Int. J. Electronic Finance, Vol.

Development of a mobile airline reservation and payment system

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Abstract: Airline Reservation in developing countries is carried out either manually or electronically. Either methods, reservation and payment operations are done in piece-meal fashion; this is cost prohibitive, time consuming and tedious leading to inefficiency. We present an integrated mobile airline reservation and payment system. Ours is a Client/Proxy/Server system with the proxy layer serving as mobility-aware middle layer providing real-time self service support. The study shows that mobile technology is matured for airline operators in developing countries as an avenue to improve efficiency, reduce operation costs, improved revenue generation and provision of value-added customer service for airline passengers

Keywords: mobile business; WML; airline reservation; payment; electronic finance; WAP.

Reference to this paper should be made as follows: Olaniyi, O.M., Ajose, S.O. and Adegoke, M.A. (2010) 'Development of a mobile airline reservation and payment system', *Int. J. Electronic Finance*, Vol.

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1 Introduction

The rapid development in the wireless communication technologies and immeasurable advantages of the internet has presented a new concept of Business to Consumer (B2C) business environment. This new model, called Mobile business (*M-business*) model, defined as e-business model enabled by wireless communications, is the new frontier of electronic communications and business opportunity (Deitel and Deitel, 2008). It involves the combination of mobile technology and internet technologies to offer m-business services to users almost at anytime and anyplace. Mobile services are not just limited to conducting transactions but also allow communication, collaboration and coordination through mobile devices (Chen and Nath, 2004). In fact, the impact goes beyond improved communication with employees and customers, it enhances customers' experience by providing them the ability to interact and transact at anyplace.

However, m-business applications are different from its precursor, e-business applications, since most e-business applications cannot be readily transferred to mobile platforms. Therefore, developing m-business applications requires a different set of tools, techniques and strategies. When a company attempts to replicate their e-business success by simply moving its web applications to a wireless environment, the environment often fails to provide the support for the applications need to be successful or usable. To successfully move a web application to a wireless environment, the scope of the application must be redefined, the user interface redesigned, and its network and processing requirements reassessed (Chen and Skelton, 2005).

Currently, millions of airline passengers in Nigeria routinely conduct flight reservations manually through airline operators/third-party travelling agent or electronically through the operators' unique URL. These two business channels of airline reservation are not only highly costs-prohibitive, but also time-consuming and tedious.

This has resulted to numerous shortcomings on the part passengers, the most important of which are high record levels of passenger complaints owing to meagre service from third-party travel agencies and deferred flight schedules (Olaniyi, 2009).

From an operating point of view, the Nigeria airline industry is characterised by a trend towards consolidation (David, 2006). Such consolidation has not generated expected cost savings in the light of current global economic recession; it remains an important task for Nigerian Airline operators to increase operating efficiency and to reduce process costs to retain profit margins (Kerry, 2006). The integration of a 'mobile' technology business model into the value chain can increase an airline's operating efficiency and customer satisfaction (Paviaglas et al., 2005). This in no small measure will facilitate improved business processes, providing customers with value-added services by creating synergies between an airline's core competencies and the emergent mobile technology.

Moreover, implementing an m-business model can increase the level of personalisation of a company's business relations, which in turn creates new possibilities of customer segmentation (Paviaglas et al., 2005). This m-business model is generally deployed in form of mobile web applications, which integrate the existing internet technology with the competitive edge of mobile technology making it possible to have access to information anytime, anywhere. A web application is an application that has been specifically designed to be executed in a web-based environment (Wireless Center, 2008).

This paper focuses on the design and implementation of a secure and scalable m-business reservation and payment system for airline operators in Nigeria using flight operations of an indigenous airline operator, Afrijet Airline as a case study. The paper is organised into the following sections: Section 2 reviews previous works on mobile web services and mobile applications in tourism, transportation and related domains. Section 3 highlights the system design and implementation. Section 4 highlights results and discussion; Section 5 concludes and highlights the gap for future work.

