SEMANTIC WEB FOR NEXT GENERATION OF E-COMMERCE

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ABSTRACT

Web technology left a significant impact for business transaction. The role of buyers and vendors has been replaced by informative websites where the available information of products and services could improve supply chain and delivery cycles. As the market segment grows, the need of having organized and thoughtful web content is increasing. Search functions using keyword-based search are known for its inability for the machine to interpret different terminology with the same meaning. Information needs to be structured for parametric search to locate products with certain combination of traits. Ontology is the solution to structure semantic of product data. It allows computer to process content with meaning for human based consensual terminologies. Ontology provides a shared platform and common understanding of a domain that can be communicated between user and application systems. The purpose of this paper is to highlight the importance of exploiting ontology based e-commerce for Semantic Web. The ontology is mediator for software agents to communicate and exchange data. These agents can search products with certain traits, negotiate products or automatically configure product or services according to the required specifications. The semantic combination of product data elevate full potential of e-commerce and development of many specialized reasoning services bring full power of Semantic Web Based E-Commerce.

KEYWORDS

E-Commerce, Semantic Web, Ontology

1. INTRODUCTION

Most people associate e-commerce with online shopping (business-to-consumer, or B2C). The success of internet shopping has revolutionized the way people doing business today. Public has moved from B2C to B2B (business to business) where it has change Internet into electronic market place. It has become a platform for buyer and vendor to conduct high business value transaction, creates long term relationships, complex processes, inter-computer communication, security and multitude of transaction model (Feldman 2000). It combines aspects of negotiation, information, business process and social interactions. Electronic marketplaces provide support for auction, search, payment, insurance and security (Feldman 2000). Participant of electronic marketplaces able to construct highly profitable but more complicates deals.

Internet has become a competitive market place for electronic trading. It offers various products and services allowing vendors and buyers to negotiate for the best price. However with the increasing number of e-commerce web site growth and the complexity of business and negotiation model, it is impossible for the electronic merchant to spend most of his time to gather, understand and analyze business information. The electronic merchant needs technology to assist them to do the above mention tasks.

New business services such as XML, software agent and knowledge driven customer relation application are created to support electronic data exchange, automated auction and negotiation and to provide better customer services (Trastour, Bartolini et al. 2003). However, with the creation of Semantic Web, e-commerce has to take this challenge to organize and present the product and service data in a machine processable format.

The purpose of this paper is to discuss and highlight the importance of Semantic Web based e-commerce. This paper shows how semantic web technology could enhance e-commerce capability for more highly profitable and less complicated deals.
This paper is organized as follows. Section 2 highlights current issues and challenges of e-commerce today. Section 3 describes in detail semantic web and ontology technology. Section 4 discusses how semantic web could enhance e-commerce potential. Section 5 discusses Malaysia's small and medium scale industries (SMI) readiness for semantic web e-commerce and finally section 6 concludes this paper.

2. THE ISSUES AND CHALLENGES OF E-COMMERCE

E-Commerce has received much attention from governments, businesses and regional bodies. It has change the way consumer interacts with business and others as well. E-commerce and Internet brings together many online vendors and buyers to participate in business interactions. It provides high level platform of flexibility and openness which helps to optimize business relationship (Omelayenko and Fensel 2001). E-commerce has increase efficiency in purchasing and it allows reaching global market.
With the rapid growth of e-commerce websites, buyers and vendors are exposed to various types of product and services. The products and services are presented on e-commerce websites with its description, company profile and contact details. These products and services are categorized in such a way to ease navigation and searching. However with the advent of search engines, it is still difficult for vendors to locate product with specific traits because most of the search engines are keyword based. The search engines are not able to reason semantic relationship for the desired products or to find generic product that has similar traits.

Heterogeneity in information system has it advantages and disadvantages. However in e-commerce heterogeneity of description for product and service is not an advantage. E-commerce merchant describes their products and services using the terms that they are familiar with. Other merchant will describe the same or similar product and service using different term but convey the same meaning. In other e-commerce website the same term is used to describe different product which delivers different meaning. Some products and services are represented in different language. The translation of description for the products and services are not accurate resulting wrong interpretation made by the consumer because it the translation algorithm did not translates into its intended meaning. The current search engines are not able to recognize similarity of two terms and two terms with different meanings. Furthermore there is no formal mapping procedure to unify the product and service description. The search engines will retrieve the product and service that contains keyword specified by the buyers. The buyers will be overloaded with unnecessary information and he/she needs to filter the product or service that relevant to him/her. However buyer and vendor do not have much time to understand, gather and analyze product content (Gomory, Hoch et al. 1999).

