Full Paper

ARCHITECTURAL FRAMEWORK FOR MOBILE ONLINE HOTEL RESERVATION IN NIGERIA USING GSM TECHNOLOGY

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ABSTRACT

Going by the continuous spread in the number and geographical coverage of mobile operators and facilities of the Global System for Mobile Communication (GSM) technology in Nigeria, there exists a compelling need for creating more value added services to the network. One example of a value added service is the mobile online Hotel Reservation Systems. This paper focuses on Hotel rooms' reservation being a vital part of the growing tourism industry in Nigeria, where quality of service could be critical; hence, it sets out to improve upon the existing Hotel reservation system. This it achieved by designing and evaluating an architectural framework for mobile hotel reservation system using the Global System for Mobile communication, which will create a platform for hotel reservation from any location. In order to achieve this, the existing hotel reservation systems in Nigeria were reviewed. We examined the development of hotel reservation system from manual method to computerized system to online reservation system. The problems and challenges inherent in these systems were highlighted. Arising from the challenges in the existing system, an improved GSM-based model was designed using the traditional *Model-View-Controller (MVC)* architectural pattern. This pattern consist of three parts: the Model which represent the data and business logic of the application; the View which is the actual screen that displays data and related commands to the users; and finally the Controller which receives user actions and dispatches them to the Model. The following performance parameters were used in the evaluation of the proposed architecture: response time, bandwidth consumption and cost per request.The results revealed that using the HTTP-based design approach, instead of the WAP based approach; a performance evaluation of the architecture used was carried out. The result revealed an improved response time; reduced bandwidth consumption leading to reduced bandwidth cost per request. Evaluation shows that the architectural framework is highly implemental and that it is of greater advantages over the existing hotel reservation systems in Nigeria because of its flexibility, availability, ease of use and reliable.

Keywords: *GSM, Hotel Reservation, Mobile, HTTP, WAP, WML*

1. INTRODUCTION

The hotel industry is a sub-system in the travel and tourism industry, which is concerned with the provision of lodging and other such services to different categories of people. However, for the hotel industry to flourish and meet the different demands placed on it by its teaming customers, it needs a fast and reliable reservation system that will help in handling its reservation processes. Hotel reservation system is, therefore, any process that helps in efficient and optimized allocation of hotel facilities to willing customers. Such systems, apart from being able to keep necessary information about the specific user hotel, it should be able to make informed decisions based on the information provided by customers on their hotel facilities preferences. Nigeria is taking a leading role in the mobile market. Since, the sector opened up in 1999 (IT-Edge, 2004), the mobile market has ushered in a once unknown competition amongst the Information Technology Providers in the Telecommunication industry. Companies have been licensed as global system for mobile communication (GSM) operators in Nigeria and, the operators have within five years connected over 20 million subscribers and evidently still growing. Because of this, there exist needs for value-added services to be added to the wireless network provided by the viable GSM technology in Nigeria. The paper focuses on developing a mobile reservation system for hotels through which customers can carry out booking for hotel facilities. This will invariably lead to increase in the number of users of GSM technology and coupled with the fact that people want dynamic change in location while they still have seamless access to remote information, the best solution to hotel reservation can never be best conceived than a mobile/wireless one.

Therefore, design and analysis of an architectural framework for the operation of a mobile hotel reservation system (christened mHotReservator) in Nigeria, is being proposed which would allow allocation of hotel facilities via micro devices such as mobile phones and other handheld devices.

The hotel business is an important industry in many countries, especially in those attracting a large tourist trade and as such has gone through a series of developmental stages over these past decades (Jacques, 2003; Bureau of Labor Statistics, 2005).

A hotel management system's function is to coordinate the different subcomponents involved in the planning, direction, and control of the operations of a hotel business. The subcomponents in hotel management system include: facility reservation/booking, building cleaning departments, hotel bars and restaurants, room services, security system, gaming surveillance, counter and rental clerks. Hotel reservation system is organized process/methods that assist in efficient and optimized allocation of hotel facilities to customers. Such systems, apart from being able to keep necessary information about the specific user hotel, it should be able to make informed decisions based on the information provided by customers on their hotel facilities preferences. Reservation as regards to hotel means advance booking, for instance of hotel room, train, coach, cars

Increased competition among establishments in the hotel industry has spurred many independently owned and operated hotels and other lodging places to evolve reliable reservation systems, which allow travelers to make hotel facility reservations.

