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WEB-BASED REVENUE MANAGEMENT SYSTEM FOR PREPAID METER

Obinna Uche*
Department of Computer Science
University of Port Harcourt

Prince Oghenekaro Asagba
Department of Computer Science
University of Port Harcourt

Abstract— A Web-Based Electricity Revenue Management and Prepayment Vending Systems in Nigeria have been implemented. The Prepayment Revenue Management System (PPRMS) which has been in use by the utility and its successors is associated with several limitations due to its implementation strategy thereby causing loss of revenue to the utility and lack of trust among customers. Web-Based Revenue Management System (WBRMS) which uses a single database compared to existing systems of the utility is developed on a web based architecture using open source platform applications, thereby creating opportunities for a wide range of implementation options and reducing costs due to client/server systems. Users can login and perform transactions from any web enabled device, thus reducing transportations and/or Simple Messaging System (SMS) cost and providing quick access to data for management decision making, planning and efficiency. The Object Oriented Analysis and Design (OOAD) methodology was adopted for our design and development. The WBRMS has been developed in accordance with Web 2.0 specifications. It uses the YII framework to create a Model-View-Controller (MVC) design to layer the application. By layering the application, the system is able to separate the data (Model) from the presentation of the data (View). The Controller handles the input logic between the View and the Model which makes updating the application far more efficient and ensures faster data retrieval. There was comparison of WBRMS with the Utility Prepayment Revenue Management System, and found that investment cost was reduced by about 50%, overhead and maintenance cost also reduced by the same margin.

Keywords— WBRMS, OOAD, YII, MVC, Bottom Line

I. INTRODUCTION

All over the world, business organizations daily face important decisions regarding what to sell, when to sell, to whom to sell, and for how much. The outcome of these decisions goes a long way in determining the profitability or survival of these organizations. In recent times, available literature indicate that business organizations, especially service-based organizations, are relying more on Revenue Management concepts and systems to improve their bottom lines. (IDeaS, 2005).

This paper looks at a Web-Based Revenue Management System (WBRMS) that will reduce the cost of implementation and improve efficiency as well as scalability. The specific objectives of the study include:

I. To analyze the current state of prepayment metering and the Revenue Management systems used in the electricity industry.
II. To design and implement WBRMS in a web-based architecture using open-source platform for scalability, efficiency and cost savings.
III. To compare the performance of the WBRMS with the Utility Revenue Management System (Nigeria's preferred prepayment option).

II. LITERATURE REVIEW

a. Overview of Revenue Management Systems

Generally speaking, one can describe Revenue Management as the science and art of enhancing a firm's revenue while selling essentially the same amount of product. Revenue Management's fit within the organizational structure depends on the type of industry and the company itself. Revenue Management generally assumes costs and sometimes capacity are fixed and instead looks to set prices and customer allocations that maximize revenue given these constraints. A company that has achieved excellence in Revenue Management may have many opportunities to increase profitability by linking their respective operational focus and customer-facing focus together. Business Intelligence platforms have also become increasingly integrated with the Revenue Management process (Wikipedia, 2015). These platforms, driven by data mining processes, offer a centralized data and technology environment that delivers business intelligence by combining historical reporting and advanced analytics to explain and evaluate past events, deliver recommended actions and eventually optimize decision-making. Not synonymous with Customer Relationship Management (CRM), Business intelligence generates proactive forecasts, whereas CRM strategies track and document a company's current and past interactions with customers. (Cross,1997).

b. Related Work

In their paper titled "A Secure Web Service for Electricity Prepayment Vending in South Africa: A case study and industry specification" Subramoney and Hancke, 2015 stated that "Current standardized offline vending systems play a critical role in supporting electricity prepayment-metering infrastructure by enabling convenient access to point of sales for customers to purchase prepaid electricity tokens. Electricity utilities are now opting for online vending systems over offline vending systems. Online vending represents a step change in prepayment vending systems, which promises several benefits to utilities. However, the lack of an industry specification for online vending systems was a cause of major concern and risk for utilities, as they faced the problem of being locked into proprietary online systems. Further, the unchecked proliferation of proprietary online vending systems would have a detrimental impact on already successful standardization efforts in the electricity prepayment industry. Thus, the South African prepayment industry, initiated a project to develop an open industry specification for online vending systems. This paper analyses the industries migration to online vending systems, the specification development process, the design issues that emerged and implementation of the specification as a Web service".

