International Journal of Engineering Innovation & Research
Volume 3, Issue 5, ISSN: 2277 – 5668

Semantic Discovery and Selection of Electronic Payment Services

O. I. Omotosho
Department of Computer Science and Engineering,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Email: oiomotosho@lautech.edu.ng

I. A. Adeyanju
Department of Computer Science and Engineering,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria
Email: iaadeyanju@lautech.edu.ng

E. O. Omidiora
Department of Computer Science and Engineering,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria

J. O. Emuoyibofarhe
Department of Computer Science and Engineering,
Ladoke Akintola University of Technology, Ogbomoso, Nigeria

***Abstract* – The ease of payment when purchasing goods and services through the internet is one of the benefits of information technology. However, customers are currently restricted to their payment (credit or debit) cards being matched to a static list of payment services on electronic commerce websites. This reduces the reliability and efficiency of the transaction, when their card issuer is neither available nor on the payment service list. In this paper, a semantic based framework for providing dynamic discovery and selection of electronic payment services is proposed. The semantic based framework uses ontology to integrate all payment components (client, payment agent, card issuer and bank) within the framework by defining all possible relationships that can exist between the components. This definition enables dynamism that helps in selection of the best relationship at the point of payment. The framework will be implemented using client server architecture and evaluated by prospective users. The semantic framework will be of high benefit during payment for goods and services in electronic commerce transactions.**

***Keywords* – E-Payment, E-Commerce, Ontology, Semantic Web.**

I. Introduction

Modern day trade has almost completely evolved from direct cash or cheque transactions to the use of digital media either at point-of-sale terminals or via online web interfaces to effect transactions otherwise known as e-commerce. A key function of e-commerce websites is their ability to process online e-payments for products and services using digital media such as credit/debit cards and E-Cheques/Wallets [1]. Currently, performance attributes of e-payment services which includes availability, reliability, response time and cost are usually detected in the course of service usage on merchants' website. Also, payment service discovery involves a manual process where selected services are hard coded into the web application. This means that a prospective customer will not be able to complete online payment transactions when his/her payment card service provider is not listed or unavailable. This leads to loss of revenue for the merchant as disappointment on the part of such customer. This work addresses this problem by proposing a framework for semantic/dynamic discovery and selection of electronic payment (e-payment) services.

This work focuses on achieving flexibility in the interaction between merchant websites and payment processors in a framework of standard components. However, it does not include the security framework, which is a major concern regarding electronic payment. Moreover, the framework only caters for credit/debit card payment services discovery process, which often takes place in business–to–consumer (B2C) transactional style [2]. It does not address solution to inadequate telecommunication infrastructure as a major challenge of e-payment in developing countries [3], which include connectivity failure in telephone lines, low internet bandwidth, high internet cost, unavailability of dedicated data service networks and close financial networks as well as frequent power interruption.

Section II provides a critical analysis of related work while Section III gives detailed explanation of our proposed framework. Evaluation of the framework is discussed in Section IV with Section V concludes the paper by summarising our contributions.

II. Related Work

Traditionally, the web has been conceived as a distributed source of information. However, the emergence of the web service technology permitted an extension of that conception to a distributed source of functionality. Thus, web services [4] connect computers and devices with application type solutions using the internet to exchange and combine data in new ways while delivering functionality with the illusion that all processing is done on one machine. E-payment services such as payment gateways and payment processors follow a Service Oriented Architecture where the end user interacts with the merchant's website via a user interface (Customer to Business), merchant's website communicates with the payment processor server (Business to Business) which in turn communicates with the various credit cards' issuing bank and sends the response back through the same track to the merchant's website. The payment processor provides encapsulated functionality on behalf of merchant websites thereby relieving merchant website designers of the complexity of functions involved in payment processing as well as relieving merchants of the exuberant cost of building a

payment processor for their website. Merchants' websites need a payment processor only when an end user is making payment for a product online so most medium and small scale merchant websites prefers a third party payment processor.

