained from suitable service providers and can be combined into innovative and attractive product offerings to customers. When there is more than one service provider of the same function, it can be used to choose one service based on the client's requirements. Inside the discovery service, there is a query formulator which builds queries based on the domain ontology that will be sent to the registry service. This module retrieves a set of suitable services selected from the previous step and creates feasible/compatible sets of services ready for binding.

Dynamic Binding Service is a component that binds compatible business processes described as Web services. In this sense, the module acts as an API wrapper that maps the interface source or target business process to a common interface supported by VEGITO.

Dynamic Invoker transforms data from one format to another. This component can be seen as a data transfer object which contains the data flowing between the requester to the provider applications of Web services. We used Web Services Invocation Framework (WSIF) that is a simple Java API for invoking Web services, no matter how or where the services are provided [4].

WSDL Document Analyzer validates WSDL documents that describe business processes by their interfaces which are provided and used by B2C e-commerce partners. WSDL documents employ XML Schema for the specification of information items either product technical information or business processes operations. In this context, this component reports the business processes operations, input and output parameters, and their data types in a XML DOM tree. We used WSDL4J to convert the XML DOM nodes in Java objects [5].

Response Formulator receives the responses from the suppliers about a requested product. This module retrieves useful information from the responses and builds a XML document with information coming from the service registry and the invocations' responses. This XML document is presented in HTML format using the Extensible Stylesheet Language (XSL).

In the next section, we describe the process for building B2C Web portals based on Web services.

3 VEGITO Prototype

By using VEGITO, clients can use an Internet browser to access the services offered. VEGITO provides a GUIs set to capture the features of the B2CWeb portal to generate. VEGITO has as main objective to generate B2C Web portals based on the requirements defined by the clients. Each one of the components in VEGITO has an assigned task to achieve the main objective. VEGITO carries out the operations to respond to the client's requests through Web services interfaces provided by the enterprises. The importance of our proposed solution can be appreciated in the increase of the commercial activity observed on online enterprises along with the social benefits that this bears. In this sense, we describe the following scenario where the functionality of VEGITO can be observed. The case of study describes how VEGITO facilitates the discovery and invocation of Web services for products searching that are offered by some enterprises. Suppose the following scenario:

- There are a set of enterprises that sell products, which have been registered previously in VEGITO. The business processes of them also have been registered as Web services in VEGITO.
- A client needs to expand its business partners through selling both products and services offered by the registered enterprises. For doing this, a B2C Web portal is required but the development time is critical for the enterprise.

In this scenario, how a client can develop a B2C Web portal to sell product offered by the set of enterprises if the client does not know about the enterprises?

The solution to this issue is VEGITO. VEGITO offers a GUI in each step for building the B2C Web portal based on Web services. Firstly, the client must choose a Web site design; this is shown in Fig. 2.VEGITO creates a collection of pages that reside on a web server and present content and interactive features to the end user in form of Web pages. Such elements as text, bitmap images, forms are placed on the page using HTML/XHTML/PHP tags. VEGITO has15 predefined templates for Web site design. Once selected the Web site design, the client must configure the background color for each Web page inside the frame sets (see Fig. 2). For simplicity, all frame sets have four Web pages: (1) the frame namely logo where the marketing information from the client is placed, (2) the frame namely results where the products search is displayed, (3) the frame called credits refers to the programmer's info and, (4) the frame namely search where the queries for products search are established. Once configured the selected frame, the client choose what products and services he wants to offer. These products and services are provided by the enterprises registered in the private UDDI node. For this case of study, Amazon was selected as services and products supplier.. Amazon Web Services provides developers with direct access to Amazon's robust technology platform. These fundamental services allow build web applications in a reliable, scalable, and cost-effective manner. However, in a near future more registered enterprise can act as suppliers. Amazon holds 34 product categories such as Books, Music, Baby, Hardware, Toys, Photo, and Magazines, to mention a few. The client can select either all available categories or each category in a separately way. In Fig.3, Amazon's product list is shown. Next, the client must fill a form with his contact information and about his enterprise (see Fig. 3).