2 Review of previous work

A number of related research works exist in the literature. Authors in Ming-Chun and Shyan-Ming (2005) proposed a framework to ease the development of platform-dependent mobile applications based on J2ME. While authors in Joeng et al. (2006) propose a mobile application streaming service in which server-side infrastructure does most of the job and customises screen display for the mobile device. This approach assumes a permanent availability of a connection to mobile web services. The difference between web services and mobile web services depend on the way mobile applications interact with these web services (Mohammed et al., 2009). There are two main ways:

- direct interactions
- interactions over gateways.

In direct interactions, the mobile web service must customise messages exchanged with mobile applications. The web service might implement XML compression (Ekelhart et al., 2000), encryption (Hens et al., 2005), or light versions of standard web services technologies. In the other approach, extra features are implemented at the gateway and

the (mobile) web service may even not notice it is interacting with a mobile application (Mohammed et al., 2009).

Also, authors in Haziq et al. (2008) proposed a mobile web application architecture that runs on a Personal Digital Assistant (PDA) to provide cost-effective solution for travellers to reach their desired destination. The architecture uses dynamic route map of Kuala Lumpur's Integrated Transit Network of Malaysia to dynamically generate route map to achieve its purpose by determining the nearest station according to the specific places. The mobile application design modelled a three-tiered client/server architecture that consists of: a thin client layer, an application server layer and a data layer, which holds the databases and data stores for the application. Interactions between the client and the server operate in the same way as they do in a two-tier system. The proposed architecture was implemented at the client-side with an Interactive User Interface and Java Application components whereas server-side, with Apache and PHP back-ended by Structured Query Language (SQL) database.

However, the framework does not take into consideration the optimisation of the size of data exchanged between mobile applications at the client end, owing to the limitation of data storage of mobile device and mobile web service linking the handheld device to the server end.

In Mohammed et al. (2009), main issues to consider when developing mobile application and mobile web services were discussed and then a framework that can facilitate efficient and secure mobile applications was proposed. Some of the features of the proposed framework were experimented with 'Eivom' mobile application – a cinema guide application that integrates data from different information systems of different cinemas through web services technology to provide users with various services that engage them in a truly entertaining experience. The business logic coordinating interactions between rich client end and back-end was partly divided between the client and the server. The framework was experimented in 'Eivom' Cinema guide mobile application using technologies such as: J2ME, J2EE, MySQL, KSOAP and web services. In the framework, authors followed most of the framework development methodologies and best practices proposed while solving the previous challenges of mobile application development by implementing advanced and business logic and compromising local/remote computation.

In airline application area, authors in Oloyede and Adeyemo (2006) developed a Wireless Application Protocol (WAP) application to access flight information of an airline operator and make reservations on any flight using a mobile handheld device. The simulated mobile application is a two-tier client–server application tailored towards Nigeria airline flight operations. The business logic coordinating interactions between client end and back-end was fully deployed at the back-end server. The application was implemented with Wireless Markup Language (WML), PHP 4.0.6 and Apache 1.3 web server with MySQL 3.23 database system at the server end and the client simulated with the WinWAP Smart phone Browser emulator installed on the computer used for the WAP application development.

Although the designed model featured a WAP site, it however does not take into consideration the following salient factors:

- *Security*: Airline business reservation information is very sensitive and airline operators should be confident that this information is appropriately secured from erring hackers and intruders. Security procedures were not in any way emphasised both at the client and at the server end.
- *Payment of the booking*: The payment mechanism demonstrated by the model is not only time-consuming, but also places unnecessary demand on passengers who could take advantage of mobile banking privilege by majority of banks in Nigeria.
- *Support for offline operations*: The model was only implemented on a smart phone browser emulator installed on the computer used for the WAP application development. Roaming is a very basic feature of actual wireless networks and there are situations where a connection is not available, possible or desirable. In practice, a mobile user should be able to use a mobile application in the absence of a connection. This was also not considered. And finally,
- *Business logic*: Like framework proposed by Mohammed et al. (2009), the business logic orchestrating different interactions was not stated expressly and decision on where to deploy this business logic: on the mobile device, mobile web service, or the gateways if any were not in any way elucidated.