E-payment systems can be categorised into two broad types: payment instruments and mobile payment. Payment instruments include e-cash, e-cheque [5] and debit/credit cards [6]. E-Cash consists of self-authenticating divisible tokens that can be processed offline in place of banknotes while e-cheque is an electronic implementation of the paper cheque system. Card payment schemes provide a payment mechanism through the existing electronic card payment infrastructure [6]. Mobile payments, on the other hand, use mobile devices as "electronic wallets" to store payment and account information. Two main wireless protocols used for mobile payments are WAP (Wireless Application Protocol) and iMode. WAP is an open and global specification that helps mobile devices to access information and services and its specifications include an XML-type mark-up language known as Wireless Mark-up Language (WML) and a lightweight protocol stack. I-mode is a proprietary protocol that uses Personal Digital Cellular-Packet to provide network services. I-mode allows efficient network usage by using packet switching technology for wireless communication and TCP/IP for wired communications. I-mode uses c-HTML (compact-HTML) to display content on mobile devices [6].

The semantic web has made e-commerce interactions more flexible and automated by standardizing ontologies, message content, and message protocols [7]. Neiat et al [8] propose an agent based semantic web services discovery framework using a broker which provides semantic interoperability between the service provider and agents by translating Web Service Description Language (WSDL) to a Resource Description Framework (RDF). An architecture has previously been proposed for agent-based dynamic web service discovery with quality of service (QoS) where the functional and non-functional QoS requirements such as matching, ranking and selection are taken into account during service discovery [9]. However their work did not involve any semantics but only captures users' requirement at design time. Our work proposes a semantic framework to achieve dynamic discovery and selection of semantic payment services through the use of ontology to enable discovery at client's run time based on defined QoS criteria.

Another related work is the extension of the Universal Description, Discovery and Integration (UDDI) registry by adding a capability port for searching for services based on the capability descriptions [10]. Inputs, outputs, pre-conditions and effects (IOPEs) of a service were used as capability descriptions, since the searches based on the existing UDDI registry neither use the semantic information present in the advertisement nor the capability description provided by the OWL-S Profile information. The limitation in their work is that the discovery mechanism is only based on capabilities of services. It is inevitable that there will still be services offered by multiple providers with the same functionality, since for example most payment services reflects the same functionality. This paper proposes a QoS based dynamic discovery mechanism which does not only take e-payment services capability into consideration but also non functional attributes of QoS criteria such as availability, accessibility, reliability and cost.

III. ARCHITECTURAL FRAMEWORK

Our framework consists mainly of ontology as discussed in Sub-section A. The details of the model are then discussed as a flow diagram in Sub-section B while Sub-section C explains the proposed prototyping of the framework in a client server architecture.

A. Ontology payment service

The proposed framework uses an ontology [11][12], which integrates all payment components which include client, payment agent, card issuer and bank by defining all possible relationships that can exist between the components. All payment concepts and entities are captured in a hierarchy as well as the relationships between such entities. This definition enables dynamism that helps in selection of the best service at the point of payment. Figure 1 gives a snapshot of the ontology. The diagram shows how the components are logically and functionally related. The design is such that a desired payment service could be located with or without human intervention. All the payment service discovery and selection are handled by the payment service agent or platform. Here, different entities are shown with arrows linking them to show relationships. For example, the client and merchant entities are linked through the product (or service) entity when the client orders a product as well as the payment entity when paying electronically for the ordered product. Such payment will assess one or more payment service entity which in turn communicates with the client's bank for authorisation. The assessment of which payment service to use is determined by quality of service criteria at the point of payment. The bank determines if available funds are sufficient for the transaction and whether any currency conversion is required depending on account type of the client.