In their paper titled "A Smart Card Based Prepaid Electricity System" (Raad et. al., 2007) stated that "Over the past few years, smart cards have achieved a growing acceptance as a powerful tool for security, identification, and authorization. Financial card issuers are moving to replace magnetic stripe cards with chip cards to reduce counterfeiting and fraud. The increasing computational power placed on the chip along with advances in cryptography has made the smart card a very powerful tool for identification. The advent of multi-application smart card operating systems for both contact and contact less applications has put smart cards on the edge of information technology. This paper features a 3-tier smart card secure solution for a novel prepaid electricity system. The proposed system uses an IP-based controller in addition to a power meter, providing efficient online control of the amount of electricity consumed by the user. The user will be notified if his credit balance goes below certain threshold".

III. WBRMS ANALYSIS AND DESIGN

a. *Methodology*

We used the Model–view–controller (MVC) software architectural pattern to layer the application. The YII open source PHP web application framework was used to create the Model-View-Controller (MVC) design. By layering the application, we are able to separate the data (Model) from the presentation of the data (View), thus making updating the application far more efficient. The Controller handles the input logic between each View and Model pair.

i. The Models]

The model uses MySQL relational database as persistent storage. Translation between PHP objects and relational mapping is handled internally by YII.

ii. The Views

Since the application is a web application, the view is PHP-based html-pages. This makes for a powerful and flexible design, using the strength of both languages. Javascript was used to handle user interactions with web page elements. AJAX and JQuery were also used to enhance the application. The graphical layout is handled with Cascading Style Sheets (CSS), making graphical web page changes easy to implement.

iii. The Controllers

The controllers are YII based classes that are designed to handle http-typed request messages (POST/GET) and map these to any other resource in the application.

b. Design of a Web Based Revenue Management System
Our aim is to develop a Web-Based Revenue Management System that will reduce the cost of implementation and improve efficiency as well as scalability thereby reducing capital cost and increasing revenue.

i. Proposed System Architecture

For the architectural design of the Web Based Revenue Management System, we adopted a Three Tier Model-View-Controller design pattern to design the user interface and activities of the software application which is shown in Figure 3.0 below.

Building the application in three-tiers provides the flexibility to organize the software to meet performance and business needs while it is operational. With the three-tier architecture, being able to alter the software with little to no impact to existing software modules is more easily done. Well designed three-tier architectures are more easily understood and maintained than other approaches.

Figure 3.0 Shows the proposed web-based revenue management system architecture.