The reservation system can be used to reserve a wide variety of entities, including: Hotel, motel, and resort rooms, Conference rooms; However, this work focuses on hotel rooms' reservation.

2. Related Works

Basically in Nigeria, the most rampant implementations of hotel reservation solutions are the following:

i. Manual hotel reservation system

Manual hotel reservation system, employs booking/reservation processes carried out by an assigned front-desk clerk who is responsible to the hotel as a public eye and, who, through his/her attitude and behavior, greatly influence the public's impressions of the hotel. Suffice to say that this method is fraught with many problems. (Samson, 2005)

ii. Computerized hotel reservation system.

It is however noteworthy to say that nowadays, front-desk clerks' work have been enhanced by the use of computer for the automation of the booking process (computerized hotel reservation). This of course, does take place at the hotel. This reservation system is just an enhanced manual method of hotel reservation where the record of individual customer is kept on the computer instead of the usual paper and ink form so that data could be more organized and safe. Aside the computer enhancement, the method has all the disadvantages of the manual system. (Samson, 2005)

iii. Call-in hotel reservation system

Many hotels in Nigeria encourage their customers to call-in to make lodging reservations via telephone. This method also has the disadvantage that the customer must know the hotel phone number and it could be expensive since call cost varies with duration of calls and because voice transmission is involved. Furthermore, a single hotel could be reached at a time; hence it could be time-wasting if the hotel cannot meet the requirement needed. (Samson, 2005)

iv. Online hotel reservation system

In the on-line hotel reservation system willing customers visit the web site of the hotel of interest where they would provide information concerning their preferred hotel facilities such as type of hotel room, number of room etc. The information is then used by the hotel to decide which facilities to make available for such customers. Payment facilities are also provided.

Galor System and Software Development Ltd developed Gilboa Software which was originally developed for PCs operating in a Local Area Network (LAN) under the DOS operating system but it has been designed to parallel the manual work of the travel agents. Wilkinson (1999) of Oceanic Consultancy Company Ltd developed Globekey, hotel reservation software designed for hotels, resort, guest houses, motel, villas, bed and breakfast etc.

Bug Softwares (1998) also developed web-based hotel reservation software called Bug Hotel Reservation system software. Bug was designed to simplify the task of online booking. When customers book online, they receive notification in 3 days by email and/or fax.

All of the above reservation systems have common features such as:

i. Provision of internet users with ability to make reservation when they browse their web sites.
ii. They allow travel agents to manually make reservations for their clients.
iii. They allow instant or between 2 to 3 days notification of reservation either through email, fax etc.

One of the problems with these methods is that the user/client needs a physical point of connection to the Internet. This restricts the users/customers from physical mobility. Similarly there is the need for the customer to know the existence of a hotel (especially its URL) before he/she can browse for its reservation information. Another demerit of these methods is that it links the user with a single hotel at a time. This can be time-wasting, especially if the hotel does not meet one's requirements.

3. Proposed Architecture

In view of the problems facing the afore-mentioned hotel reservation systems, this work seeks to proffer an alternative method of reservation that will eliminate the problems above. This solution christened mHotReservator uses M-commerce technology combining the telephone/fax using the Hypertext Transfer Protocol (HTTP). Nigeria is presently occupying the front seat in the global system for mobile phone market in Africa. Moreso, cost of mobile phone SIMs are getting cheaper. This invariably leads to increase in the number of users of hand-held devices. Conveniences in term of unhindered physical mobility are a welcome development by most users. Therefore, a reliable and a widely-acceptable solution which is also an improvement to the existing hotel room reservation systems is needed, and this can be found in *mHotReservator*. This work would allow hotel users to reserve hotel rooms via the use of hand-held devices such as mobile phones.

The feasibility of this work hinges on the following:

i. Acceptability and Relevance of the system
ii. Cost of Resources
iii. Availability of the needed technology (Wireless Network)

A mobile hotel reservation system in Nigeria is of utmost importance and relevance now, as it bring ease of operation to the Tourism and Hospitality business. Though, Cost is always a paramount factor in every decision-making procedure. The survey of the resources needed shows that the price of most computing equipment is falling by 50% every year. It is also a fact that GSM operators are expanding and extending the reach of their infrastructure making it readily available in most cities and local communities in the Nigeria. Suffice to say that this expansion more than anything else account for the projected success of Mobile Hotel Reservation System. A mobile hotel reservation system architecture would have the following components among others:

i. The client component
ii. The hotel registration component
iii. The host hotel component.

