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The Case for Developing and Introducing the M-Procurement System in Nigeria, the Agent, Service and Cloud Perspective

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ABSTRACT: *In this paper the author points out how in the last few years mobile technology has improved a great deal in countries like Nigeria, where individuals possess two or three SIM (Subscriber Identity Module) cards issued from different major mobile service providers. The paper opines that owing to this increased pervasiveness of mobile networks, in the enterprises mobile computing should gradually be replacing the use of desktop systems; the paper went on to highlight the need to leverage this ubiquity of mobile computing and network in improving and overhauling the Nigeria's clumsy, very slow and oftentimes corrupt procurement system. An architectural model that will support the introduction of m-procurement (mobile procurement) systems was unraveled and examined. Ongoing related works in this regard were discussed. The paper concluded by spurring software application developers and designers to start thinking on the perspectives highlighted by the author.*

KEYWORDS: *M-procurement, SOA (Service Oriented Architecture), Cloud Computing, Mobile Agents, SIM cards.*

1. INTRODUCTION

Within the last two decades, mobile technology has achieved great progress. Mobile networks have improved from cellular networks to 3G, and now 4G networks. In countries like Nigeria, mobile devices have become much more powerful than they were twenty years ago. Thus the future and power of enterprise computing is gradually shifting from desktops towards mobile computing devices, and even wearables. Both, individual consumers and businesses are getting increasingly connected via the wireless. Consequently both, the scientific community as well as the software industry try to envision new models and technologies to make use of this ubiquitous connectivity. This rapid progress of mobile computing has become a powerful driver in the recent quest for the development of mobile business applications. Many application designers and solutions experts are joining the "bandwagon" though, the mobile devices are still facing peculiar challenges in their resources (such as: battery life, storage, and bandwidth), and hitch-prone communications (e.g., problematic mobility and security). Unfortunately, designers need to still combat these limitations that impede the improvement of the qualities of service rendered as mobile to clients.

Procurement is central to the management of business operations in enterprise organizations. There is a comprehensive process that covers every aspect of acquiring goods and services such as determining the need, buying, delivering, etc. The effectiveness and efficiency of this process is essential to obtain goods and services of the right quality, at the right price and at the right time.

Much research has been undertaken to assess the design and implementation of e-procurement and the investments that are necessary for its deployment and adoption. But the literature on design and implementation of mobile procurement applications in enterprise organizational settings is scarce, constrained by the small range of available applications, low actual usage, and limited experience.

Hawking et al, (2004) defined e-Procurement as the use of electronic technologies to streamline and enable procurement activities. Corporations reported benefits from the increased information transparency of an organizational function that was typically not very well standardized or understood.

Mobile procurement (m- Procurement) is the business to business purchase and sale of supplies and services over the internet using mobile devices. It is a term used to describe the use of mobile devices, wearables, wireless networks and internet connections to streamline and enable procurement activities. M- Procurement is a mobile e-procurement model that allows mobile devices (buyers and sellers) to perform procurement processes at remote locations. An e-procurement participant (supplier) can make bidding via his/her mobile device (such as personal digital assistant (PDA), mobile phone or a wearable).

Authors report that m- Procurement would enhance more efficient and effective sourcing, improves supplier collaboration, reduce the cost of supplier engagement and better leverage of full buying power. The m-

Procurement model extends the traditional e-procurement model from the use of stationary computing devices to mobile devices connected to the internet. It has the following value added attributes: ubiquity, instant connectivity, convenience, personalization and localization of products and services.
In countries such as Nigeria, with the recent boom in ICTs (Information and Communication Technologies), the need to extend the e-procurement system from stationary desktop computers connected to the internet to m-procurement apps that can be accessed using mobile devices anywhere and anytime has become imperative is gaining attention and becoming of essence.

To achieve this, this paper investigates the possibility of the implementation of Mobile Procurement Apps which integrate cloud computing into multi-agent and service-oriented architecture. Cloud computing integrated into multi-agent and service-oriented architecture is capable of providing interoperability in a standard framework, and can be implemented in devices with limited storage and processing capabilities such as mobile devices. This paper unravels and proposes an architecture which is dynamic, flexible, robust, adaptable to changes in context, scalable and easy to use, and also easy to maintain. The architecture discussed aims at integrating three different technologies: Mobile Agents Technology, Service Oriented Architecture and Cloud computing in order to solve the problems of interoperability.