Furthermore, authors in Sarisakal and Aydin (2005) developed a prototype mobile airline reservation system to assist airline passengers to gain easier and faster way for seat reservation and booking of airline ticket on real time. The developed prototype used a gateway approach to provide airline reservation service to mobile clients. The gateway translates all the protocols used on the internet to that easily understood by mobile device. A simple WAP platform was implemented using XML for a tourism agency working for different airline companies. The platform provides a reservation service for both domestic and International flights of these companies. Like Oloyede and Adeyemo (2006), however, authors fail to implement the online/mobile payment procedure for mobile airline reservation service provided by individual companies to airline passengers.

Moreover, authors in Oyelade et al. (2009) developed a prototype mobile airline reservation system using the WML as front-end, MySQl 4.0 database management system as back-end and Hypertext Processor (PHP) as the scripting for airline customers. The developed model was meant to assist the public to gain easier and faster way for seat reservation and booking of airline ticket on real time.

In Young et al. (2006), a paper on the state-of-the-art mobile payment systems and major issues that must be properly handled when planning for mobile payment systems was presented. The authors stated that payment solutions will be fully achieved if the identified issues are clearly handled. Some of these issues are: security, trust and privacy. The authors draw from today's technical capabilities of mobile devices and from different applications environment, which made it difficult for hackers to re-use payment protocols.

Consequently, Guan et al. (2008) presented a modularised payment system for agent-based e-commerce. The Secure Agent Fabrication, Evolution and Roaming (SAFER) architecture was proposed to facilitate e-payment system. The Secure Electronic Transaction (SET) protocol and E-cash were selected as the basis for the electronic payment system implementation.

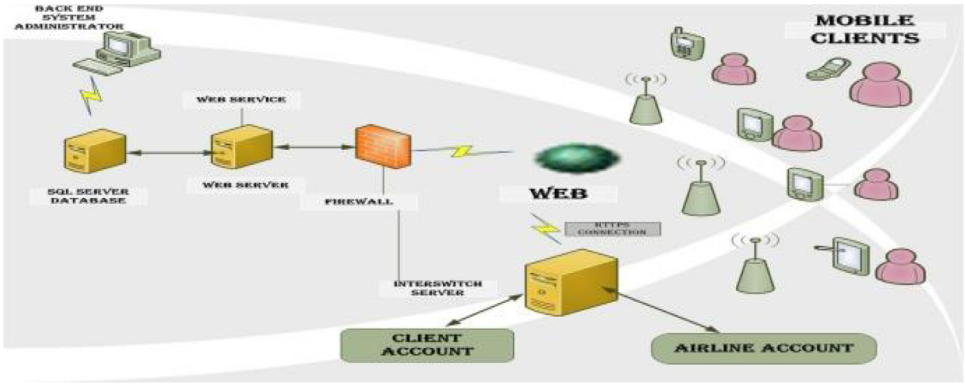
Also, in Aziz (2008), the importance of efficient payment systems was emphasised as a vehicle to drive Malaysian economy. He identified electronic payment as a technology to increase operational efficiency and improve productivity levels through expedient payments and receipts of funds. E-payment system was identified as a technology to provide the speed and convenience of making payments from any place and time thereby enhancing the competitiveness of the economy. The consumer's mobile handheld device was suggested as one of the delivery channels that should be leveraged on since 88% of the Malaysian population subscribed to mobile phone services.

This work, therefore, presents in a platform, a secured mobile airline reservation and payment system that will assist mobile flight passengers in flight services like mobile flight reservation, mobile payment via the ubiquitous mobile handheld device with the view of providing a competitive financial advantage for Nigerian airline operators, improved and value-driven customer service for flight passengers and a better alternative to existing airline business line of transactions-manual and electronic.