Static product and service representation on the Internet does not permit data, information and knowledge to be exchange across application and platform. The products and services are represented in multifaceted format – text, audio and video for example. The electronic merchant needs to gather and analyze this information to look for business opportunities and engage business relationships. The information need to be transform into a format that is easy to manipulate by the electronic merchant. The current web service has very limited support for this. The electronic merchant needs to convert product and service information manually into Excel (for example) for multidimensional analysis. The conversion process is tedious and time consuming. Information may loss or corrupts during the conversion. Furthermore, the representation of product and service on the web has poor abstraction level due to the limitation of technology used.

In dynamic e-commerce environment, almost everyday new products or services are introduced into the market. These products and services need to be categorized according to its features. Product and service categorization is very important for correct and precise searching but to classify product and service data is time consuming and error-prone. Categorization process is easy for simple product like CD and other computer hardware. How would a vendor classify complex product like automobile or airplane parts where the parts and the functions are interrelated with one another? This requires an extensive efforts and knowledge of the product and service domain (Leukel 2004). Product and service classification basically associated with a set of requirement for user to narrow down the search for complete set of applicable products. The merchant needs to comprehend the individual product description of to the precision needed for a specific application (Schulten, Akkermans et al. 2001). The e-commerce community need to have classification system and standardized attributes for that purpose. Ideally, product and service classification would be utilizing in e-commerce platform. However, in real-world the implementation of product and service classification seems not feasible because product and services come and go. New products and

services introduced to the market and outdated product and services are removed from the market. Hence, product and service classification will always be under development (Schulten, Akkermans et al. 2001). With the rapid growth of enterprise on the Internet, there are possibilities of products and services overlapping. The industry could not wait for the completion of product and service classification.

Negotiation is a complex activity to reach for an agreement on one or more matters of common interest. This task has been stimulated by the software agents negotiating with other software agents to buy and sell product on behalf of the merchant in the future of Internet-based global market. Traditional negotiation pose number of constraints where negotiation mechanism and protocols are hard coded in participating agents (Tamma, Phelps et al. 2005). This is difficult to maintain and need to be reprogrammed each time the agent needs to participate in other negotiation. Some enforce rigid rules of automated negotiation. Only selected protocols can participate in the negotiation. Therefore, software agents need standard negotiation protocol and moved freely to enter marketplaces and engage in the negotiation. The new paradigms should conceive less restrictive to operate in open environment.

3. SEMANTIC WEB AND ONTOLOGY

With all the issues and challenges in electronic marketplaces describe in section 2, Semantic Web is seen as the suitable solution. As coined by Tim Berners Lee, Semantic web intent for a collaborative medium and to make machine understands web content semantically (Daconta, Obrst et al. 2003). He foresees the future of the Web more than just a collection of web pages. In future, computer should be able to consider the meaning or semantic of information publish on the web (Pretorius 2004). Therefore, computer will provide more than just automated task. It can perform task autonomously using software agents and communicate with other computer to exchange information regardless the architecture, operating system and hardware configuration. The semantic web allows software agent to interpret information meaningfully as the knowledge lies within body of information on the web.

Semantic Web can be thought as a "layer cake" as shown in Figure 1. Each layer supported each other. It provides more than automated services. Ontology has become the backbone of Semantic Web that provides shared and common domain theories. Ontology defines specific vocabulary that can be used for computational language recognition. It helps human and computers to access information that they need and communicate with each other.

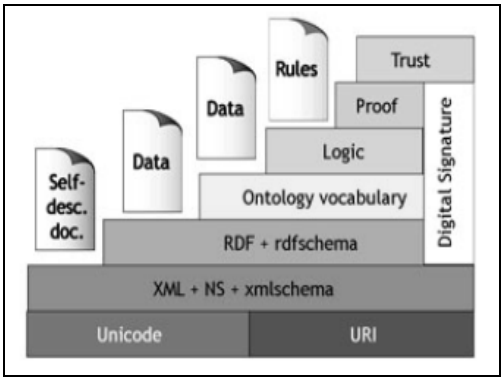

Figure 1 : Layers of Semantic Web

Formally, ontology is defined as formal specification of conceptualization (Gruber 1993). It brings the level of data abstraction into higher level where it permits machine to understand the content of information and knowledge to be shared on different computer configuration, network protocol and programming language. Ontology conceptualizes knowledge of specific domain of discourse by abstracting it into class, object, relationship, constraint and rule. Relationship is binary connection between two classes that conveys semantic of information. Constraints and rules are restriction imposed to a certain concept for precise data and information inference. Loosely speaking ontology made data 'smarter'.