The relationship among the three parts are depicted in figure 1.

The client component

This component resides with the user of the mobile hotel reservation system. The component runs on mobile phones, pager or PDA. This component determines which host hotel component a request for room reservation belongs to, and dispatches it to that host hotel component. This component consists of

i. Facility for supplying customers' information.
ii. Facility for payment on successful room reservation.

Facility for supplying customers' information: It is a well-designed mobile hotel reservation system interface through which the customers put their information through to the system itself. Some of the costumer's information include name, customer's state of interest, particular location in the state, hotel category (this can be 5-star, 3-star or others),check-in date, check-out date, number of rooms etc.

Facility for payment on successful room reservation: This component also provides a means of payment for the reserved hotel room. This can be via a credit card.

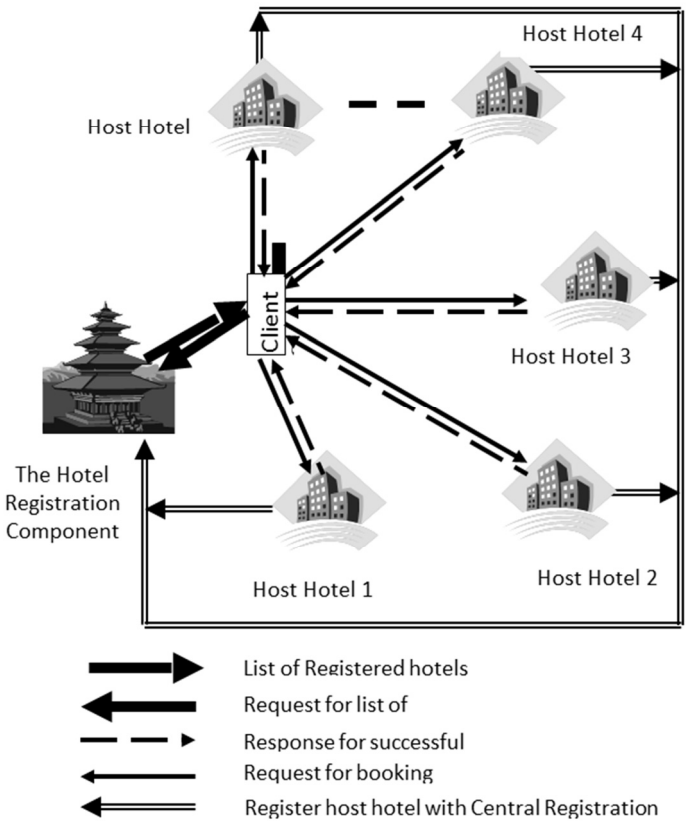

Figure 1 The three components of mHotReservator architecture and how they relate with one another

The central hotel registration component

It is also responsible for the registration of the host hotel components. This component has a house-keeping facility that allows the host hotel components to get registered and/or unregistered. Therefore, it keeps all records of registered host hotels. This component is responsible for deciphering and responding to requests for hotel list from the client component.

Facility for house-keeping: House-keeping facilities are used for record management activities. These can be any data base management system or any proprietary web-based record management application such as oracle and MySQL servers.

The host hotel component

This is the component that determines room availability, price if room is available. It also keeps all records of reservation made in the host hotel. It has a facility for acknowledgement of successful room reservation. It also has a local facility for house-keeping work.

Mobile device limitations impose many constraints on the design of wireless mHotReservator. The system must offer useful and usable interfaces even though the devices on which it runs have limited screen size, input capabilities, processing power, memory, persistent storage, and battery life. Wireless enterprise applications such as mHotReservator, are especially constrained because of their dependence on the network. The constraints imposed by a mobile network are significantly larger than those of a typical Web browser connected to the Internet (e.g. on-line hotel reservation system). It may be necessary for clients to operate offline or disconnected from the network for two reasons: the network quality may be poor (compared to wireline networks) and the typical use to which mobile wireless devices is put may justify it.