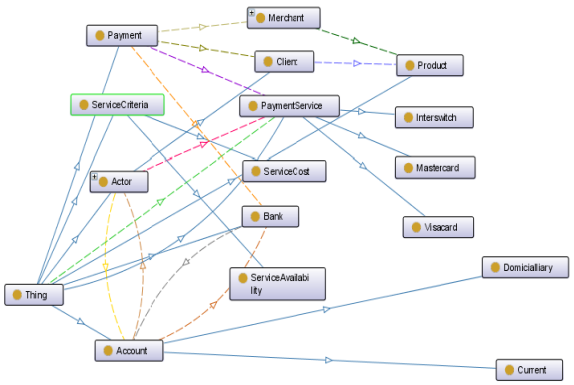

Fig.1. Ontology graph diagram showing relationships between e-payment entities

B. Modelling the semantic e-payment framework

Figure 2 shows the flow diagram model of the framework for semantic discovery of e-payment services. A remote customer accesses the Uniform Resource Locator (URL) for a merchant web site from which he or she makes selection of online products. At the display of the total price for selected product(s), the customer fill in his/her card details which includes card number, expiration date, cardholder's name and customer's address. The card details are then sent to the issuers' system for authentication and verification. The authenticated card type is displayed if the card is valid; otherwise, the payment platform requests the customer to enter another payment detail. Where the card is valid, the ontology payment service retrieves the card service details such as card type, availability rate, quality of service (QoS), service availability, and service charge (if any). The same details are also retrieved and displayed for other available card providers.

The framework's ontology service displays a ranked list of payment services based on availability assurance, reliability of service and service charge after the customer's selection of the order of importance of these criteria. When a customer decides to switch dynamically to another payment service for this payment, he/she has to find an alternative card service within the range of customer bank's card providers which are expected to be more varied that those of merchants. The client then completes payment with the selected payments service.