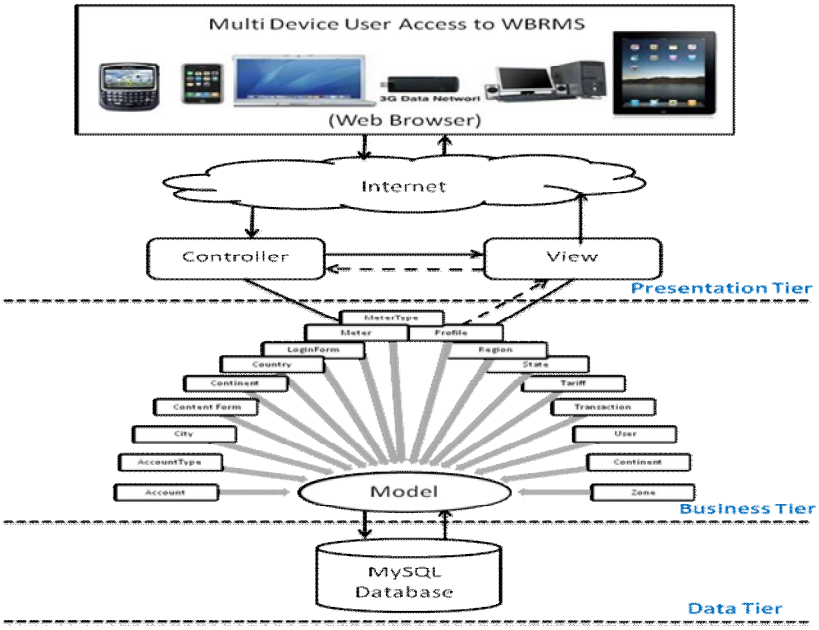

Figure 3.0: Architecture of the Web Based revenue Management System

c. Architecture of the Existing System

The PPRMS comprises of a Management Server, a Vending Server and a Vending unit/client or POS. The Vending Coordinator manages the traffic in and out of the Management Server. The Security Module is responsible for token generation. Customer Registration is in a tripod – customer details, Account details and Meter details. Also, PPRMS as shown in Figure 3.1 made up of the Management Server, the Vending server and the Prepayment Meters.
A communication link/protocol is required to establish communication between the two Servers.

d. Multi-Tier System of the Existing System

The PPRMS allows a multi tiered system with multiple Client computers being able to be registered on a single PPRMS Management Server, each managing POS and or Vending Clients. The system is fully scalable, with the only dependence being on hardware used and the number of Client-Server seats licensed. There is no limitation to the number of POS and or Vending Clients, Customers registered on a system, or the number of transactions managed, as long as the hardware can fulfil the processing requirement.

Figure 3.1 shows the PPRMS multi tier system.

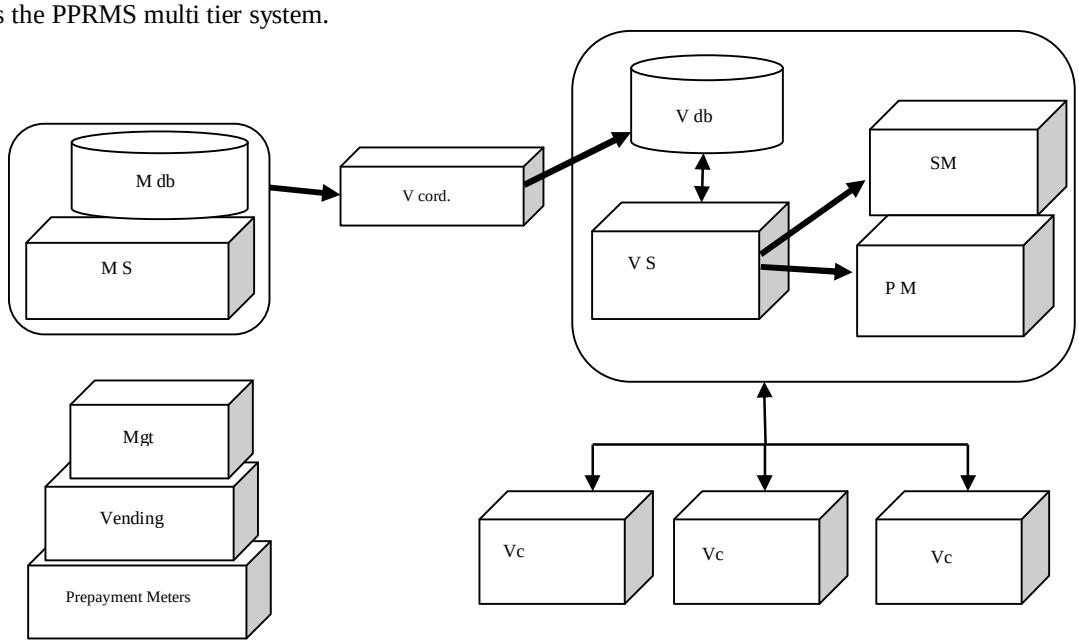

Fig 3.1 Multitier system of the existing system architecture

Legend:
MS - Management Server
VS – Vending Server
V Cord. – Vending Coordinator
V.db – Vending Server Data base
M db – Management Server Database
SM – Security Module
Vc – Vending Client