II. STATEMENT OF PROBLEM

For a decade now, Nigeria has been going through an exponential explosion of improvements in Information Technology; ICTs are penetrating every nook and sector of the country's economy. The increase and penetration of the use of mobile and smart electronic devices has become viral among the strata of workers and populations of the country. The introduction of mobility in electronic procurement process is therefore increasingly becoming vital.

Adesina (2010) noted that the existing models of procurement in most multi-organizations are plagued by inefficiency and fraud because of the structural complexity, and heterogeneous nature of a multi-organization. Most mobile applications are written for stationary computing systems and servers without regard to the power consumed by the system, the amount of storage available, and the variety of user interfaces. Most of the e procurement systems today are designed for stationary and non-mobile systems.

Thus, in Nigeria, the current procurement platform and business services do not have sufficient facilities for modeling sophisticated procurement activities for mobile condition. There is an increasing need for system designers to plug and fill this gap.

III. OBJECTIVES OF PAPER

The objectives of this paper are:

i. To unravel the need for a good architectural model that will support m-procurement application systems for mobile users.
ii. To investigate and discuss the case and ways of extending/implementing such mobile procurement framework in Nigeria.

IV. AN ARCHITECTURAL MODEL FOR M-PROCUREMENT

Background: The Procurement System in Nigeria

According to Ayodele et al., (2010), the Nigerian government procurement procedure over the years has been done manually by the process of inviting contractors to bid for projects (i.e. Invitation for Prequalification/Tender) to the selection of successful bidders and then finally project completion. In this procurement procedure, purchase orders are not being processed in a timely fashion and delivery dates are not being met. For example, the failure and demise of Nigeria National carrier, the Nigeria Airways is traceable to an extremely poor procurement system and the resultant effect is that Nigeria and Nigerians have had to suffer this defect for a long time (Bureau of Public Procurement, 2008).
This author further noted that the Nigeria's public procurement system is also reportedly prone to corrupt practices, with as many as 45% of companies expecting to give gifts to public officials in order to secure a government contract. Analysis have shown that most contracts awarded by the government or its officials are awarded through corrupt means. Some of these contracts are awarded to contractors who have agreed to give the procurement official a certain percentage of the original contract amount. This encourages contractors to use substandard goods, render poor services or sometimes project abandonment (Business Anti-corruption portal, 2010).

According to Attah, (2009)procurement accounts for about 80 per cent of Nigeria's government expenditures at all levels. The traditional systems of procurement in government Ministries, Departments and Agencies (MDAs) through manual modes suffer from various problems such as inordinate delays (approximately 4 to 6 months) in tender/order processing, heavy paper work, multi-level scrutiny that consumes a lot of time, physical threats to bidders, cartel formation by the contractors to suppress competition, human interface at every stage, inadequate transparency, discretionary treatment in the entire tender process, etc.

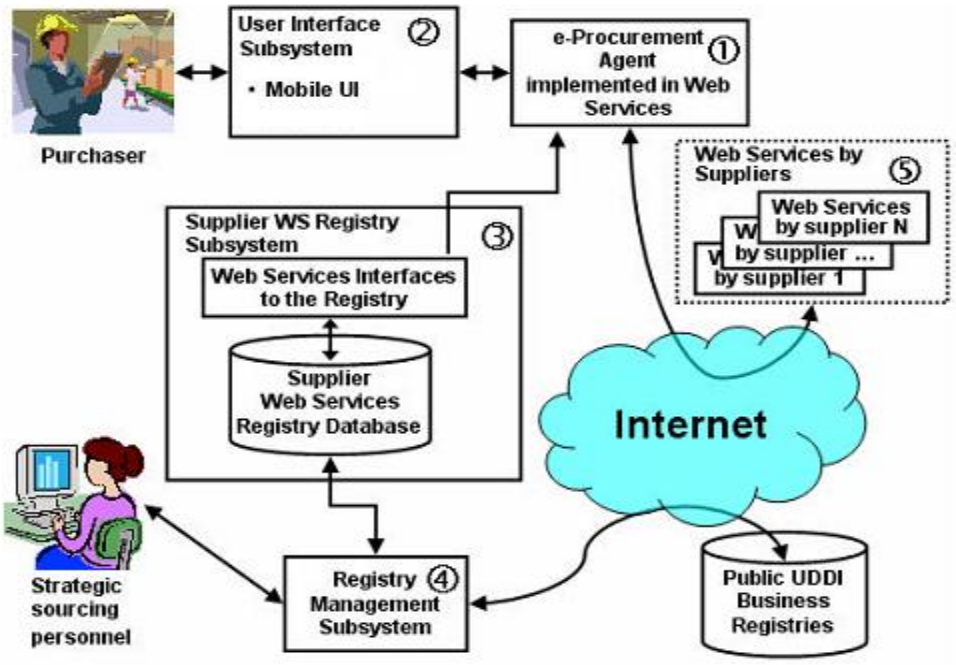
The Architectural Model for m-Procurement

