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Ontologies and semantic web services for m-commerce applications

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ABSTRACT

The semantic web provides the infrastructure that enables the semantic interoperability of web services. Semantic web services, which are services that are self-described and amenable to automated discovery, composition and invocation, will form the next generation of the Web. These services can be represented using ontology and rendered for use in e-commerce vis-a-vis m-commerce. This paper gives a design based on ontologies and semantic web services for m-commerce applications in the domain of Internet bookshelf. This design enhances the security, communication and interoperability between systems, customers and objects and provides a framework for effective m-commerce applications.

INTRODUCTION

We define electronic commerce (e- commerce) as business processes on the Internet. For example, advertisements; buying and selling of goods and services on the Internet. These transactions can be carried out between either two or more business operators (B2B) or- between business operators and individual and consumers (B2C). Among the numerous factors that contribute to the development of e-commerce are the tremendous development of the Internet and related technologies, the understanding and exploitation of the business potentials that rest behind this development. The relative ease and varieties consumers have when buying and selling on the Internet have led to exponential rise in e-commerce globally.

The facilities in e-commerce extend to include the devices that the end-user employs to gain access to the Internet. The main technologies developed to gain access to the Internet are the wired-line (e.g. using a home PC as end-user device) or wireless (e.g. using a mobile phone as end-user device). While e-commerce continues to impact the global business environment profoundly, technologies and applications are beginning to focus on mobile computing and the wireless web (Tarasewich et al.,2002). Mobile commerce (also called m-commerce, mobile e-commerce) involves all activities related to commercial transactions conducted through communications network that interface with wireless (or mobile) devices (Tarasewich et al., 2002).

That is, m-commerce is concerned with the use of wireless devices to gain access to the Internet for the purpose of carrying out business processes (or ecommerce). M-commerce therefore is a subset of e-commerce (Knospe and Schwiderski-Grosche,2002).

The main driving force for the rapid acceptance of mobile devices (for example bluetooth, smart phones, mobile phones, laptops, earpiece, GSM etc) is the capability to get services and run applications at any time and at any place, especially while on the move (Veijalanen et al., 2003;Gray, 2003).

Semantic web is a web of meaningful contents and services, which can be interpreted by computer programs. Semantic web addresses the weaknesses of current knowledge management systems; such as extraction of un-integrated relevant information from different sources, inability to maintain structured sources of information leading to difficult updating processes, unavailability of machine processable semantic representation of information to enhance automation, etc. On the other hand, ontologies provide a shared and common understanding of a domain that can be communicated between people and application systems; a way to cope with heterogeneous representations of web resources. Veijalainen et al., (2003) propose an ontological transaction monitor which acts as an intelligent component between the application and the servers accessed during m-commerce transactions; and controls the perceivable communication behaviour of the terminal towards the servers. The main issues and activities in m-commerce are discussed in Tarasewich et al. (2002).

There are demands for efficient ways of processing data especially on the web. The tools to use become even more important as the society becomes more complex with associated large volumes of data. M-commerce has additional advantages of convenience; accessibility and localization hence used by a lot more people, thereby increasing the volume of data and complexity of transactions on the web.

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Ontology and semantic web services are the tools suitable for processing this type of complex, voluminous amount of data, and enhances interoperability and communication between the heterogeneous systems (Williams et al., 2004). These indicators form the driving force in carrying out this study. In this paper, a design of ontology based semantic web services for effective m-commerce transactions in the domain of Internet bookshelf is proposed.

AN OVERVIEW OF ONTOLOGY

The term ontology has been in use for many years. Merriam Webster, for example, dates ontology circa 1721 and provides two definition: (i) a branch of metaphysics concerned with the nature and relations of being and (ii) a particular theory about the nature of being or the kinds of existence. Many authors propose slight variations in their definitions, in many cases to suit their research interests. Grant, (2001) gives a widely accepted definition of ontology - a formal, explicit specification of a shared conceptualization. Uschold and Gruninger,(2004) further explain each of the terms '*formal*', '*explici*t', '*specification*' and '*conceptualization*' as follows. A conceptualization refers to an abstract model of how people think about the world, usually restricted to a particular subject area or domain. Explicit means that the concepts and relations are given explicit names/definitions (terms and definitions). The *name* is a term and the definition is a specification of the meaning of the concept or relation. *Formal* means that specification is encoded in a language whose formal properties are well understood. *Shared* means that the main purpose of an ontology is generally to be used and reused across different applications and communities.