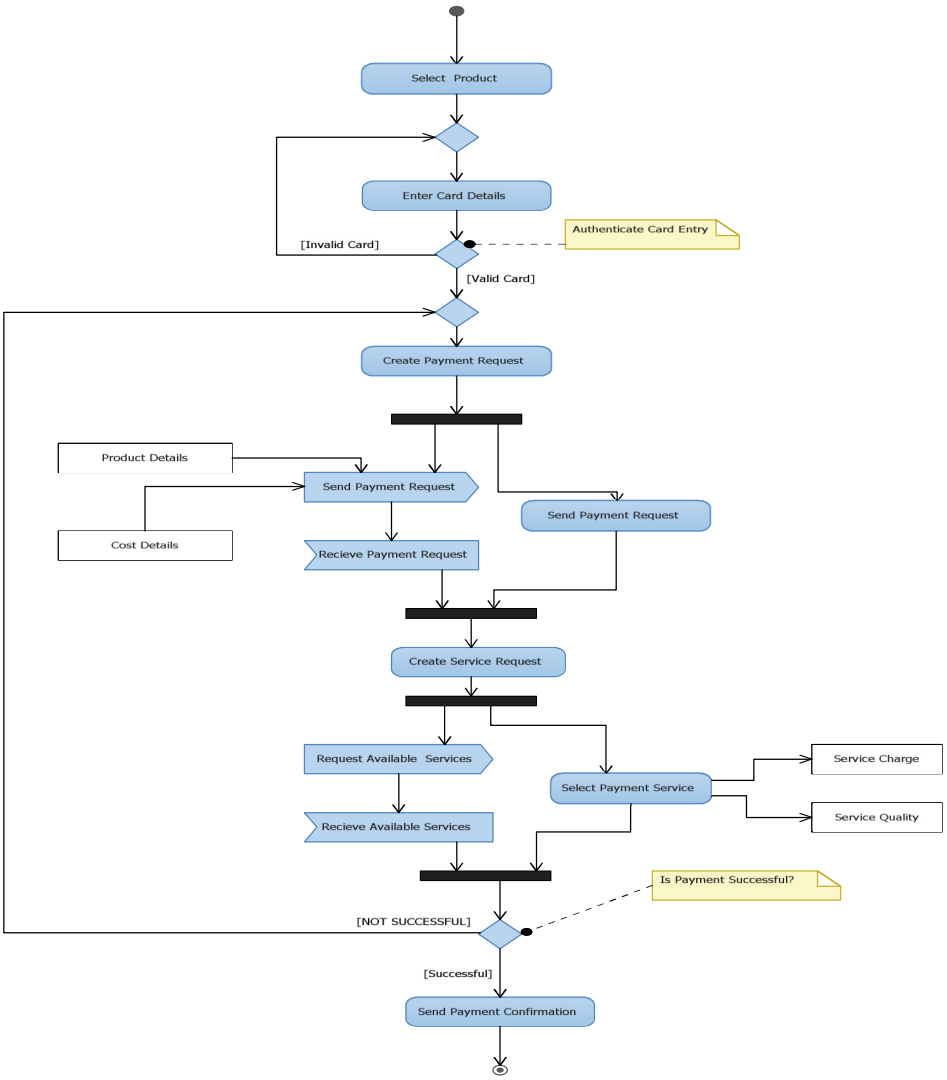

Fig.2. Flow diagram model of the semantic e- payment service discovery framework

The semantic e-payment discovery system is designed to enable customers to find or discover their appropriate e-payment service while making online shopping in merchant web-sites. The architecture is contrary to the existing mode of discovery in which customers are confined to some static (pre-discovered) e-payment services with likelihood of non subscription, unavailability of service, high service charge and low service quality.

C. Framework Prototype

The framework will be prototyped by implementing an application based on the framework using the three tier architecture consisting of the client, server and ontology

database. Figure 3 illustrates the components of this implementation. The client tier consists of the payment terminal in the merchant web site. Communication is done through remote customers' personal computers or mobile devices (tablets or phones). The application server consists of the payment platform server which is responsible for the execution of requests from the client side, processing it and sending the response to the client tier. The application server tier will be made up of a payment service agent, service registry and the semantic web files. The payment service agent interacts with clients/customers to get payment details and request for processing. It retrieves from the ontology database server and uses it access the service registry to process clients' requests. Service registry stores payment services' profile information and addresses while semantic web [13][14] files will consists of the payment domain ontology in web accessible format for servicing clients' request.

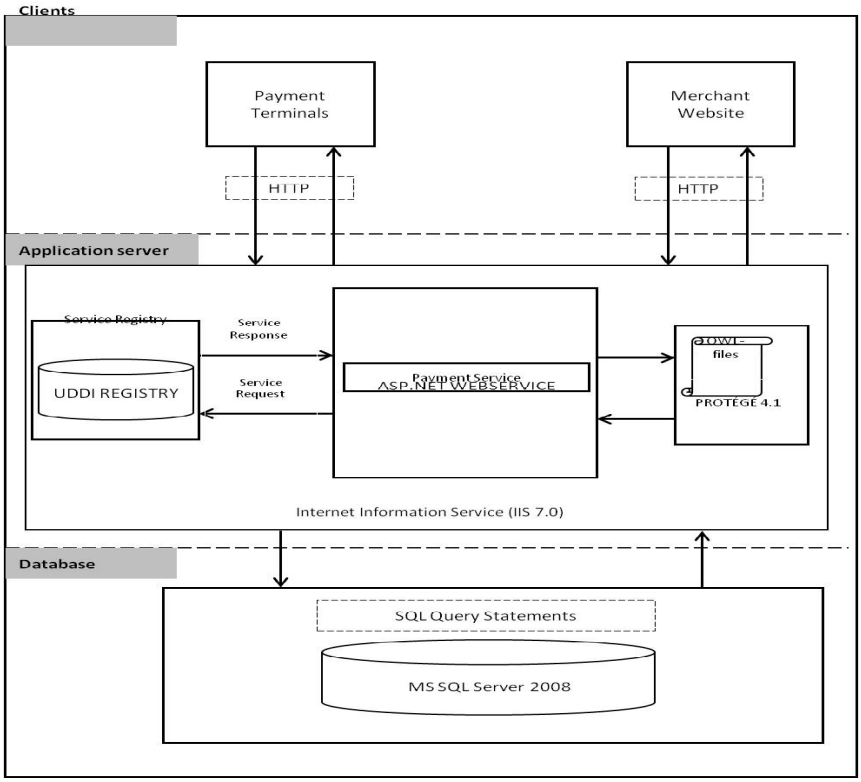

Fig.3. Framework Prototype on Client Server Architecture

The database tier consists of the database server [15] and is the core service for storing, processing and securing data. The database server provides controlled access and rapid transaction processing to meet the requirements of the client tier [16]. The customers' bank account/card details and services' information details, when stored for future use, will reside on this server.