Wireless devices generally do not maintain a dedicated connection to the network, but connect only intermittently due to imperfect network coverage and poor network reliability (such as when the user enters an area where the network cannot be reached). These will be resolved by: Connecting to the network only when needed, consuming only as much data from the network as needed and remaining useful when disconnected.

The constraints faced would be taken into consideration under the following:

- The client design (presentation)
- The central hotel registration and the host hotel components
- Communication protocol
- Design tools used.

The client design

The client design of the reservation system used the traditional *Model-View-Controller (MVC)* architectural pattern. MVC is categorized as an architectural style, while others think of it as a design pattern (Mikko, 2004). The MVC pattern solves the problem of updating an application's views (UI screens) as its data changes. The MVC pattern consists of three parts: model, view, and controller.

Figure 2 shows the MVC pattern. The view contains the graphical user interface, which is the part of the application the user can see. When the user alters the data on the screen and then initiates an action, that action goes to the controller. The controller determines what kind of action has been requested and calls the appropriate interfaces of the model. The model consists of several components, classes, or packages, depending on the technology that implement the application's business logic.

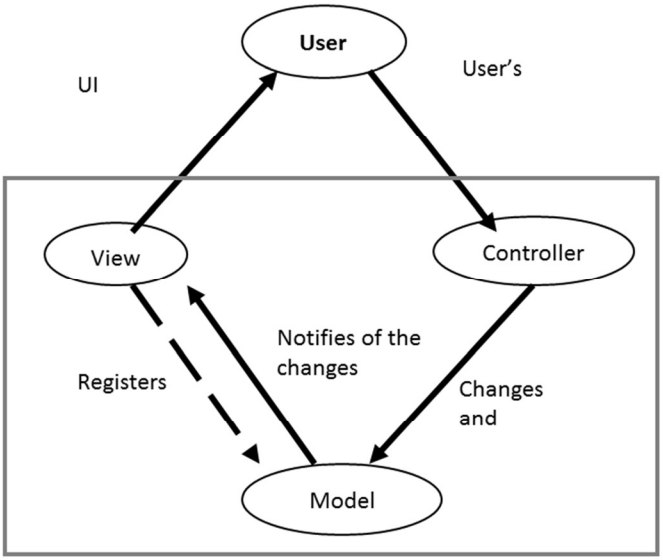

Figure 2 Elements of Model-View-Controller design pattern

Using MVC architecture offers benefits that may outweigh the costs.

Application flow is kept isolated from data and presentation: By separating the controller from the view and the model, the flow of the application is isolated in one place. Consequently, developers can look at just the controller to understand the client's perspective. They can also change the flow of the application by modifying the controller, with little, if any, disruption to the rest of the code.

Data is insulated from presentation: Separating the model from the view insulates the model from changes to the view. In other words, developers can alter the look of the client without having to change the model.

Presentation is not contingent on how the data is stored: Separating the view from the model insulates the view from the details of how the model works.

The view is not affected by how the model manages data: the model may get its data from local storage, from a server using HTTP net-working, or from an in-memory cache, or a combination of these sources.

The last benefit is probably the most important reason to use MVC for mobile clients. To use the network sparingly and remain

useful when disconnected, a client must decide when to fetch data from the server or from local storage. Local data strategies may be based on caching or synchronization to improve responsiveness and maintain data coherence. Partitioning these details into a model makes implementation, testing, and maintenance easier than if those details were spread out across the application. The client is the system component that resides with the client mobile device and is responsible for presenting responses from the central hotel registration and the host hotel components. The client design can be achieved using: Wireless Markup Language (WML)-based design approach and Hypertext Transfer Protocol (HTTP)-based design approach. In this work, the HTTP-based design approach was used based on its many merits over the WAP-based approach.

The central hotel registration and the host hotel components

The central hotel registration component and the host hotel component comprises of the web server and the database server. The database server is mainly is a database server employed in the paper is the hardware on which the data resides (Deitel and Deitel, 1999; Yank, 2003). The important feature of consideration in the design of this aspect is in order to ensure safe data sharing and durability. Durability implies that committed updates are permanent. Failures that occur after a commit cause no loss of data. Durability also implies that data for all committed transactions can be recovered after a system or media failure. These features ensures that persistent data always conform to their structure, that a series of operations can assume a stable set of inputs and working data, and that persistent data changes are recoverable after system failure (Samson, 2005).