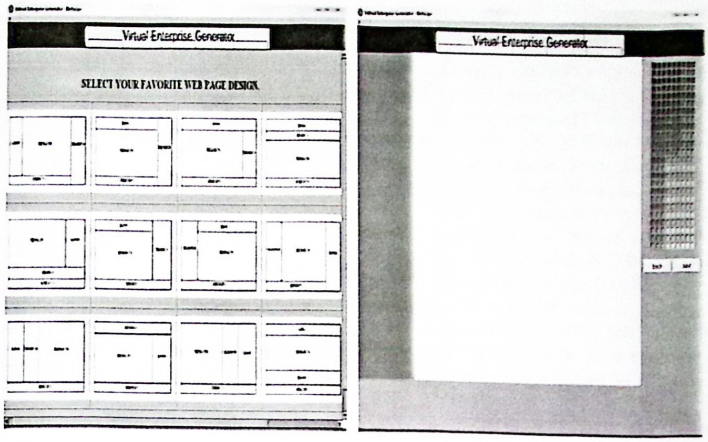

Fig. 2 Screenshots of the selection of Web site design and configuration for background color of each Web page inside frame sets.

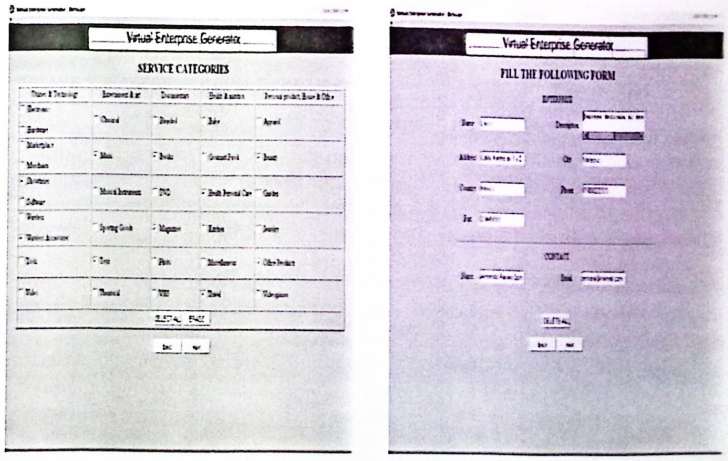

Fig. 3 Screenshots of product list provided by Amazon and the Web form for contact information

This functionality is similar to the BusinessEntity element in a standard UDDI node. Once filled this form, VEGITO verifies the information placed in each step of the Web portal generation process. If an information error is presented, the client can back to step where the information error was found. Otherwise, the B2C Web portal is generated by using PHP. PHP is the most popular scripting language for web applications. The above procedure is depicted in Fig. 4. Now, the client can find a product in the B2C Web portal generated. In the Web portal there is an option "Search" in the main menu. When the option "Search" is clicked, a XML message is build to consume the Web services provided by Amazon. We have used REST as messaging service among Web services.

REST stands for "Representational State Transfer". REST is a simpler approach than XML-RPC or SOAP, using standard HTTP methods such as GET, POST and PUT to send and retrieve XML data [6]. By using this approach, tools like PHP DOM, SAX, or even XSL can be used to do the parsing. REST differs a great deal from SOAP and XML-RPC. Firstly, it's not a standard, whether formal or informal. Second, there is no standardized toolkit or pre-built client and server classes in PHP. The strength of REST is that special extensions or tools to develop web services are not required. The HTTP protocol specifications contain all the necessary to transmit and receive XML messages. Once the XML message is sent to the Web service provider, a XML message is received as response. The response is analyzed and the useful information is extracted. The B2C Web portal displays the response as a HTML document concluding the product search. This is shown in Fig. 5. Is necessary to mention what the products list is sent by the enterprise to address provided by the client during the register process in VEGITO.