3 System design and implementation

The system was based on .NET framework development and MS SQL 2005 database management system for the back-end and .NET compact framework environment for Pocket PC smart application development for the front-end using current business operations of one of the indigenous airline operator in Nigeria; Afrijet Airline, Lagos, Nigeria. The system (shown in Figure 1) is a three-tiered rich client/proxy/server system designed around a thin client layer requesting and consuming web services of mobile reservation, scheduling and payment using available 3G mobile wireless networks from an application web server layer, which provides a web service and an SQL Server database data layer, which holds the databases associated with data stored for the application.

Figure 1 System design (see online version for colours)



This type of architecture holds many advantages over simple client/server architecture; including the easy deployment and maintenance of the thin client layer and the inherent scalability of the middle and data layers. The web server consists of web application services configured to execute airline business processes and transactions, as well as data

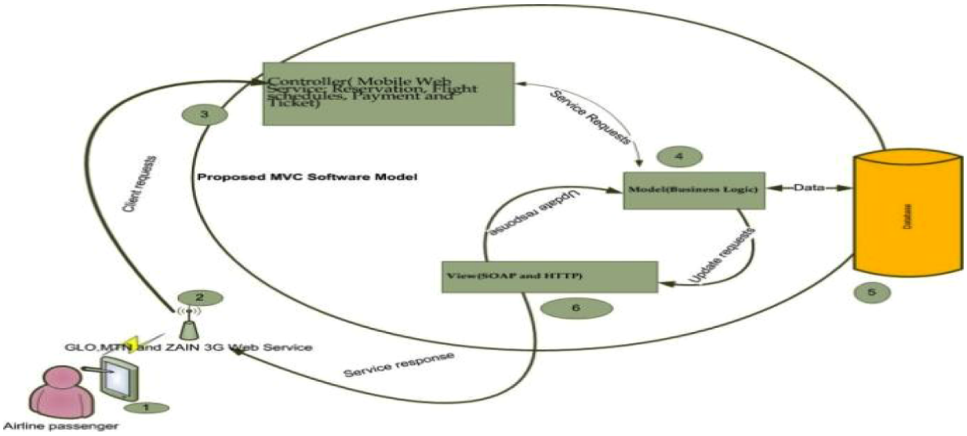
communication while accessing database server. It responds to the requested information by client through mobile devices.

On the mobile client side, the passenger's PDA or any GSM/GPRS enabled Mobile phone running Windows Mobile or compatible operating system to execute the secured mobile applications developed for the front-end. The interaction between the front-end mobile application and back-end web application and SQL Server is secured from an intruder via the firewall and triple data encryption algorithm implemented on the web server.

Considering the fact that, standardising payment mechanisms on the internet and through wireless devices is essential to the success of m-business application and that airline business operator offering domestic and international flight operations will be concerned about payment of their services from clients/passengers. The mobile payment capability of the proposed system is delegated to recognise online payment service operators like Interswitch, E-transact and VISA through their respective secured web server over Secured hypertext transport protocol (https) as shown in Figure 1. This security mechanism ensures that mobile payments will be received, and that the transactions are valid for every flight transaction that mobile users carried out. Thus, valid mobile payment of the proposed system is ensured upon the successful debit transaction of appropriate amount on mobile passenger account with his financial service provider, e.g., Interswitch in Figure 1, and successful credit transaction on airline's operator, account with the financial service provider.

This design was based on m-business software model using Model-View-Controller (MVC) model (Krasner and Pope, 1988) shown in Figure 2. This model was chosen because it allows multiple views to share the same enterprise data model, which makes supporting multiple clients easier to implement, test and maintain.