The communication and messaging techniques

Under the communication and messaging techniques, we considered different communication and messaging method/format employed between: i. client and web server; ii. Web server and database server; and, iii.Client and database server.

Client-webserver messaging format: The simplest and most flexible messaging format involves sending HTTP GET or POST requests to a web server in a proprietary format (Taylor, 2002; Day, 2004). The web server then responds with a HTTP response in a proprietary format. In a HTTP GET request, the proprietary request data is encoded into the URL.

Webserver-database server messaging format: The web server and the database communicate via the use of some native communication techniques such as through Structured Query Language (SQL) embedded in Open Database Connection (ODBC) which allows for connection to different databases (Sun Microsystems, 2003).

Client-database messaging format: Here, there is no direct communication between the client and the database. Generally, clients should not connect directly to the database. Clients require a powerful interface, such as the ODBC API, via the web server to manipulate data on a remote resource. In some circumstances, it may be acceptable for clients to access the database directly; such clients could be database administrator for management tasks. As mentioned earlier, mHotReservator's design is a three-tier application and the architecture for it is as shown in figure 3.

4. System Preformation Evaluation

Evaluation was meant to justify mHotReservator by comparing its design approach to the existing mobile application design approaches. Essentially, the wireless application protocol (WAP)-based design approach and the hypertext transfer protocol (HTTP)-based design were compared. The parameters used for the evaluation are Response Time, Bandwidth Consumption, Bandwidth cost and Request Optimization.

The **response time** of the framework is the amount of time required for information requested from the Mobile Hotel Reservation

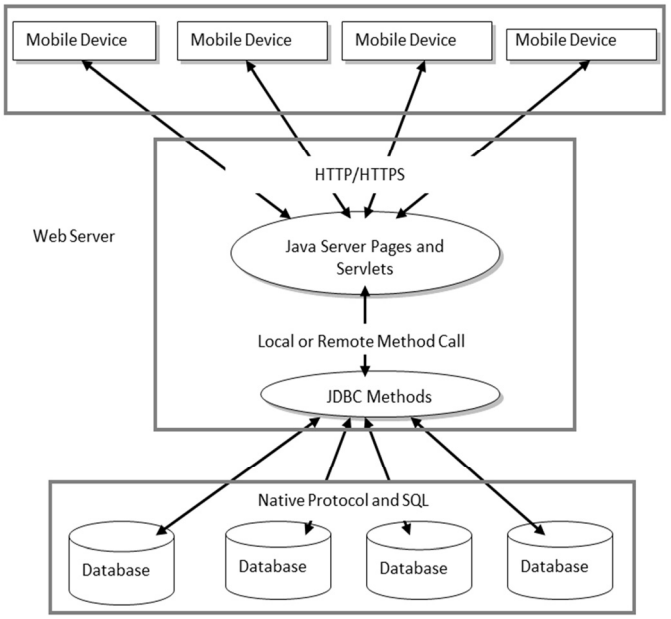

Figure 3 The three-tier system communication architecture of the three components

system to get to the requestor (the user). This is simply the time that elapses between when a request was made and the time a response to the request arrives. If we assume a fixed and a hypothetical bandwidth, *Bw*, then the relation for Response time for WAP and HTTP are given below:

$$Rt_{HTTP} = \frac{(rq + rp)}{Bw} \quad (1)$$

$$Rt_{WAP} = \frac{(rq + rp + fi)}{Bw} \quad (2)$$

Where *rq* is request size (in kilobyte), *rp* is response size (in kilobyte) and *fi* is formatting information size (in kilobyte). If we let Total request-response size (in kilobyte)

$$Trr = rq + rp$$

Then we can rewrite (1) and (2) generally as

$$Rt_{HTTP} = \frac{Trr}{Bw} \quad (3)$$

$$Rt_{WAP} = \frac{(Trr + fi)}{Bw} \quad (4)$$

$$Rt_{WAP} = \frac{Trr}{Bw} + \frac{fi}{Bw} \quad (5)$$

which gives

$$Rt_{WAP} = Rt_{HTTP} + \frac{fi}{Bw} \quad (6)$$

Since $\frac{Trr}{Bw}$ is the same for both WAP and HTTP, it shows that for any request, $Rt_{WAP} > Rt_{HTTP}$ because as *fi* increases, Rt_{WAP} increases. This relationship is depicted in Figure 4 using *Bw* of 64kbps while varying *fi*.