As noted earlier, Mobile procurement is the business to business purchase and sale of supplies and services over the internet using mobile devices. It is a term used to describe the use of mobile application to support all stages of the purchasing process. Mobile procurement uses mobile devices, wireless networks and internet connections to streamline and enable procurement activities.

In countries with a relatively improved mobile connectivity, Mobile procurement should be a natural successor to traditional desktop electronic procurement. With the rapid proliferation of mobile devices, including mobile phones, PDAs, and handheld computers, mobile procurement should be widely considered to be a driving force for next generation e-procurement. M-procurement is indeed a new and a much more powerful way to communicate with suppliers. Ubiquity, intimacy, time sensitivity and location awareness are key concepts that make mobile procurement so different from traditional e-procurement. A pronounced advantage which m-procurement has over e-procurement is the opportunity to connect business information with the help of objects in a more direct way than has been possible until now.

Mobile procurement provides the same basic functionality as e-procurement does. The only difference is the mobility aspect, providing the user with the ability to order services wherever he/she is and whenever he/she wants. Unfortunately, up till now few mobile and wireless B2B applications have been developed. Building mobile web sites and web presence for B2B exchanges such that mobile devices can submit bids and receive alerts of new bids thus seems to be a promising application development area.

Depicting the m-procurement architecture back in 2003, some authors and designers like Gribbins (2003); Chen & Meixell (2003) noted that the Mobile Procurement System consists of e-procurement agent, user interface subsystem, supplier web service registry system, registry management sub-systems and web services by suppliers. The detailed workflow of a Mobile Procurement System as depicted by these authors is illustrated in Figure below:



Mobile Procurement System Architecture, Source: (Chen & Meixell, 2003)

The e-Procurement agent is a software component implemented in Web services. It serves as a middle-tier component to handle the interactions with the Web Services Registry and with the trading partners' Web services. It consumes Web services provided by the Supplier Web Services Registry and Web services provided by suppliers. The e-Procurement Agent is implemented as Web services to be consumed by the front-end user interface applications.
Since the e-Procurement agent is implemented in Web services, the e Procurement UI subsystem can be easily implemented using mobile clients, which are mobile device such as cell phones, personal digital assistants (PDAs) can consume Web services. Special micro-browsers can be used to get access a server-side Web program. The mobile web programs need to render Web pages in formats such as WML or cHTML that are appropriate for the requesting mobile devices.
A private Web services registry is developed to store product and supplier information as well as Web addresses of Web Services Description Language (WSDL) (W3C, 2001a) files of Web services provided by all participating suppliers for various Web operations required for the e-Procurement application. The registry's database stores all qualified suppliers information including their capability, quality, as well as WSDLs for various interactions (e.g. price quote and order) required to complete an e Procurement transaction. The Registry subsystem expands the list of potential suppliers, an important feature especially for the expedited purchases which the standard suppliers may not be able to fill. E-Procurement agent uses a set of Web operations published by the Registry Subsystem to access information of suppliers' Web services.

(UDDI.com, 2003). Strategic sourcing personnel uses this subsystem to maintain the supplier data and their Web services entries. Potential suppliers are evaluated to determine whether these suppliers should be registered in the private Web Services Registry. New suppliers and their Web services entries can be continuously identified and updated by accessing the public Universal Directory, Discovery, and Integration (UDDI), Business Registries or directories of other public exchanges

Technologies Needed for Mobile Procurement Development and Implementation

Mobile Agents
Mobile agent–based software systems are programs that encapsulate data and code, which may be dispatched from a client computer and transported to a remote server for execution (Chess, Grosof, Harrison, Levine, Parris, and Tsudik, 1993). They execute asynchronously and autonomously (Yang, Rana, Walker, Georgousopoulos, and Williams, 2000). Mobile agents are software components that can move from server to server in the network while keeping the state of the application intact. Mobile agents manage their own life cycles based on the logic programmed into them. The mobile agents as autonomous entities can move towards other environments, contacted with other agents and complete its execution at the destination. They offer advantages such as a minimizing the use of connection between the mobile customer and the server of the data, and that which allows decreased consumption of bandwidth and the latency time (Zinnikus, Hahn, and Fischer, 2008). These agents move around different locations, from the mobile phone to the server or from the server to the providers' sites, to put the customer needs, take the results of the researcher agent, and transmit to the interface agent of mobile phone.