Figure 2 Model-View-Controller (MVC) software architecture of the proposed mobile airline system for Nigeria Airline operators (see online version for colours)



In the model, the mobile client requests or data are handled by the controller (the web service). The controller selects the view object that is applicable based on the mobile client request. Once the type is determined, a behaviour request is transmitted to the model (Business Logic), which implements the functionality or retrieves the content required to accommodate the request. The model object can access data stored in SQL

database server and the retrieved data can be formatted and organised by the appropriate view object. The formatted and reorganised data can then be transmitted from the web application server to the mobile client-based application (Smart Airline) for display on the mobile client device.

4 Results and discussions

The system was tested using a front-end smart application, smart airline, for Pocket PC using USA windows mobile ver.5.0 emulator locally on web service (*AirService*) local host as proxy to back-end .Net Server application. The system Graphical User Interface (GUI) Interaction style of Windows mobile brings usability to the system, making it easier for a naïve user to navigate around during flight reservation and payment routine. The following screen displays were obtained (Figures 3–8):

Figure 3 Services provided by the *AirService* web service (see online version for colours)

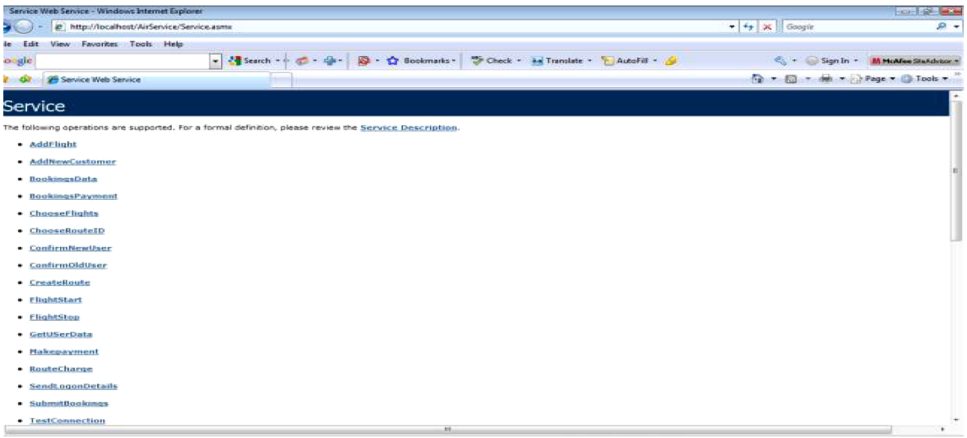


Figure 4 Users entry screen (see online version for colours)

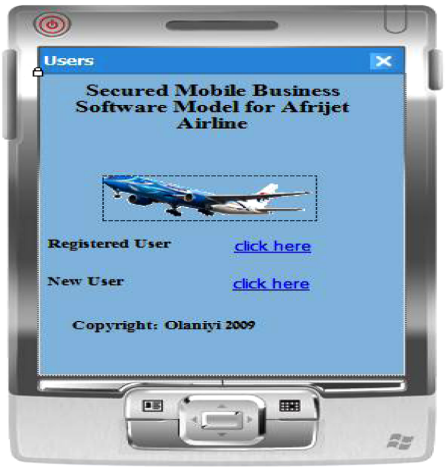


Figure 5 Registered users log-in screen (see online version for colours)

Figure 6 Mobile reservation screen (see online version for colours)

Figure 7 Mobile schedules (see online version for colours)

Figure 8 Mobile payment screen (see online version for colours)

Figure 3 shows the *AirService* proxy web service and Figure 4 shows the users entry screen to specify its user category. Figure 5 shows the screen where Mr. Adeyemi entered its login identity for system verification, authentication and authorisation.

Also, Figure 6 shows the mobile reservation screen where the passenger book for Lagos-Abuja Flight scheduled for 22 October 2009. The screen in Figure 7 shows the available flight ID for the specified date (Mobile Flight schedules), while Figures 8 and 9 finally show the payment and payment confirmation screens using hypothetical data for User's unique card number and Personal Identification Number (PIN) for successful mobile reservation and payment.