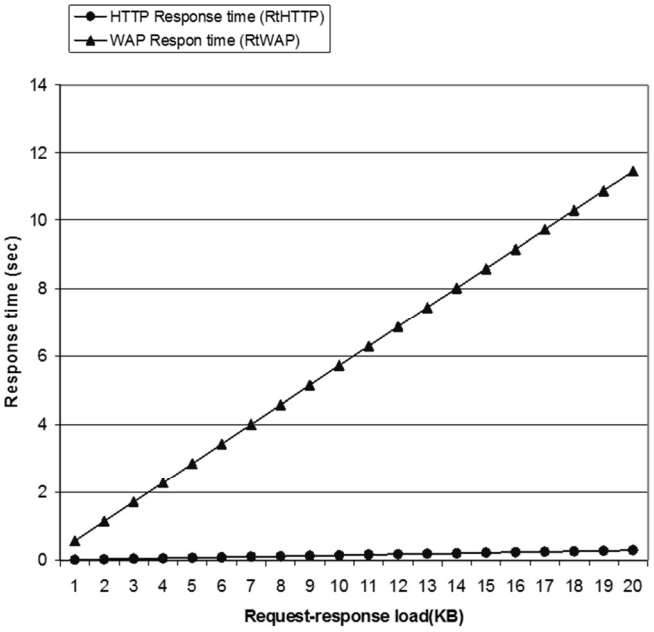

Figure 4 Response time for HTTP and WAP at Bw = 64kbps while varying fi

Bandwidth consumption of the architecture is the amount of data being sent through a data-transmitting medium, that is, a computer network in a given amount of time while considering WAP and HTTP. If the transmission time for request, *rq* is t_{rq} and transmission time for response, *rp* is t_{rp} then;

$$\text{Bandwidth requirement} = \frac{\text{Total request- response load}}{\text{Transmission time for total request-response load}}$$

therefore,

$$Bandwidth_{HTTP} = \frac{(rq+rp)}{(t_{rq}+t_{rp})} \quad (7)$$

$$Bandwidth_{WAP} = \frac{(rq+rp)}{(t_{rq}+t_{rp})} + B_{fi} \quad (8)$$

That is,

$$Bandwidth_{HTTP} = \frac{Trr}{T_{Trr}} \quad (9)$$

$$Bandwidth_{WAP} = \frac{Trr}{T_{Trr}} + B_{fi} \quad (10)$$

that is,

$$Bandwidth_{WAP} = Bandwidth_{HTTP} + B_{fi} \quad (11)$$

Where *Trr* is the total request-response size (in kilobyte), T_{Trr} is the total time for transmitting *Trr* in seconds and B_{fi} is the additional bandwidth required by the formatting information, *fi*. As B_{fi} increases, $Bandwidth_{WAP}$ increases. There is no doubt that for any request, $Bandwidth_{HTTP} \leq Bandwidth_{WAP}$. This is depicted in Figure 5 by varying $\frac{Trr}{T_{Trr}}$ between 5.5 – 550 kbps and randomly assigning values to B_{fi}.

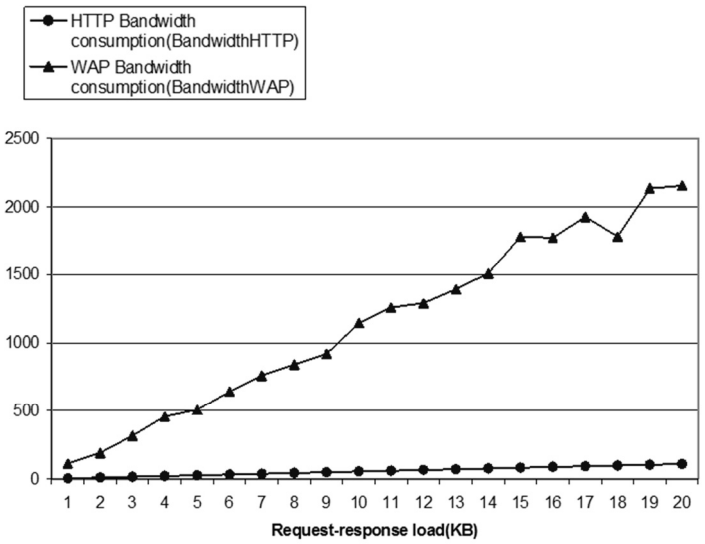

Figure 5 Bandwidth consumption for HTTP and WAP

Bandwidth Cost is the amount paid on bandwidth consumption while using the system. From equations (3) and (4), total response time were given as