Initially, data is stored in databases, proprietary to the application. With XML technology, data can move between applications of single domain. The data is processable and well understood by the application. However, when it travels cross domain, the machine is not able to correlate the data semantically. Taxonomy is used to organize data in hierarchical structure form multiple domain for easy retrieval and combine with

other data. Ontology enriched meanings of data using logical rules inference. Data is smart enough to describe with concrete relationship and formalized where logical calculation can be made.

Ontology represents common vocabulary of specific domain. It captures the intended meaning of data to be represented. The intended concepts are organized into hierarchical structure as shown in Figure 2. Figure 2 is an example of coffee beverage sells by a coffee shop. Coffee ontology captures real-world objects one wish to represent about coffee shop taxonomy. CoffeeBeverages is a superclass for all classes in Figure 2. BrewedCoffee, BrewedIceCoffee and ColdBeverages are example of subclasses for CoffeeBeverages. Any instance instantiated from BrewedCoffee, BrewedIceCoffee or ColdBeverages is an object to CoffeeBeverage. Each concept in ontology is interrelated with another concept via relationship as depicted in Figure 3. Class Coffee is connected to Class Country via hasOrigin relationship. It means each coffee object from Coffee class will have one origin Country.

Figure 2 : Coffee Ontology in Protege

Ontology allows the concept to be more specific by specifying rules and constraints. The rules and constraint are specified using algebra and logical operator as depicted in Figure 4. To infer an object belongs to EspressoHot class, the object must satisfy the following conditions; instance of Milk must be SteamedMilk and extra ingredient must be instances from DrinkExtras class.

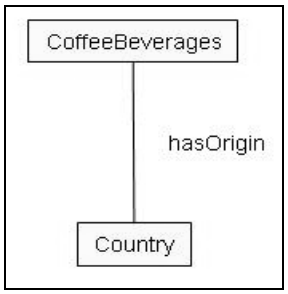

Figure 3 : hasOrigin Relationship in Protégé

Figure 4 : EspressoHot Rules and Constraints in Protege

4. INTELLIGENT E-COMMERCE

Electronic marketplaces provides opportunities for the vendor to automatically link to a large number of potential buyer and buyer can choose from a large number of business opportunities and optimize business relationship. Information of the product, services and business opportunities are scattered on the Internet in multiple format. Before any business agreement engage, the e-commerce community must harmonize heterogeneity of product, services, business terms, protocols and workflow description. They must create a platform for common understanding for the electronic merchant and the computer as well. Ontology must be developed for this purpose.

E-commerce business engagement took place in simple lifecycle – matchmaking, negotiation, contract formation and contract fulfillment (Trastour, Bartolini et al. 2003). Matchmaking is a process where a buyer locates potential of business and in e-commerce environment it is done electronically by browsing e-commerce websites. Heterogeneity of product and service description complicates document retrieval function. The search engines needs to function more than just retrieving keyword based products and services. It should be able to locate product or service that has similar traits making the full use of ontology constraints and rules. Ontology express product and service semantic and syntactic rules in shared in a shared context and cultural conventions. Software agents can be used to gather and represent the located product and services in a format understood by the consumer based on the definition in ontology. The application of software agents and ontology will greatly reduce the resources and effort of filtering relevant information and interprets the product and service description into its intended meaning.

Product and service classification compare its description (catalogs) and classification system directly. In this section we focus on how ontology can adopt into product and classification system. The classification system pre-classified the product and service to avoid direct mapping to its class. Using ontology, relationship is developing between classes in the classification system. If the query functions know these classifications then it is just a simple and automated step to classify any product or service data which fulfills the above requirement (Leukel 2004).

Multilingual should not be a hurdle for business opportunities in e-commerce. It is a form of diversity for product and service description. Ontology as backbone of semantic web is the solution for semantic translation for the description of product and service. Instead of using conventional direct translation, ontology based machine translation can be used to transform the product, service and other business agreement and contract without losing its intended meaning and represented in a form understandable by the merchant. An adoption of ontology based language translation described in detail in (Kannan, Kasmuri et al. 2006) and an example of realization for multilingual dictionary using ontology is in (Okumura and Hovy 1994).

Negotiation is a stage of the e-commerce lifecycle refines matchmaking phase into concrete agreement between two parties. Negotiation results many different protocols and rules for the negotiator to abide. A technique proposed by (Tamma, Phelps et al. 2005) use ontologies to support negotiation in e-commerce. In this approach, agents can negotiate in any type of market place regardless of the negotiation mechanism. The negotiation should not be hard coded in agents participating to negotiation instead it represent in terms of shared ontology. The agents acquire this knowledge directly from marketplace. Ontology is used to tune agents' strategies into specific protocols. This approach allows the software agents

to freely enter and participate any negotiation session. This environment is flexible and dynamic where the interaction rules can be change within or between interactions and software agents are able to choose suitable negotiation protocols based on certain traits. In the context of negotiation, the ontology shared basic vocabulary terms of participation for the negotiation session and rules that describe under which interaction agents must take place, deals can be made and permitted sequence of offers (Lomuscio, Wooldridge et al. 2001).