The operational effectiveness of the system was substantiated with a web application developed and tested for the back-end system administration to query and generate necessary reports for the airline operator's stakeholders-Managers, Technical and Financial Administrators. The application developed with VB.Net was tested and reports were generated from the data available on the SQL server from the back-end administration module. Figure 10 shows a back-end crystal report of mobile ticket generated for a mobile reservation made by a passenger with flight ticket MTK4894290213509201.

Also, Figures 11 and 12 show a crystal report of all customer's mobile airline booking for 18 December 2009 and a total revenue crystal report generated from mobile payment for the specified date, respectively.

Figure 9 Ticket for a mobile passenger (see online version for colours)

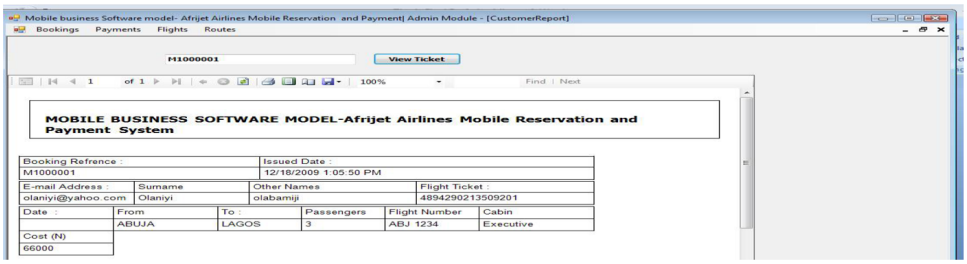


Figure 10 All mobile airline reservation till date 12/18/09 (see online version for colours)

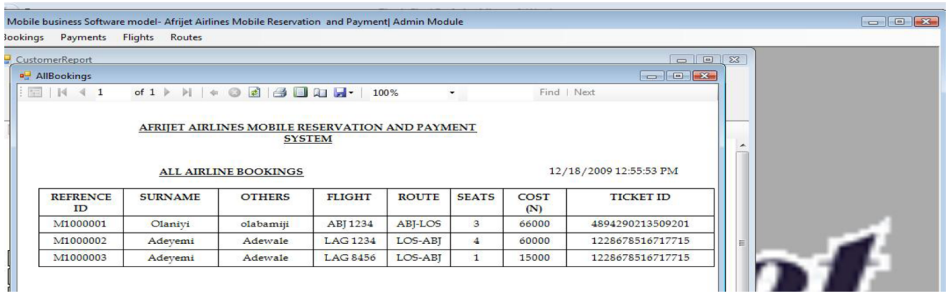


Figure 11 Total revenue generated from mobile payment (see online version for colours)

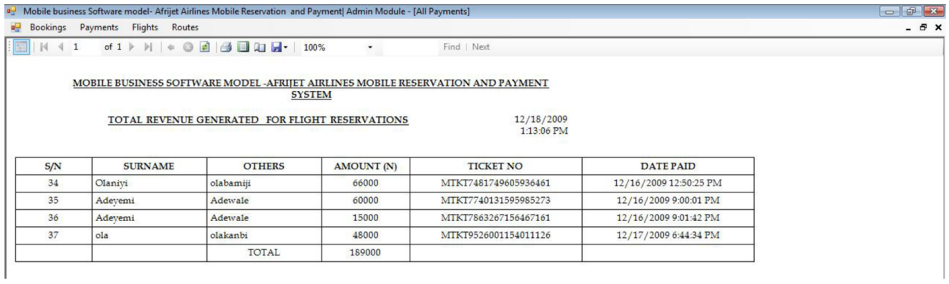


Figure 12 Successful mobile reservation and payment screen (see online version for colours)

5 Conclusion

In this study, the authors have proposed and implemented a secured and functional mobile reservation and payment system for Nigerian Airline Operators using the .Net framework and .Net compact framework for the Windows Mobile platform. The model has been tested on *AirService* web service running locally on the web server and USA

Windows mobile emulator version 5.0 Pocket PC front-end mobile application. Relevant reports were generated from data available at the back-end SQL server using crystal report.