Service Oriented Architecture (SOA)
The objective of the service-oriented architecture paradigm (Erl, 2005) is the modeling of distributed, heterogeneous and interacting software applications. Its basic building blocks are autonomous and platform independent software units (services), which are amply specified by separate interfaces. These interfaces allow for the publication, search and orchestration of the described services within open and heterogeneous networks like the Internet. OASIS Group, (2006) noted that service-oriented architecture is an architectural model for designing software systems. The main idea is to have all components in a distributed application communicate and interact via services. Thus SOA is basically an architectural superstructure for service-oriented computing.
Krafzig, Banke, and Slama, (2004) noted that the main-objective of any SOA can be formulated as enabling an efficient and powerful service orchestration for the implementation of new applications. SOA is supposed to provide a platform for an efficient and effective publication, discovery, binding, and assembly of these services.

Cloud Computing
Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Karl Scott, 2010).

The main objective of Cloud Computing is for the network to independently provide software, services and computing infrastructure. Miller and Veiga, (2009) noted that cloud computing can be thought of as an infrastructure that provides storage, processing and applications as service. These services can be accessed over the internet by using some standard browser.

Mobile Cloud Services

Currently, the Google Application Engine and the Apple Cloud are the most prominent cloud providers that enable the consumption of cloud services from the handset, since their cloud solutions are completely integrated for their own mobile platforms. Some open source that enables the communication with multiple clouds include: Jets3t, Jclouds, Typica and Amazon Navite API. The Google Application Engine contains all the set of services provided by Google. It uses a SaaS approach for delivering services over the Internet. It also provides support for storage (Google for developers). Android mobile platform is tied to the solutions provided by Google, and thus most of the services released over the Internet were extending for proving a mobile version 8.

The specific role of mobile Agents in the m-Procurement architecture is to provide autonomy, reactivity, proactively, interactivity, mobility and a set of easily re-usable services, and capacity for error recovery, solve the problems of information overload and management. The specific role of SOA in the architecture is to allow application services to be loosely coupled, location transparent, and protocol independent and to enable the interoperability of disparate systems. The specific role of cloud computing in the proposed architecture is to allow users to use infrastructure (e.g., servers, networks, and storages), platforms (e.g., middleware services and operating systems), and software (e.g., application programs) provided by cloud providers (e.g., Google, Amazon, and Sales force) at low cost in an on-demand fashion.

V. RELATED WORKS

Focusing on the bidding/tendering process, (Kerridge, et al, 2000) reviewed a list of existing information systems over the Internet that supports the e-procurement process. They developed a Supply Point system, which can electronically support and automate the whole tendering/bidding process of virtual consortia for construction industry. Another similar system is e-Tendering with Web Services by (Lai et al, 2007). The system provides the tender document details for the tenderers, and the tenderers submit their tender price via Web services. The paper had a case study on building construction.

The *PreQTender*, by (Abdullah, 2008) is another Web-based tender management system for selecting prequalified tenderers in construction projects. The system aims to increase the integrity and transparency of the prequalification tendering processes. Criswanto et al., (2013) proposed a Prototype e-Commerce mobile Marketing System. They highlighted the techniques used to resolve information personalization, privacy protection, up-to-date content, and market targeting. The research method used was based on the e-Commerce Mobile marketing conceptual. The system consists of a website and mobile application where both communicate directly via http as well as via cloud services. The website acts as both Publisher and Broker while the Mobile Application functions as a Subscriber system component.

Li Xining and Guillaume Autran (2009) in the 33rd Annual IEEE International Computer Software and Applications Conference proposeda mobile agent platform for M-commerce. Their proposal is an approach based agent for a distributed environment, which makes it possible for the consumers to send mobile agents their handheld devices to visit the E-stores inventories for search, comparison, evaluation, purchase and the payment of the goods. The proposed architecture composed of three layers: The kernel layer: for the planning and the execution of agent code. The layer of the virtual machine: for guaranteeing the security by the control of incoming agents, and the M-commerce applications based mobile agent layer: in this layer the authors implemented a logic programming language with a rich application programming interface for designing mobile agent applications.