In summary, this definition can be expressed as a formal explicit description of concepts in a domain of discourse. This description is usually made up of axioms that define each thing, thus giving a model that represents the domain and can be used to reason about the objects in that domain and the relations between them. The use of ontology in representing knowledge and its relationship with epistemology is described in Williams et al, (2004).

CURRENT AND FUTURE APPLICATIONS OF ONTOLOGY

Although ontologies have had a long history, they remained largely the topic of academic interest among philosophers, linguists, librarians, and knowledge-representation researchers, until somewhat recently. Currently, ontologies have been gaining interest and acceptance among computational audiences (in addition to philosophical audiences). Guarino, (1998) provides a collection of fields that embrace ontologies, including knowledge engineering, knowledge representation, qualitative modeling, language engineering, database design, information retrieval and extraction, and knowledge management and organization. That collection put together in early 1998 did not include the web emphasis that is seen today.

In particular, ontology, as the shared and common understanding of the domain that can be communicated between people and application systems, has a significant impact on areas dealing with vast amount of distributed and heterogeneous computer-based information. These application areas include World Wide Web and Intranet information systems, complex industrial software application, knowledge management, electronic commerce and e-business. In this paper, we are concerned with marketing on the web with the use of mobile communication devices. There is increased need for shared semantics and a web of data and information derived from it. Scientist, researchers and regulatory authorities in genomics, proteomics, clinical drugs trials and epistemology all need a way to integrate these components. This is being achieved in large part through the adoption of ontologies (Shadbolt, 2006). Generally, ontologies can be used to communicate between systems, people and organizations, interoperate between systems, and support the design and development of knowledge-based and general software systems (Williams et al.,2004)

SEMANTIC WEB AND SEMANTIC WEB SERVICES

Semantic Web

The Semantic Web aims to add a machine tractable, re-purposeable layer to compliment the existing web of natural language hypertext. In order to realize this vision, the creation of semantic annotation, the linking of web pages ontologies, and the creation, evolution and interrelation of ontologies must become automatic or semi-automatic processes. (i.e. in a distributed computation, semantic web aims at distributing data and services defined and linked in such a way that they can be used by machines, not just for display purposes, but for automation, integration and reuse of the data and services across various applications and heterogeneous users). Berners–Lee et al., (2001) summarize semantic web as a vision of a web of meaningful contents and services, which can be interpreted by computer programs. The emergence of the semantic web allows answers/results to be given to specified queries in the Internet; people can now add new facts/ideas to the Internet because they will be structured and maintained in such a way that machines can reason about them. A number of languages such as Extensible Markup Language (XML), Resource Description Framework (RDF), RDF schema (RDF-S), and Recently, Web Ontology Language (OWL), etc., have been developed to facilitate the implementation of the concept of semantic web.

Semantic Web Services (SWS)

There are services on the web for users, defined through a service ontology, which enables machine interpretability of its domain knowledge. A web service is a software or program identified by a

Uniform Resource Locator (URL), which can be accessed through the Internet through its exposed interface. The interface description declares the operations, which can be performed by the service, the types of messages being exchanged during the interaction with the service, and the physical location of ports, where information should be exchanged. For example, a web service for calculating the exchange rate between two money currencies can declare the operation getExchangeRate with two inputs of type string (for source and target currencies) and an Output of type float (for the resulting rate). A binding then defines the machine and ports where messages should be sent (Grant, 2001)

ONTOLOGY BASED DESIGN OF ONLINE BOOKSTORE FOR M–COMMERCE

We now use a domain, the selling and buying of books on the Internet to illustrate the application of ontology and SWS in m-commerce. The domain is an online bookstore. An online bookstore provides a means of allowing users to browse the web for a suitable offer to buy the books they want. The architecture of the proposed model is as presented in Fig.1. The architecture depicted in Fig. 1 shows two interface layers between the individual customer and the retail institution/distributor. The mobile devices are used for communication and allow the user(s) to get services and run applications at any time and any place. The ontologies provide a means of describing the structure of semantics of objects/transactions in the domain and provides interoperability between the mobile devices of the customer and the retailing institution/Distributors. Between these layers are the possible transactions, which include placing order, tracking the order, processing the order, bill customer/receive bills and distribution order. The transactions are described with the use case diagram, which forms part of the design.