This work is an improvement over Mohammed et al. (2009), Oloyede and Adeyemo (2006), Oyelade et al. (2009) and Young et al. (2006) where different prototype mobile systems were developed to provide a convenient means of making airline reservation and payment easier for flight passengers using different platform on a separate channel of communication. This results in extra efforts and costs on passengers as well as extra service operational costs on the part of airline operator. Our work, therefore, is a one-stop solution that combines these two transactions on a single platform using the same channel of communication thereby assisting airline operators in provision of competitive financial advantage of delivering mobile solution through increased income with ease of new service deployment; generation of revenue by driving repeat business and customer loyalty; reduce operation costs by enhancing service levels through simplified tasks; ease back-office administration by improving data accuracy and reducing manual processes. The delivery of custom real-time mobile web-based reporting solution, total mobile-payment options: Visa, E-Tranzact, Inters witch.

Consequently, for airline passengers, value-driven customer service through access to the right information at the right time. This can make a critical difference to the performance of both routine and unplanned tasks. Key advantages include better quality decision-making, delivering a personalised service to passengers.

6 Recommendation and future research

The developed prototype, therefore, proposed a value-driven synergy among Nigerian Telecommunication operators (GLO, MTN, ZAIN, ETISALAT, etc.) 3G mobile networks, Electronic/online payment service operators like Interswitch and VISA through their respective secured web server over Secured hypertext transport protocol (https) and Airline Operators in Nigeria Airline Industry. It is, therefore, recommended that the Nigerian Airline operators take competitive advantages of deploying m-business technology business model by involving these players into their current e-business value chain.

However, the full implementation of our model on Windows Mobile platform only promised an improved airline service where customers and airline operators stand to enjoy better relationships with substantial cost savings; mobile platforms interoperability is still a mirage. There is, therefore, the need to introduce a cross-platform, cross-runtime solutions implementation of the model for multiple mobile clients, e.g. Java (J2ME) platform, Symbian Platform, Linux Mobile platform and Android platform.

Other areas of future research, therefore, include:

- quantitative performance metrics of the proposed software model in availability, reliability, response time, speed, throughput, etc.
- extension for the model to provide Quality of Service (QoS) support and management
- evaluation of the model service performance for a large number of users across West African countries.

References

Aziz, Z.A. (2008) *Towards a More Efficient Payment System-Electronic Payment*, A keynote address at the mobile digital symposium, Cyberjaya, Malaysia, 3rd June 2008, Obtained through the internet: http://www.bis.org/review/r080605d.pdf [Retrieved 15/04/2010].

Chen, L. and Nath, R. (2004) 'A framework for mobile business applications', *International Journal of Mobile Communications*, Vol. 2, No. 4, pp.765–776.

Chen, L.D. and Skelton, G. (2005) *Mobile Commerce Application Development*, Cybertech Publishing, USA.

David, L. (2006) *Nigeria to Get Tough on Unsafe Aviation Authorities*, Obtained through the internet: http://www.flightglobal.com/articles/2006/01/31/204369/nigeria-to-get-tough-on unsafe-aviation-authorities.html [Retrieved 27/05/ 2009].

Deitel, P.J. and Deitel, H.M. (2008) *Internet and World Wide Web-How to Program*, Prentice-Hall, USA.

Ekelhart, A., Fenz, S., Goluch, G., Steinkellner, M. and Weippi, E. (2008) 'XML security – a comparative literature review', *Journal of Systems and Software*, Vol. 81, No. 10, pp.1715–1724.

Guan, S., Tan, S.L. and Hua, F. (2008) 'A modularized electronic payment system for agent based e-commerce', *Journal of Research and Practice in Information Technology*, Vol. 36, No. 2, pp.67.