3.3 Vending Transaction Activity Flowchart

Figure 3.1: Shows the Vending Transaction Activity

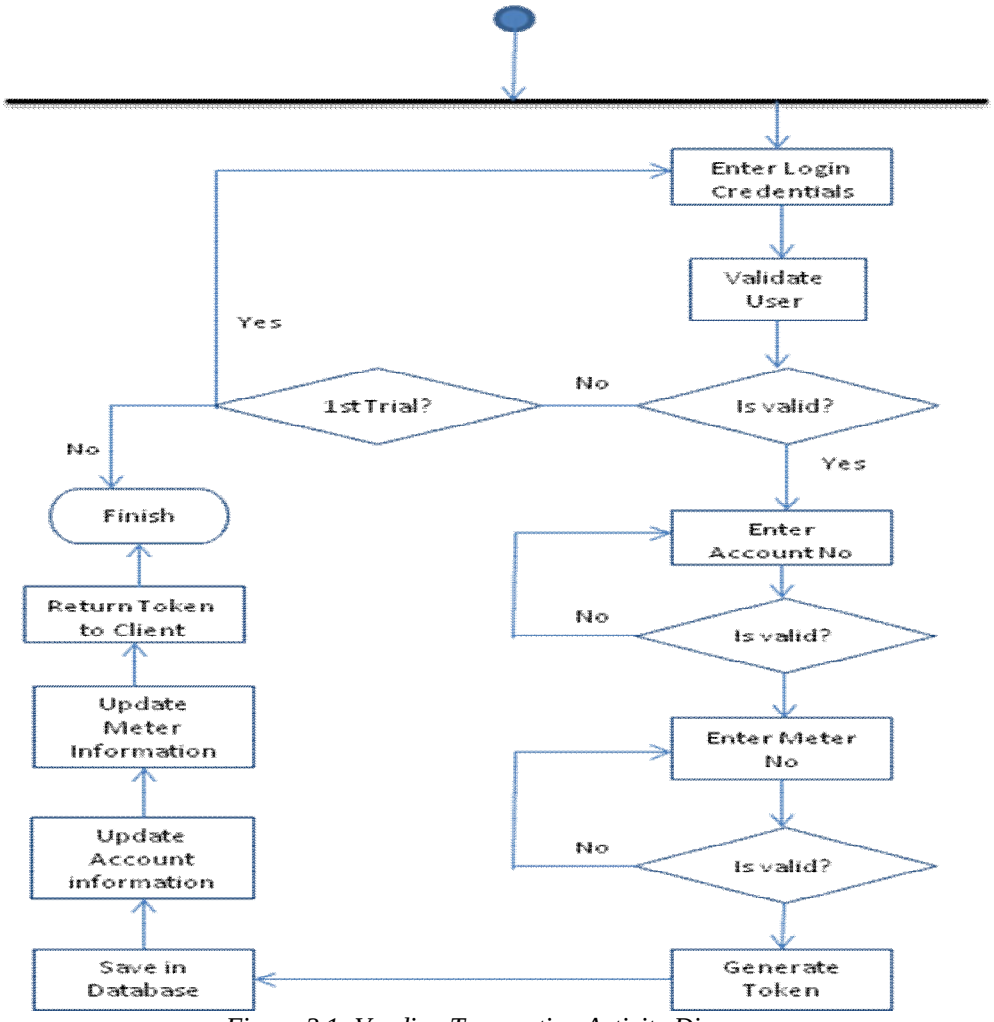

Figure 3.1: Vending Transaction Activity Diagram

IV. IMPLEMENTATION

a. System Requirements

The Web Based Revenue Management System has to be hosted on a web server. The application can be hosted on a local server, an intranet or the internet.

