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E-services in e-business engineering

Kuo-Ming Chao

School of Computing, Electrical and Mathematics, Coventry University, Coventry, UK

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ABSTRACT

E-business engineering involves the study of evolving IT technologies and management science approaches to revolutionise e-business models and behaviors, and the demands from new e-business activities that prompt the development of new technologies and to make progress on management methods. In this essay, the scope of e-business engineering is illustrated and its importance to e-business is highlighted. *Service-oriented computing* (SOC) was chosen among numerous related topics for further analysis due to its role in the increasing popularity of cloud services and *Internet of services* (IoS) as they are hot commodities in e-business and important enabling technologies for e-business. The focus of this state-of-the-art review is on two SOC core technologies: *service description language* and *service registries for service discovery and composition*. A number of key frameworks and developments in the area are discussed in terms of their pros and cons and their associated challenges in the fast growing e-services marketplace. This essay also points out future developments and research directions to meet the related challenges, such as the standardization of service description and directory modelling, and the automated generation of annotation based on semantics and domain ontology.

1. Introduction

The introduction of computer and information systems to business changed the way in which enterprises operate and manage their businesses, and have moved from paper-based manual operations to digitalised and automated processes. Inadequate traditional business management methods have led to the boom of business engineering, which focuses on the joint efforts of business management and information technologies (IT) researchers and entrepreneurs to develop innovative business solutions. They include new business models and processes to adaptive organization structure and culture (Davenport and Short 1990). With the emergence of the Internet, businesses and individual users have utilized the related technologies to expand their activities and business relationships with other individuals, groups and businesses. E-business is the term used to describe the administration of conducting businesses via the Internet (Damanpour and Damanpour 2001).

E-business engineering has evolved from the aforementioned areas of business engineering and e-business, which also involve the study of computer science and management science. The methods of these disciplines have been leveraged to improve business processes and business models. They also have been applied to create innovative enabling technologies on the Internet to shape the future of IT-transformed enterprises, business commerce and government capabilities with computing.

New IT breakthroughs have brought about the evolution of e-business, including the development of new marketing and sales channels, and rapid sense-and-respond capabilities for organizations. E-business engineering aims to offer new methods, models, systems, software applications, services, processes and businesses for modern enterprises to adapt to the changing computing paradigm and stay competitive in the challenging new environment with the aid of technology. The interdependency between technologies and the e-business market is exhibited by their intricate interactions (Lee and Phang 2015) as new business models take advantage of innovative technologies to create new market opportunities and new technologies are developed to meet the extended requirements of the new business models.

An example is the *Internet of Things* (IoT). Business and individual users have adopted a growing number of IoT-enabled devices, and smart phones have become more popular and powerful too. These technologies have encouraged new approaches to supply chain management and courier services. They help to provide real-time information that allows decision-makers or businesses to visualize and monitor business processes and material flows anywhere and anytime (Lou et al. 2011).

Security and insurance companies can deploy security alarm systems using low processing power chips and IoT devices (Ansari et al. 2015), for example, to monitor unoccupied houses

E-mail address: k.chao@coventry.ac.uk

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or business premises, and to receive notifications when any abnormal motion or activity is detected. The system can automatically send photos and recorded videos to a cloud server, which can be remotely viewed and analyzed by the relevant personnel to make decisions. The business or individual user can use the services by purchasing an insurance policy and registering their devices with an insurance company over the web, to set up a guarantee to receive the services. A new business model is needed to determine business process, product and service price, quality of services and service boundary for the emerging market due to the new technologies.

Researchers in e-business engineering are not only interested in mechanisms design and economic models, but they also have great interest in IT. This is a driving force that is shaping the e-business engineering landscape and the research directions that make sense to pursue. This has led to the changing themes over time in e-business engineering in the presence of technological evolution. This includes recent developments in: agent technologies for e-business (He et al. 2003, Si et al. 2007) big data technologies and data science (Chen et al. 2014, Stanton 2012) cloud computing (Mirashe and Kalyankar 2010) SOC (Chung and Chao 2007, Papazoglou and Georgakopoulos 2003) and virtual marketplace engineering. It also includes: IoT, mobile and pervasive commerce (Karagiannidis et al. 2009) security, privacy, trust, and credit; and software engineering for e-business. The recognition of technology progress in these themes has made great contributions to the maturity and expansion of e-business. Researchers from academic and industry in the last two decades have expressed an interest in the development of SOC based on web technologies also, and this is an important foundation to advance IoT and cloud computing to support further development of e-business.