IV. Proposed Evaluation

The prototype of the framework will be evaluated based on users' assessment in terms of system reliability and effectiveness, system ease of usage and efficiency of the system. We intend to carry out an initial pilot study where the experimental procedure and guideline will be properly mapped out. The experiments will make use of Questionnaires with Likert rating scale [17] for each question and would be administered to individual users for the prototype system and a static version without semantic discovery and selection of e-payment services. We intend to formulate the three quantitative parameters; System Reliability Index (SRI), System Ease of Use (SEU) and System Degree of Relevance (SDR) from user responses during the evaluation. Appropriate Statistical test of significance will also be carried out to on the user responses as part of the data analysis.

V. Conclusion

The success of e-commerce cannot be affirmed without a critical examination of the electronic payment systems and services. Hence, the framework proposed in this work will enhance global accessibility of payment cards powered by different providers and payment services. Users will need no prior knowledge of payment services available on a merchant's website as this will be dynamically discovered at the point of payment based on the user's requirements. The outcome of this study will also be of great benefit to merchants as failure or indisposition of a payment service will no longer halt the merchant's ecommerce activities since the next appropriate service could be discovered almost immediately. This also implies many down tooled merchant site springing back to operation.

REFERENCES

[1] Sangjoh O., Lee H., Kurnia S., Johnston B. & Lim B. (2006), A Stakeholder Perspective on Successful Electronic Payment Systems Diffusion, Proceedings of the 39th Hawaii International Conference on System Sciences, 1-10

[2] Beynon-Davies P. (2004), E-Business, Palgrave press, Basingstoke, United Kingdom.

[3] Ayo C. & Ukpere W. (2010), Design of a secure unified e-payment system in Nigeria: A case study, African Journal of Business Management, 4(9), 1753-1760

[4] Pathak J., Koul N., Caragea D. & Honavar V. (2005), A Framework for Semantic Web Services Discovery, Proceedings of the 7th Annual ACM International workshop on Web Information and Data Management, ACM press, NY, USA, 45-50

[5] Anderson M. (1998), Electronic Check Architecture, Financial Services Technology Consortium

[6] Pasupathinathan V., Pieprzyk J. and Wang H. (2008), An On-line Secure E-Passport Protocol, Information Practice and Experience, LNCS 4991, 14-28

[7] McIlraith S. & Martin D. (2003), Bringing semantics to Web services, IEEE Intelligent systems, 18(1), 90-93

[8] Neiat A., Mohsenzadeh M., Forsati R. & Rahmani A. (2009), An agent based semantic web service discovery framework, International Conference on Computer Modelling and Simulation, 194-198

[9] Rajendran T. & Balasubramanie P. (2010), An Efficient Architecture for Agent-Based Dynamic Web Service Discovery with QoS, Journal of Theoretical & Applied Information Technology, Islamabad, Pakistan, 15(2), 86-95

[10] Srinivasan N., Paolucci M., Sykara K. (2004), Adding OWL-S to UDDI: Implementattion and throughput, Proceedings of the first International Conference on Semantic Web Services and Web Process Combination, Hiroshima, Japan

[11] Mizoguchi R., Valwelkenhuysen J. & Ikeda M (1995), Task ontology for reuse of problem solving knowledge, Towards Very Large Knowledge Bases, IOS press, Netherland.