$$Rt_{HTTP} = \frac{Trr}{Bw} \quad \text{from (3)}$$

$$Rt_{WAP} = Rt_{HTTP} + \frac{fi}{Bw} \quad \text{from (6)}$$

But $Bandwidth\cos t = Rt * Cost\ of\ 1kb/s$ therefore,

$$Bandwidth\cos t_{HTTP} = Rt_{HTTP} * Cost\ of\ 1kb/s \quad (12)$$

$$Bandwidth\cos t_{WAP} = Rt_{WAP} * Cost\ of\ 1kb/s \quad (13)$$

From (12) and (13) and following from (3) and (6), $Bandwidthcost_{WAP} > Bandwidthcost_{HTTP}$. This is depicted in Figure 6 at 1kbps costing ₦ 200.00.

Request optimization of the framework is a means of reducing the number of times requests are sent to server, thereby reducing access cost. Suppose that *n* is the number of supposed requests to the server and that *m* is the number of requests out of *n* made to local store of information on the mobile device. Hence,

$$Optimization\ index, e = n - m \quad (14)$$

As m increases, cost is greatly reduced and vice versa. Therefore,

$$Optimization\ index, e_{HTTP} = n - m \quad (15)$$

$$Optimization\ index, e_{WAP} = n \quad (16)$$

But optimization, $O \propto 1/e$. Therefore, as *e* decreases *O* increases and vice versa. This shows that $m = 0$ for e_{WAP} hence, for any group of requests $e_{WAP} \geq e_{HTTP}$ showing that $O_{WAP} < O_{HTTP}$. This can be depicted as shown in Figure 7.