i. *Installation*

To use this application, both client and server ought to be properly set up.

ii. *Setting Up The Server*

Depending on how the server is to be run (either as a local server or a hosted server), the server is to be set up in such a way that it is able to run the necessary scripts. To run the server on a local machine for testing purposes or use on a LAN network, the following steps are to be taken:

- Install a local server application. On Windows, packages like WAMP or XAMPP can be installed. On Mac OS, packages like MAMP can be installed.
- Import the necessary project files into the web directory of the local server.
- If needed, set up the hostname of the server machine using a Domain Name Service (DNS).
- Set up MySQL server by importing necessary tables.

To run the application on hosted servers:

- The server should be set up in a way that it is only accessible by the Administrator.
- Push the project files to the hosted server using a File Transfer Protocol program (e.g. Filezilla).
- Follow the server manual to configure the server for PHP.

iii. *Minimum Server Requirements*

- Operating Systems: Any of the following: Windows XP, Vista, 7, 8, 8.1, 10, Server 2003, 2008, 2012 or higher
- CPU: 2 x Intel Core 2 (2.4 GHz, 128 Cache).
- RAM: 2GB.
- Minimum database space: 10GB.
- Software packages: Apache Tomcat, MySQL, PHP 5.0.

iv. *Minimum User Requirements*

Users only need a working web browser to run the application from any device.
Supported Browsers: Microsoft Edge, Internet Explorer, Safari , Google Chrome, Mozilla Firefox, Opera , Opera Mini and any other compatible PC or Mobile Device browser.

b. *Cost and Efficiency Comparisons between WBRMS and PPRMS*

Table 4.1 below shows the efficiency comparison between PHCN PPRMS and WBRMS.

PROCESS	PPRMS	WBRMS
DATA CAPTURE	**3**	**3**
DATA TRANSFER BETWEEN DATABASES	**2**	**N/A**
TRANSACTION STEPS	**5**	**1**
REPORT GENERATION STEPS	**6**	**2**

Table 4.1: Efficiency Comparisons between PPRMS and WBRMS

i. *Cost Comparison*

In terms of implementation and management cost, the WBRMS is about 90% cheaper to implement and manage. Table 4.2 shows cost comparison between PPRMS and WBRMS while Figure 4.8 depicts this cost differences.

	SOFTWARE COST (NGN NAIRA)	HARDWARE COST (NGN NAIRA)	INFRASTRUCTURE COST (NGN NAIRA)
PPRMS	**3,000,000**	**1,000,000**	**2,000,000**
WBRMS	**0**	**400,000**	**1,000,000**