5. SEMANTIC WEB BASED E-COMMERCE FOR SMI IN MALAYSIA

Semantic web technology has been widely accepted by the Internet community. It popularity can be measured with several of standard proposed for the alignment of business process. Examples are: BizTalk (www.biztalk.org), CommerceXML: CXML (www.cxml.org.), Electonic Business XML: ebXML (www.ebxml.org), Open Buying Oon the Internet Consortium OBI (www.openbuy.org). Open Applications Group Integration Specification: OAGIS (www.openapplications.org), Organization for the Advancement of Structured Information Standards: OASIS (www.oasis.open.org), Rosettanet (www.rosettanet.org), UN/CEFACT (www.unece.org/cefact) and XML Common Business Library : xCBL (www.xcbl.org). These standard covers specification for services and product in IT industry, automotive industry, consumer electronics and telecommunication industries. It provides standard and common vocabulary for e-commerce platform.

With the implementation of semantic web and ontologies, this could lift Malaysia SMI for reaching global market. In Figure 5 below, we proposed a conceptual architecture preparing SMI readiness for semantic web hype. As shown in Figure 4, the architecture consists of 4 layers and the core layer is the ontology layer where it describes all the SMI product and service attributes and description. Merchant business profile conceptualizes the type of business, terms of agreement and other business workflow. The ontology is represented in OWL which allows for logical reasoning, knowledge and semantic sharing between e-commerce website and other computer application. In the next stage, the SMI ontology can be integrated with other ontologies for example Rosettanet and ebXML for broader and extensive knowledge sharing.

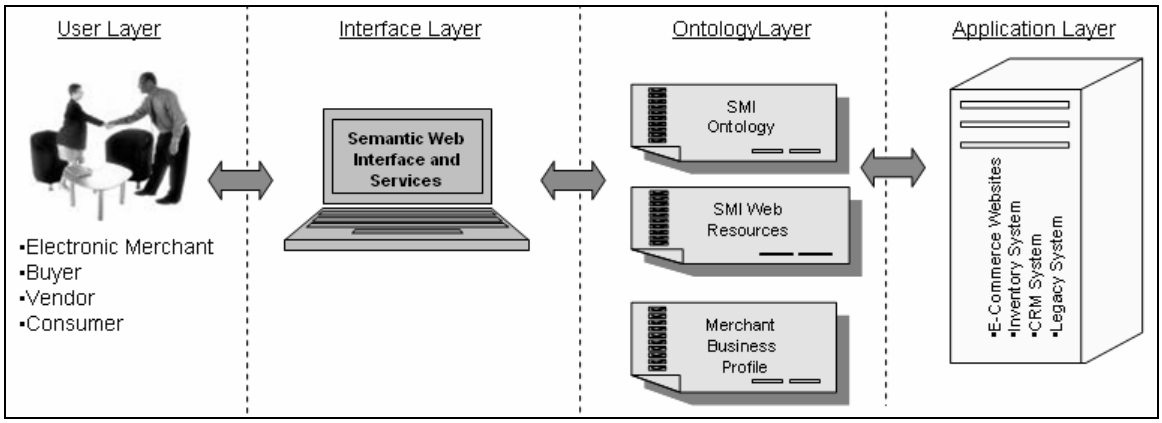

Figure 5 : Conceptual Architecture of Semantic Web Based for SMI

6. CONCLUSION

Poor abstraction of product and service description hurdles e-commerce to reach for global market due to the merchant lack of knowledge and technology limitation. However with ontology, it provides common understanding of e-commerce domain knowledge through organization of taxonomy. It creates new business opportunities where information is process and understood semantically by the software agents and presented to the user.

In future, each e-commerce websites will have its own ontology allowing interoperability. However, this will creates a new challenge for the computer to process the information semantically using heterogeneous terms of the same domain. There will be overlapping of terms and the cost to maintain it is expensive.

Therefore these ontologies need to a technique to unify and standardized the terms. These ontologies need to be map, merged and align for integrated and comprehensive e-commerce ontology to reduce machine complexity interpretation. There are semi automated tools to support ontology mapping and merging such as PROMPT(Noy and Musen 2000), Chimaera (McGuinness, Fikes et al. 2000) and MoA (Kim, Jang et al. 2005).

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