Haziq, L.A.M., Azlianor, A.A., Suhaizan, S.M. and Massila, K. (2008) 'Architecture of mobile web application generating dynamic route map', *International Journal of Computers*, Vol. 2, No. 2, pp.107–111.

Hens, R., Goemine, N., Hoecke, S.V., Verdickt, T., Bouve, T., Gielen, F. and Demeester, P. (2005) 'Design of a multimedia gateway for mobile devices', *SPIE – The International Society for Optical Engineering*, *Proc. SPIE – International Society of Optical Engineering*, USA, Vol. 5684, 1st ed., pp.137–145.

Joeng, K., Ricardo, A., Barratto, A. and Nieh, J. (2006) 'An application streaming service for mobile handheld devices', *IEEE International Conference on Services Computing, 2006 IEEE International Conference on Services Computing*, IEEE Computer Society, pp.323–326.

Kerry, A. (2006) *Nigeria Sets Minimum Capitalisation Levels for Airlines to Boost-Aviation*, Obtained through the internet: http://www.Flightglobal.Com/Articles/2006/05/26/206888/ Nigeria-Sets-Minimum-Capitalisation-Levels-For-Airlines-To-Boost-Aviation.html [Accessed 27/05/2009].

Krasner, G. and Pope, S. (1988) 'A cookbook for using the model-view controller user in interface paradigm in Smalltalk-80', *Journal of Object-oriented Programming*, Vol. 2, No. 3, pp.26–49.

Ming-Chun, C. and Shyan-Ming, Y. (2005) 'An adaptive mobile application development framework', *The International Conference on Embedded and Ubiquitous Computing*, *Embedded and Ubiquitous Computing – EUC 2005*, *International Conference EUC Proceedings*, Lecture Notes in Computer Science, Vol. 3824, Springer-Verlag, pp.765–774.

Mohammed, A.S., Abdelghani, B., Rachida, D. and Rabeb, M. (2009) 'Toward an efficient framework for designing, developing, and using secure mobile applications', *Proceedings of World Academy of Science*, Engineering and Technology, Vol. 40, April, pp.122–128.

Olaniyi, O. (2009) *Development of a Secured Mobile Business Software Model for Nigerian Airline Operators: A Case Study of Afrijet Airline*, MSc Thesis, Lagos State University, Lagos, Epe-Lagos, Nigeria.

Oloyede, H. and Adeyemo, A. (2006) 'Design and implementation of WAP application for airline reservation system', *Proceedings from International Conference on New Trends in the Mathematical and Computer Sciences with Applications to Real World Problems* (*NTMCS 2006*), Convenant University, Ota, Nigeria, pp.485–503.

Oyelade, O., Fatumo, S., Azeta, A. and Ayo, C. (2009) 'Development of a mobile airline reservation system', *The Journal of Computer Science and its Application – An International Journal of the Nigeria Computer Society [NCS]*, Vol. 16, No. 1, pp.58–69.

Paviaglas N., Marburger, P., Stratmann, M. and Young, S. (2005) 'Mobile business – comprehensive marketing strategies or merely IT expenses?, A case study of the US Airline industy', *Journal of Electronic Commerce Research*, Vol. 6, No. 3, pp.251–260.

Sarisakal, M. and Aydin, M. (2005) 'Mobile commerce', *Journal of Electrical and Electronics*, Journal-Istanbul University, Vol. 5, No. 1, pp.1249–1251.

Wireless Center (2008) *Mobile Application Architectures*, Obtained through the internet: http://www.wirelesscenter.net/Mobile-and-Wireless/Mobile-Application-Architectures.html [Retrieved on May 27th 2009].

Young, B., Crowgey, R.L., James, M.P. and Joseph, S.V. (2006) 'The state of the art of mobile payment architecture and emerging issues', *International Journal of Electronic Finance*, Vol. 1, No. 1, pp.94–103.