The Use case diagrams describe what a system does from the standpoint of an external observer. The emphasis here is on what the system does rather than how it is done. The actors are the customer, the retail institution and the Distributing agent, who communicate through the specified Use Cases such as place order, track order etc., which depict some aspect of system functionality that is visible to an actor such as a customer. A semantic web service is provided to by ontologies actualizes these processes. The user adds information to the semantic web to accept the offer and gives details (such as name, shipping address, credit card information, etc.) of delivery via mobile devices. The buyer is notified of reception of his/her order leading to the completion of the transaction and the distribution and delivery of the requested book(s).

The type of ontology adopted in the design is the on2broker ontology described in Fensel et al., (2001). It has four main components: the query engine, the information agent, inference engine, and database manager. The query engine receives query from the user and answers them by checking the content databases that were filled by the information agent and inference engines. The information agent is responsible for collecting factual knowledge from the web. Facts and ontologies are processed to derive additional factual knowledge by the inference engine. The backbone of the entire structure is the database manager, which receives and stores facts/knowledge from the information agent, exchanges the facts as input and output with the inference agent and provides facts to the query engine. The customer/consumer (the retail institution) interacts with the query engine, through mobile devices. The various activities possible on the internet bookshelf are presented in Fig. 2.

The activity diagram for the online bookstore is shown in Fig. 2 while the class diagram is depicted in Fig. 3. The activity diagram represents a fancy flowchart with additional enhancements. It shows three objects; the customer, sales and bookstore, which interact with each other to accomplish the task of ordering a book from the bookstore. The activity diagram uses swim-lanes to show which objects take responsibility for which parts of the process. This can be represented by ontology showing objects and their relationships. The three classes involved; customer, sales and bookstore have activities they perform represented with rounded rectangles. The process begins at the black start circle at the top and ends at the concentric white/black stop circle at the bottom. The customer places an order by requesting books.

The order is sent and processed in the sales and eventually on successful processing of the order; the requested books are pulled from the bookstore and shipped to the customer. The customer pays bill(s) to the sales and the transaction is closed after an order shipment and credit card billing is successful. As indicated in Fig.2, the customer can continue working while waiting for response, such as notification of reception of order placement from the sales.

The class diagram depicted in Fig. 3, is used to describe the types of objects in a system and their relationships. Class diagrams give an overview of a system by showing the classes and the relationships among them, represented by ontology. It shows interaction between the customer and the bookstore as well as the shipping agent. Since a bookstore can be empty, there is an association relationship between the bookstore and a book. Many books can be found in one bookstore and no book may be found as well.

The book class has a GetBook() function of type Boolean that returns true if the requested book is found, otherwise returns false.

A many to one relationship exists between the shipping agent and book class as well as the customer and shipping agent.

Each class has three parts:

i. a name e.g. Customer

ii. attributes e.g. Name, Address, Price etc.

iii. operations e.g. PlaceOrder(), GetBook() etc.

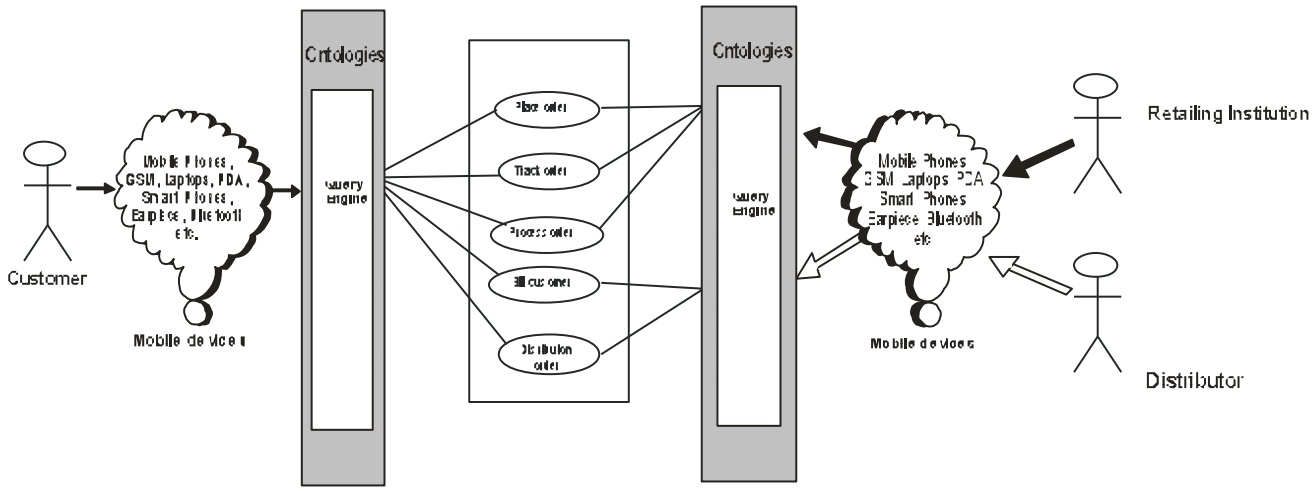

Fig.1.Conceptualized model and use case diagram.