So far, we have shown only one example that illustrates the generation process of a B2C Web portal in VEGITO. However, a wide variety of other cases of study involving several optimization criteria can be developed and included such as shopping with the minimum delivery time, lowest price, specified quantity, and finally with no constraints too.

Furthermore, VEGITO can implements Web services orchestration The utility of Web services is further enhanced by the introduction of mechanisms for composing, them in order to generate new Web services and applications. The composition of Web services is defined as a process that enables the creation of composite services, which can be dynamically discovered, integrated, and executed to meet user requirements. In VEGITO, a composite Web service can be obtained by the orchestration of several simple Web services. Composite Web services can be created in both design and execution time.

Finally, VEGITO architecture can be extended to a service-oriented architecture (SOA) likely BPIMS-WS [7] to improve the critical issues of creating, modifying and extending, solutions for enterprise application integration, process automation and automated exchange of information between organizations because Web services technology follows the SOA's principles for developing and deploying these types of applications.

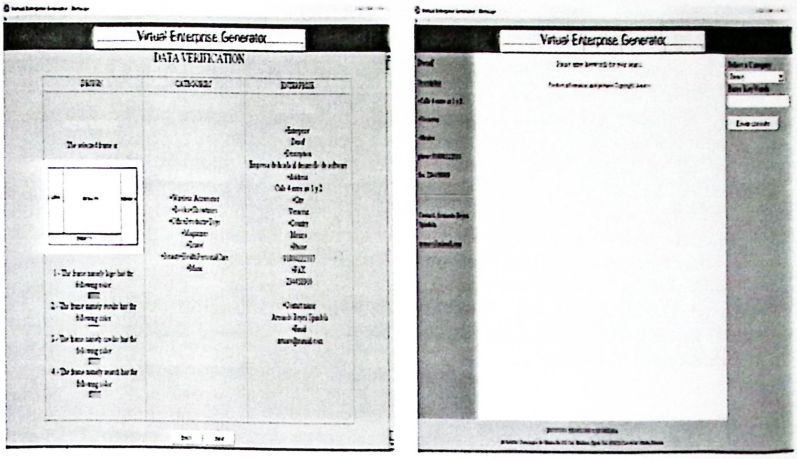

Fig. 4 Screenshots of the information verification for each step in the Web portal generation process and preliminary view of the generated Web portal