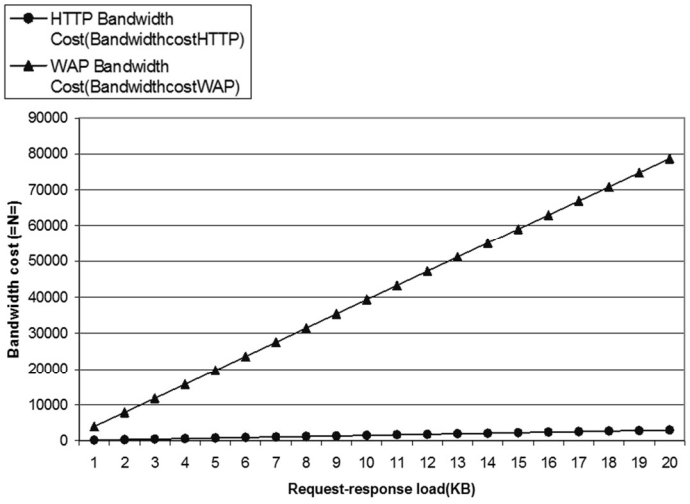

Figure 6 Cost per request for HTTP and WAP at 1kbps costing ₦200.00

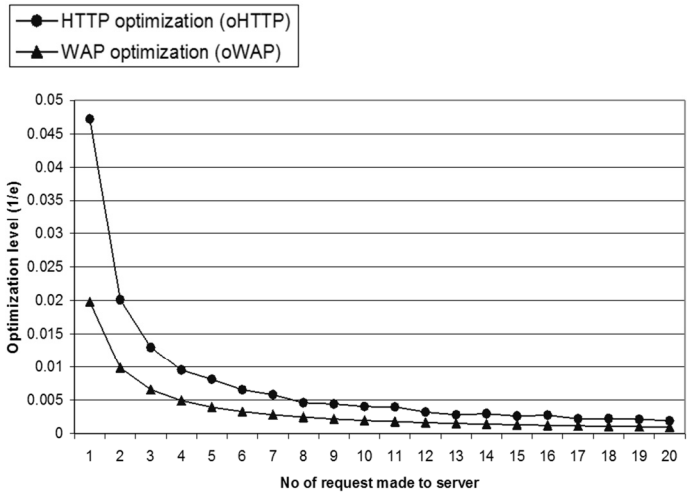

Figure 7 Request optimization for HTTP and WAP

5. CONCLUSION

The growth of Tourism and Hospitality business is predicated on an efficient technology driven industry that meet the basic needs of Clients with ease and convenience. The review threw light on the problems associated with the existing hotel reservation systems in Nigeria. Such problems include among others time-wasting processes, insecurity of information, need to physically to book, need for knowledge of hotel existence, error-prone processes.

The existing method requires Client to be physically available the hotel site or use a computer Terminal for online reservation. The designed architecture for mHotReservator proposed uses adaptable interfaces such as PDA, Mobile Phone, other handheld devices and it support flexible User interfaces. The framework empowered the Users of the system in making Hotel Reservation possible at any time, anywhere using GSM technology. Further research work is being considered to extend the technology to the West and Central African region and possibly, to incorporate the concept of Geographic Information System (GIS) into the evaluation of Hotels location relative to GSM base station locations.

REFERENCES

Anand Systems Inc. (2003) "*ResMe.Com: Online Hotel Reservation Software*". Internet document online at: http://www.resavenue.com/index_resav.jsp.

Armstrong, E.; Ball, J.; Bodoff, S.; Carson, D. B.; Evans, I,; Green, D.; Haase, K.; Jendrock, E. (2004), *The J2EE™ 1.4 Tutorial*, Sun Microsystems, Inc., California, 1.4 edition, pp.2-10

Bug Software LLC (1998) "*Bug Hotel Reservation: Online Reservation Software*". Internet document online at: http://www.bug_hotel.org/index.html.

Bureau of Labor Statistics, U.S. Department of Labor, (2005), *Hotels and Other Accommodations*, In: Career Guide to Industries, 5th Edition. Internet document online at: http://www.bls.gov/oco/cg/cgs036.htm.

Day, B. (2004), *Developing Wireless Applications using the Java 2 Platform, Microedition.* Day is a Technology Evangelist in Sun Microsystems, Inc. Internet document online at: www.billday.com.

Deitel, P. and Deitel, J (1999) *Java How to Program*, Prentice Hall, New Jersey, 3rd edition, p.888.

Galor Systems and Software Development Ltd. (1994) "*Gilboa: Online Hotel Reservation Software*". Internet document online at: http://www.galor.com/index.html.

Internet Merchandising Systems (2003) "*Voyager: Online Hotel Reservation System*". Internet document online at: http://wwwimscart.com/index.html.

IT-Edge (2004) No *More Fishing in Dangerous Water*, July/August 2004. ed, p10.

Jacques L. (2003), *Hotels: A Brief History.* Internet Article. Jacques is the Manager of the Hotel Marketing Department of Siemens Landis & Staefa in Zug, Switzerland. Internet document online at: http://www.ehlite.com/

Mikko K. (2004), *Simplify your GUI development process with MVC.* Internet Article, Mikko is the Technology manager, Enfo Solutions, USA. Online document at: http://www.ibm.com/

Sun Microsystems, Inc.(2003) *Designing Wireless Clients for Enterprise Applications with Java Technology. In:* A Java BluePrints for Wireless White Paper, p.3

Samson O. S. (2005) *Design and Simulation of a mobile hotel reservation system using global system for mobile communication (GSM) technology in Nigeria.* Unpublished thesis submitted to the Department of Computer Science & Engineering. Obafemi Awolowo University, Ile-Ife.

Taylor, M. (2002), *Strategies For J2ME MIDP/J2EE Integration Over HTTP*, Development Consulting Limited, North Yorkshire, U.K, Version 1.1. Online document at: http://www.developnet.co.uk.

Wilkinson, R. (1999) "*Globekey: Online Hotel Reservation Software*". Rod Wilkinson is a technical director of Oceanic Consultancy Company Ltd. UK..

Yank, K. (2003), *Build Your Own Database Driven Website Using PHP and MySQL*, SitePoint Books, U.S.A, 1st edition, pp.29-92.