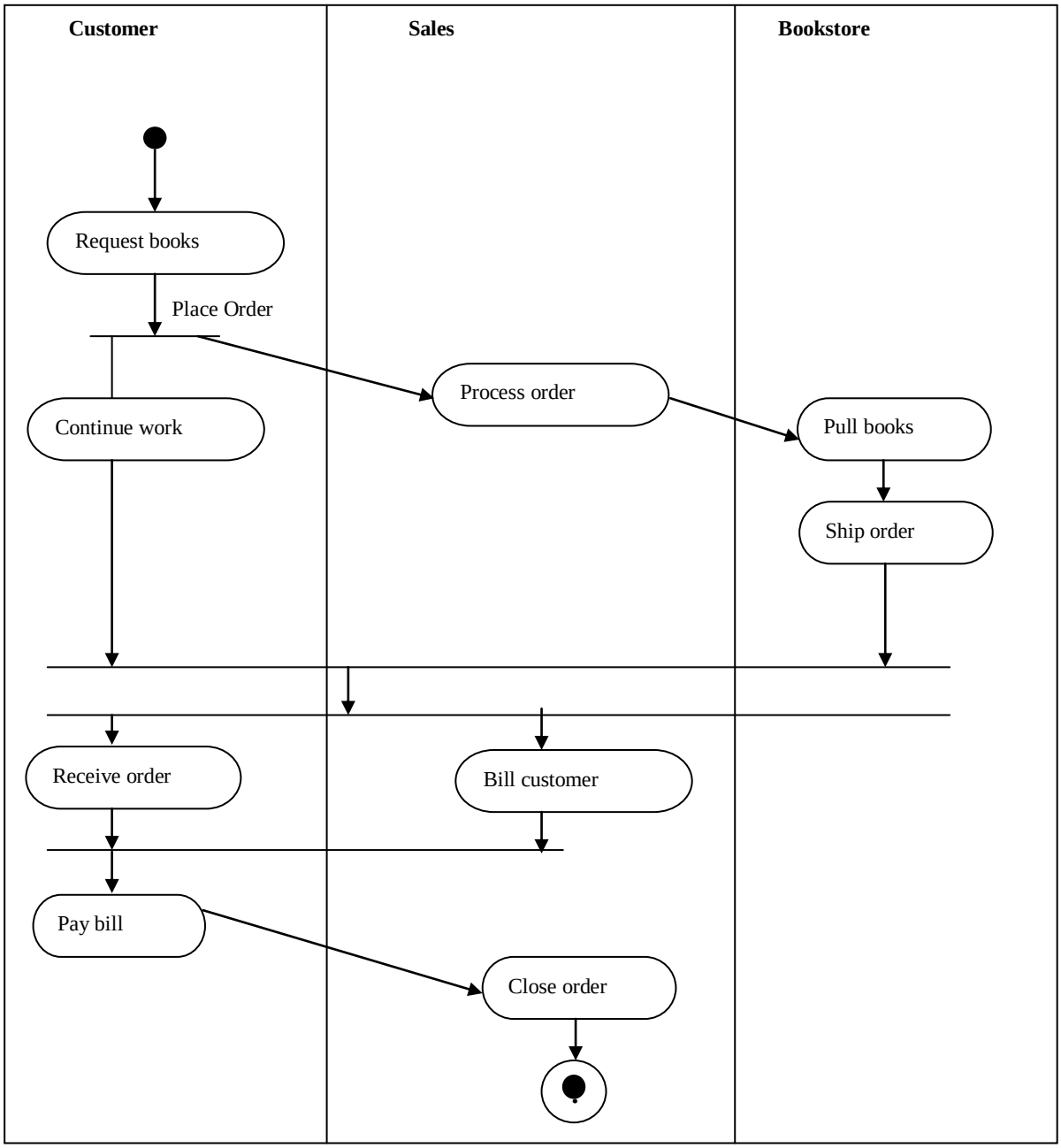

Fig. 2. Swimlanes for online bookstore design

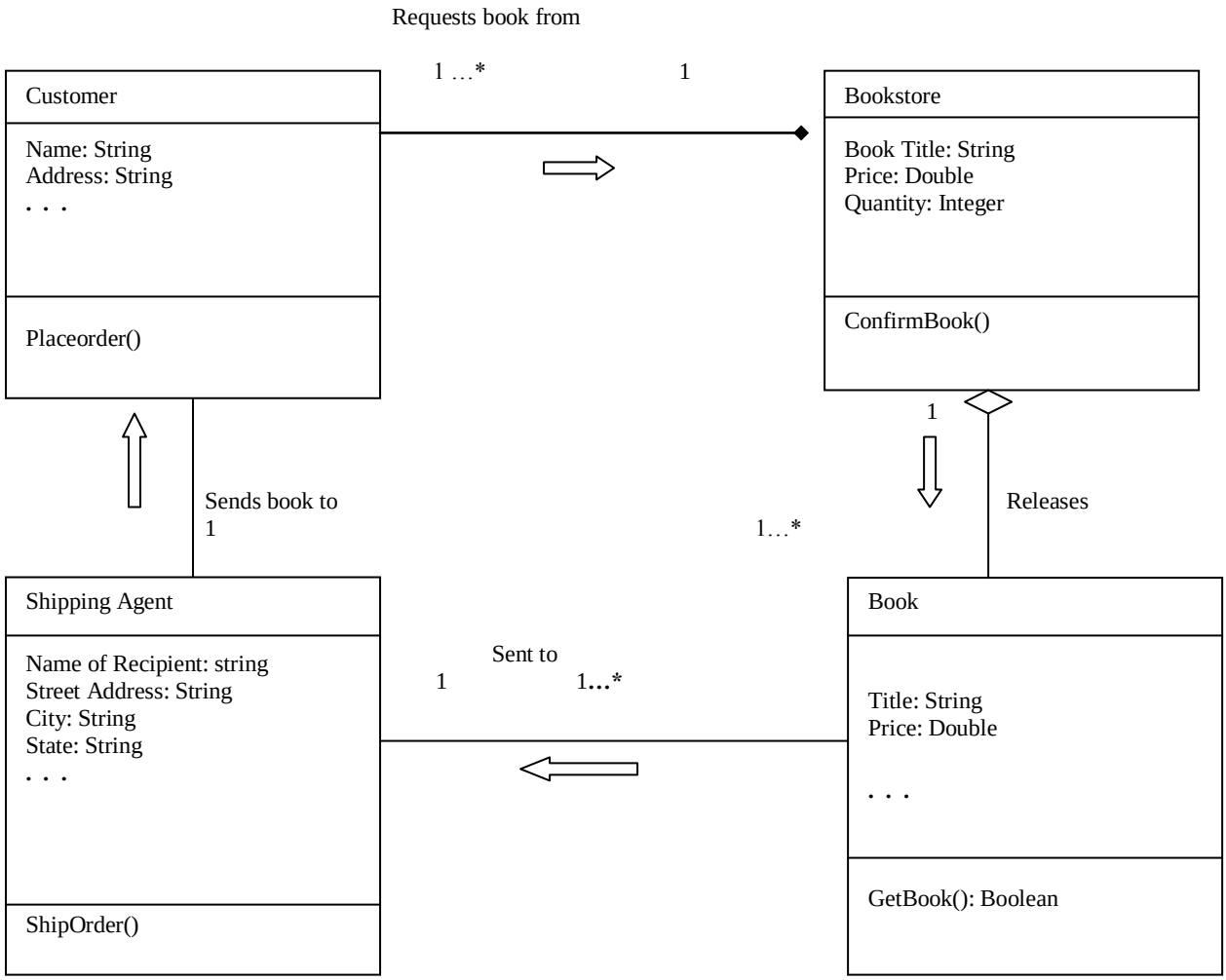

Fig. 3. Class diagram for Internet bookshelf

CONCLUSION

People engage in commerce by using or adopting the tools and technologies that are available at the moment. Also, Internet facilities and mobile devices have been used by business managers and customers and have created a good platform for them to communicate. Mobile devices are capable of getting services and runing applications at any time and at any where, especially while on the move. It also provides enhanced security (SIM card for mobile phones store confidential user information), convenience, accessibility and personalization. These factors have caused rapide acceptance of m-commerce leading to voluminous data, complex transactions and increased nature of relationship among data items and transactions; hence the need for effective tools to overcome these problems. This paper proposes a design based on ontologies and semantic web services for m-commerce applications in the domain of Internet bookshelf. This design enhances the security, accessibility, interoperability and communications between systems, devices, and objects and provides a framework for effective and easy m-commerce

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