Table 4.2: Cost comparison between PPRMS and WBRMS

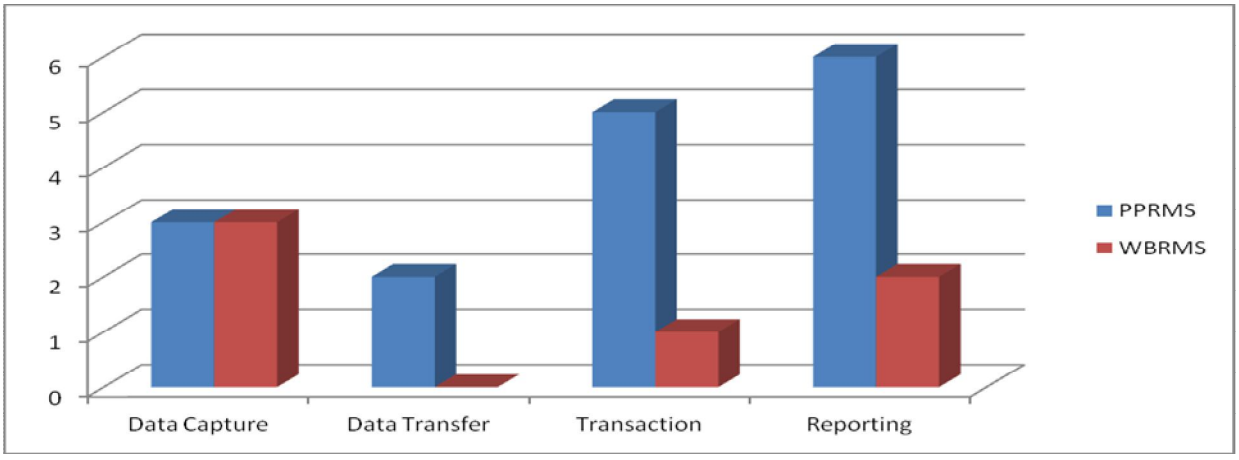

Figure 4.0: Chart showing differences in terms of data capture, data transfer, transaction and reporting.

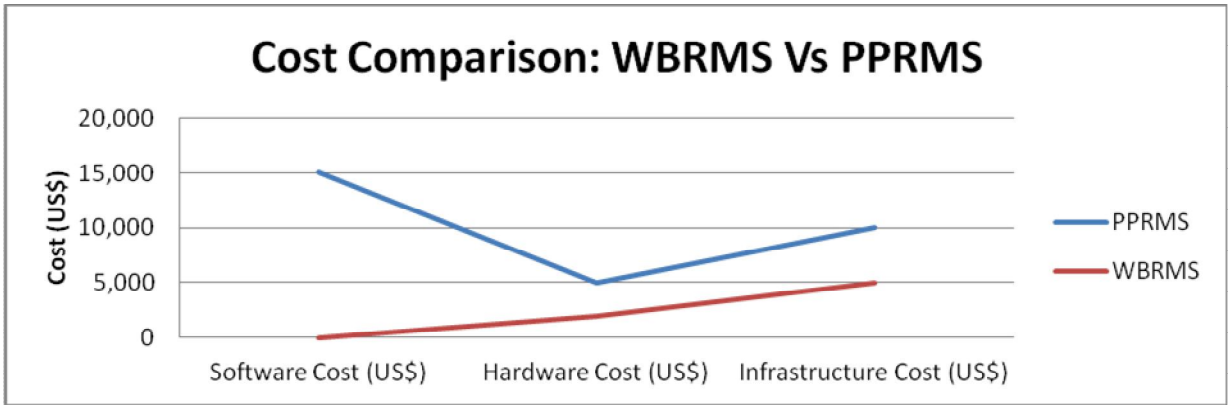

Figure 4.1: Chart showing differences in cost with respect to software, hardware and infrastructure

V. CONCLUSIONS

a. *Summary*

WBRMS eliminates the use of Vending Coordinator which is an integral part of the PPRMS Vending System. This minimizes cost and design time as well as improves speed of data retrieval or access to the database. The modern database makes use of Concurrency in design, thereby managing the multiple transactions on the database at the same time. The tripod design of the PPRMS sitting on Meter, Vending Server and Management Server is equally eliminated as all reside on same database in the new design. This equally eliminates the extra cost on infrastructure and network connectivity to the various servers. All accounts are defined under the user profile thereby reducing the number of forms and complication of the new system design. The new system has considered the capture of STS and Non STS type of meters on the same database which has been a major issue in the PHCN system. The new design has made provision for the capture of photographs to further improve system security and reduce meter theft. The online payment options were equally captured in the new system which was not available in the PHCN system.

b. *Conclusion*

The application of Revenue Management methodologies in Electricity Utility systems is one area that a lot of researchers have not explored. There has been various works on the Revenue Management System especially on Hotel and Air Transport systems. However, this work is only an insight to the numerous areas of research that are yet to be explored in the utility world.

c. *Future Work*

In the future we will explore deploying WBRMS in the cloud and other emerging technologies. We will also dig deep into the areas of tariff calculations which open up a lot of areas of research.

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