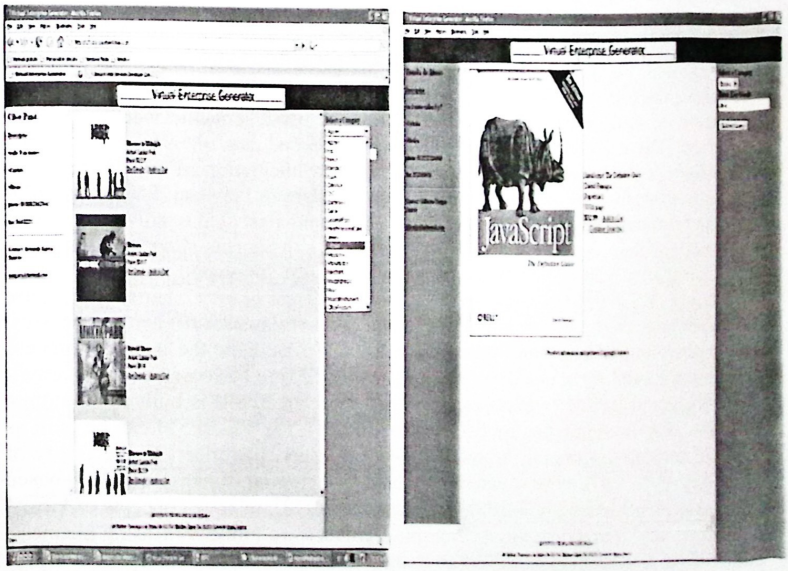

Fig. 5 Screenshots of virtual enterprises generated searching books in Amazon

4 Future Directions

We have considered extensions to VEGITO for B2B e-commerce. We have considered the use of Web services choreography that allows to enterprises create new business processes that mirror today's dynamic and ever-changing business needs. Creating a business process requires not only a clear definition of collaboration patterns of all its components, but also a way of depicting standard Business-to-Business (B2B) and Enterprise Application Integration (EAI) interactions. Furthermore, VEGITO was designed to achieve the adaptation with other broker systems of E-commerce therefore can be extended with other capabilities such as the search and buy in other enterprises who are registered in different broker systems.

Finally, we have considered change the messaging service approach to a WS-RM-based Messaging Service. Web Services Reliable Messaging (WS-RM) is a protocol that provides a standard, interoperable way to guarantee message delivery to applications or Web services.

5 Related Works

In [8], a collaboration system which uses multi-agent system (MAS) technology and specialized tuple spaces to realize supporting web-based collaboration between organizations within a dynamic real-time virtual enterprise is presented. A Web services based Intranet in Virtual Enterprises (WIVE) is proposed in [9]. In this framework, ontologies to provide a uniform shared format and MAS (multi-agent system) for dynamical communication are used. Furthermore, retrieval of service information under the above architecture is discussed. In [10], key research issues in implementation of data integration in virtual enterprise using semantic web service are discussed. The architectural framework of the proposed data integration infrastructure adopts a mediated ontology approach to data integration in which each data source is described by its own ontology and translations between different ontologies are by means of mediation. A Branch-and-Bound algorithm to solve the partner selection problem is proposed in [11]. Numerical experiments show that the algorithm is effective. In [12], a frame of business process simulation model for virtual enterprises (VE-BPSM) is presented. Business processes of a member enterprise are classified into three groups: internal, external and hybrid event-triggered processes. The inter-relationship among them is discussed. To facilitate the business process simulation model for a member enterprise (MEBPSM) to be reused every external-event-triggered BPSM or every hybrid event-triggered BPSM is built as an atomic business process simulation model (Atomic-BPSM). The VE-BPSM can be built as a BPSF through combining Atomic-BPSM of member enterprises, so the agility of modeling BPS for a virtual enterprise could be achieved. Finally, an HLA-based method of developing a VE-BPSM is discussed. In [13], relative concepts of virtual enterprise, and a practical virtual enterprise architecture framework using business, application, and technology layers to realize an adaptive virtual enterprise are presented. An enterprise application integration pattern is proposed which is useful for inter-enterprise application integration has been proposed for the development of adaptive enterprise information system in tobacco industry. In a case study, this pa-

per presents a contemporary tobacco distribution system to proof the proposed virtual enterprise architecture framework. A model driven approach is presented in [14] whereby a composite service specification is generated automatically from a simple declarative definition. It is based o n three concepts: services, virtual enterprises and business rules. Using an e-travel application as a running example, the steps of the generation process is explained. In [15], novel distributed workflow execution architecture for virtual enterprises in grid environment is proposed. The procedure of distributed process execution and the model partition method are demonstrated by using the bike customization process of XBike. Finally, a service-based model for Virtual Enterprise workflows is presented in [16]. Modeling the workflow execution as a cooperation of services allows different organizations to interact via well-defined interfaces. This approach primarily covers three models: the conceptual model of workflow for virtual enterprise, the service model and the execution model, it discusses the agile service choice and transfer mechanism of the virtual enterprise and shows how the execution can be optimized by selecting services depending on their contribution to quality criteria of the workflow.

6 Conclusions

In this work, we have presented a virtual enterprise generator named VEGITO which is based in a shop model for B2C e-commerce. VEGITO provides a set of Web interfaces where different enterprises can offer its products and services. The responsibility of developing Web services to carry out the search of products is delegated to VEGITO. Finally, we believe that small organizations can automate many of their business processes by using VEGITO without making large investments in software development and deployment.

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