2. Service-oriented computing

Web technologies, such as HTML5, AJAX and JASON, are important vehicles to deliver e-commerce (Andriole 2010). But they focus on technological advances – programming languages, communication protocols, web data access, and the evolution of the Internet – with little consideration given to the business issues. SOC utilizes existing web technologies and provides facilities to extend its capabilities. The issues addressed include workflow, high-level interfaces for functions, and standardized communication protocols for the enterprises and businesses to develop e-business applications by allowing services that are available on the web to be discovered and reused. This constitutes a new aggregated value-added service. In *service-oriented architecture* (SOA) and SOC, all resources, such as software, platforms, and physical machines in a physical or virtual pool, are modeled or instantiated as services that can be temporarily leased or allocated to those who subscribe to them (Tsai et al. 2010). They also can be released back to the pool when their use is completed.

The number of services in the pool can be very large, the sizes of the services are varied, the behavior or functionality of services can be very complex, and the status of the services is dynamic. As a result, the supporting technologies for managing and governing such services are important to ensure that the quality of service (QoS) is up to standard.

2.1. Web Services Descriptions

With the increasing number of services available on the web, an advance is that search facilities have been developed for service consumers to specify their required functionalities and discover services from registries. Their functionality is similar to a search engine that operates on the Internet. The consumer in this context can be human users or even machines. Platforms are necessary for service providers to publish and advertise their services, and so service consumers can locate them to successfully achieve matches with their computing needs.

In addition, a descriptive language called the Web Services Description Language (WSDL) (Christensen et al. 2001) was developed some years ago. It represents the service functions by exposing externally-observable service behavior in input and output terms, and hiding their complex interactions. WSDL was specified by the Worldwide Web Consortium (W3C), and has been widely adopted. It provides standard and effective interfaces for services to increase their interoperability. However, WSDL lacks semantically-rich descriptive ontology annotation capabilities (Hohpe and Woolf 2004) and context information-based methods to facilitate automatic service discovery and composition (Da Silva et al. 2013).

Semantic Markup for Web Services (OWL-S), proposed by W3C (Martin et al. 2004), is the first attempt to address automatic service discovery by providing semantics-based descriptions with additional mechanisms to model services. These include the profile of a service, so that its functions and characteristics can be published to a registry. It also encompasses the process model, which provides essential information for clients to interact with and control the operation of the service. The description also includes some grounding, which allows a service to interact with others via messages. A number of researchers (Roman et al. 2005) have adopted this approach to model services for automated composition. Although they have proved its usability, but other have recognized that this approach lacks the ability to model asynchronous communication and sufficient descriptions in its process model to support effective service composition.

The Semantic Annotations for WSDL and XML Schema Semantic Annotations for WSDL and XML Schema (SAWSDL) (Kopecký et al. 2007) is a light-weight model compared with OWL-S. It extends attributes for the Web Services Description Language and XML Schema definition language to annotate WSDL components with its semantic models. These then can be defined as concepts outside the WSDL document. The advantage of this approach is a language-independent semantics-based modeling approach. Its disadvantage is that it requires a significant effort to develop a parser or interpreter for registries or client side services. This will allow it to take full advantage of SAWSDL annotations in service classification, discovery and matching.

There are other semantics-based modelling approaches or frameworks too. They include: Yet Another Semantic Annotation for WSDL (YASA4WSDL) (Chabeb et al. 2009) the Web Service Modeling Ontology (WSMO) and the Semantic Web Services Language (SWSL) (Battle et al. 2005). They all have advantages and disadvantages, and are mainly designed for web services that cannot be used with the RESTful web services.

2.2. RESTful Web Services Descriptions

The emerging RESTful web service (Zhao and Doshi, 2009) has become a popular alterative modelling method for services to support SOAP and WSDL-based web services. It is designed for easy use and operates with the web as a resource. It focuses on the management and transition of resource states.

The Web Application Description Language (WADL) (Hadley 2006) is the most well-accepted description language for REST interfaces. It offers resource modelling tools for application development and visualization to analyse resource interlinks, generate code for the client and the server, based on a specified interface. It uses a portable format to configure both the server and the client. So it is goes beyond the functionality of a traditional descriptive language by providing extra functions for managing