[12] Gómez-Pérez A., Fernández-López M., and Corcho O. (2007), Ontological Engineering: With Examples from the Areas of Knowledge Management, E-Commerce and the Semantic Web, Advanced Information and Knowledge Processing, Springer-Verlag New York, USA.

[13] Berners-Lee T., Hendler J., & Lassila O. (2001), The Semantic Web, Scientific America, 284(5), 34–43

[14] Akkiraaju R. (2007), Semantic Web Service: Theory, Tools and applications, Information Science Reference, Yurchak Printing Inc, New York

[15] Rob P. & Coronel C. (2004), Database Systems: Implementation and Management, Sixth Edition, Course Technology Thomson Learning Inc.

[16] Studer R., Benjamins R., & Fensel D. (1998), Knowledge Engineering: Principles and methods, Data and Knowledge Engineering, 25(1–2), 161–197

[17] Maurer T. J., & Andrews K. D. (2000), Traditional, Likert and simplified measures of self-efficacy, Educational and Psychological Measurement, 60(6), 965-973

AUTHOR'S PROFILE

Oluyinka Iyabo OMOTOSHO

is a Lecturer at the Department of Computer Science and Engineering, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria where she teaches undergraduate and postgraduate students, supervises students' project/thesis and does research in the area of Databases and information Systems. Oluyinka obtained a Bachelor degree (B.Sc. with Honours) in Computer Science from University of Ilorin, Kwara state, Nigeria and her Masters (MSc.) degree in Computer Science from LAUTECH. She is currently waiting for the final oral defence of her Doctorate (PhD) thesis report also at LAUTECH. Mrs Omotosho has several peer reviewed journal articles and conference papers across different research areas of Computer Science including Database management, Information Systems and Machine Learning. Oluyinka is happily married with kids.

Ibrahim Adepoju ADEYANJU

is a Lecturer at the Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria where he teaches undergraduate and postgraduate students, supervises students' project/thesis and does research in the area of Machine Learning, Pattern Recognition and Artificial Intelligence. Ibrahim obtained a Bachelor degree (B.Tech. with Honours) in Computer Engineering from Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria and his Masters (MSc.) degree in Computing Information Engineering and Doctorate (PhD) degree from the Robert Gordon University, Aberdeen, United Kingdom. Dr. Adeyanju has several peer reviewed journal articles and conference papers across different research areas of Computer Science and Engineering including Pattern Recognition, Distributed Constraints Satisfaction, Artificial Intelligence, Information Retrieval, Information Systems and Machine Learning. Ibrahim is happily married with kids and enjoys reading during his leisure times.

Elijah Olusayo OMIDIORA

is a Professor of Computer Engineering at the Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria where he teaches undergraduate and postgraduate students, supervises students' project/thesis and does research in the area of Biometrics, Hardware design, Information Systems and Artificial Intelligence. Elijah obtained a Bachelor degree (B.Eng. with Honours) in Computer Engineering from Obafemi Awolowo University, Ile-Ife, Osun state, Nigeria, his Masters (MSc.) degree from University of Lagos, Nigeria and Doctorate (PhD) degree from Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Prof. Omidiora has several peer reviewed journal articles and conference papers across different research areas of Computer Science and Engineering including Pattern Recognition, Information Systems, Artificial Intelligence and Control Systems. Elijah is happily married with kids.

Justice Onu EMUOYIBOFARHE

is a Professor of Computer Science at the Department of Computer Science and Engineering, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria where he teaches undergraduate and postgraduate students, supervises students' project/thesis and does research in the area of Mobile Computing, E-Health, Information Systems and Artificial Intelligence. Justice obtained a Bachelor degree (B.Tech. with Honours) from Federal University of Technology (FUT), Minna, Niger state, Nigeria, his Masters (MSc.) degree from LAUTECH and Doctorate (PhD) degree from FUT Minna, Nigeria. Prof. Emuoyibofare has several peer reviewed journal articles and conference papers across different research areas of Computer Science including Mobile Computing, Information Systems, Artificial Intelligence and E-health.