Gilda P, (2004) at the International Conference of the e-commerce proposed mobile-agent-based architecture for m-commerce applications. The main objective of this approach is to develop a more improved mobile commerce application. The architecture of Gilda pour is designed with three principal layers: The front layer is mainly for presentation, the middle layer for application logic, and the back layer for data management. Lin and Lian (2010) proposed the Design of a Mobile Agent Environment for Context-aware M-commerce. The aim of this approach is to help mobile users discover, locate, negotiate, monitor and notify, on behalf of users to carry out goal-driven commerce tasks on an anywhere and anytime basis.

Saleh et al., (2003) proposed the Specifications of a mobile electronic voting system and a mobile agent platform. They presented a complete extension of UML 1.4 standard (M-UML) to deal with all UML diagrams: Use Case, Class, Object, State chart, Sequence, Collaboration, Activity, Component, and Deployment diagrams. They also used this model to specify a mobile electronic voting system as an example.

Adesina et al (2010) proposed a SOA-based framework for e-procurement in multi-organisations. The SOA-based e-procurement framework for multi-organisations consists of presentation layer (Service clients),Business logic (e-procurement service layer) and data layer. The e-procurement services layer of the SOA framework was implemented as .Net web services using Microsoft C#. The functionalities of the web services in the e-procurement services layer were exposed to the clients through the web services interfaces but the business logic of those services was internal to their implementation classes. The implementation class for each of the web methods exposed by the web service calls the database (SQL Server) class, wraps the corresponding SQL statements that controls the retrieval of data from the database and consist of corresponding classes that get input and return output to the users.

Sheldon et al., (2002) implemented the B2B e-commerce System Specification and Implementation Employing Use-Case Diagrams, Digital Signatures and XML. It is a remote order and delivery web-based B2B e-commerce system for an auto-parts manufacturing company. In achieving B2B interaction, the system exchanges only server programs and encoded files while communicating with other business companies. The XML documentation is transmitted by using a socket on the application. The DTD and XSL are saved in a global repository and are used by the web browser's parser for validation based on the information in the XML documentation itself that is sent and received.

Ashoori et al., (2009) implemented an e-procurement framework that supports dynamic acquisition of procurement services from different suppliers dealing with changing procurement requirements based on an extension to Web Services Business Process Execution Language (WS-BPEL) standard. The Web Service Interoperability (WS-I) Supply Chain Management is based on the WS-I Basic Profile VI.O (Web Services Interoperability Organisation, 2006). It focuses on the core foundation technologies upon which web services are based: HTTP, SOAP, WSDL, UDDI, XML, and XML Schema. The B2B scenario for WS-I supply chain management is such that, the retailer system through web service requests fulfillment of a consumer's order from the internal company warehouse, which responds as to whether line items from the order can be filled.

Oussama Zerdoumi, (2011) proposed a Mobile commerce approach based on mobile agent. The proposed architecture was composed of three principal parts: the mobile part, the server part and the providers' sites part. The mobile part is composed of: an interface agent,localization service, and mobile agentserver. The server part consists of manager agent, mobile agent server and the UDDI (Universal Description, Discovery and Integration). The providers' sites are composed of a database, interface agent and the researcher agent. Sequence diagrams as used to describe the research, the server and the site.

VI. CONCLUSION

The possible implementation of mobile procurement apps in countries with increasingly exploding mobile device usage like Nigeria will reduce transaction costs; accelerate access to information and deliver flexible working times and environments. The mobile procurement apps will enable users to create purchase requisitions and check requisition status regardless of their location, anywhere, and anytime. It will enable remote approval of requests, making the process faster and cheaper, in turn reducing P2P time and increasing productivity. It will also enhance transparency, monitoring and control in the procurement process. It will help establish a level playing field and relatively, "fair", competitive and more accessible platform for the sprouting diverse suppliers and reduce administrative, operating and inventory costs to enhance quicker decision making. Such mobile procurement framework and associated data would be centrally hosted on the cloud. A Cloud based mobile procurement would benefit customers by providing improved scalability and reduced hardware costs.

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