ARCHITECTURE FOR AN SMS BASED UTILITY-SERVICES MOBILE BILLING SYSTEM IN UGANDA

By

KAGINGO UMAR
Reg. No: 2006/HD18/6825U
B.Statistics (Mak)
kagingo_u@yahoo.com,(+256)772347367

**A Project Report Submitted to School of Graduate Studies
In Partial Fulfillment for the Award of Master of
Data Communication and Software Engineering
Degree of Makerere University**

Option: Data Communications

October, 2009

Declaration

I Kagingo Umar, do here by declare that this project report is original and has not been published and/or submitted for any other degree award to any other University before.

Signed.....Date.....

Kagingo Umar
B.Statistics (Mak.)
Department of Networks
Faculty of Computing and Information Technology

Makerere University

Approval

This Project Report has been submitted with the appoval of the following supervisor.

Signed:.....Date:.....

Prof. Fisseha Mekuria, PHD

Department of Networks

Faculty of Computing and Information Technology

Makerere University

Dedication

To Allah, without whom there would be no one to thank for my achievements. Thanks be to ALLAH. Then, to my dear loving Dad and Mum. This piece of work also directly goes to Imam-Din and all his dear uncles and aunties that have set an encouraging environment for everyone to reach excellence. To Kyomuhendo Rukia, Nahabwe Zainab, Mai Kayemba, Alawi Kayemba, my dearest cousin sis Hadija Kayemba, Arinaitwe.F, Farida T, Asimwe Mubarak, my understanding sis Musimenta Sharifa, the most hopeful, Elias Ashaba and Loving wife Wiiwo.

Acknowledgment

Thanks to my supporters and most of all, my guide to everything. I Thank you Lord. I also recognise all the assistance that was extended to me by Dad, Mum, Wiiwo, Zainab, my dear loving auntie Nelly for her courage, my entire family my dearest uncles: Saidi, Kaabi, Kama, Mama Aisha and the entire family of the Kayembas.

I also extend my gratitude to my caring Supervisors, Professor Fisseha Mekuria and Professor Idris Rai. You have really been so supportive to me with brilliant ideas all through my project cycle. Thanks go to Mr. Ssemaluulu Paul and Muhirwe Jackson for being such simple and understanding gentlemen. You have absolutely been so helpful and always willing to help where things have gone wrong. The entire staff of the Faculty of Computing and Information Technology who have created such a condusive environment suitable for every one to benefit from his/her hard earned tuition. Thanks so much for your support.

The DCSE class was the most cooperative group I have ever joined. Most notably, I thank Margaret Gathondu, Shifra and Felix for the dedicated support through out the course. May God bless you all.

Lastly to thanks go to all the IT professionals that have been so willingfully approachable during the course of the project field work, all in the following companies, MTN Uganda, National Water and Sewerage Corporation, True Africa Uganda office and Warid Telecom.

May the Good God bless you all.

Contents

List of Figures

List of Acronyms

SMS(C)	Short Message Service Center
SIM	Subscriber Identity Module
MDG	Millennium Development Goals
PEAP	Poverty Eradication Action Plan
SMSSI	Short Message Service Server Inward
SMSO	Short Message Service Outward
SP	Service Provider
WLAN	Wireless Local Area Network
NWSC	National Water and Sewerage Corporation
GSM	Global System Mobile
HPLMN	Home Public Land Mobile Network
SMSC	Short Message Service Center
MSISDN	Mobile Subscriber Integrated Services Digital Network Number
SCCP	Signaling Connection and Control Part
ICT	Information Communication Technology
UPS	Utility Payment System
PDA	Personal Digital Assistants
MS	Mobile Station
VAT	Value Added Tax
NONE-BAL	Non balance requests that need human intervention to reply

Abstract

The world of telecommunications, especially mobile communications, continues to evolve with innovative technologies and high-speed data services. In many economies, mobile phones have overtaken fixed lines. In this project, we took advantage of the existing telecommunications infrastructure to study possibilities to accomplish utility payments from personal mobile phones by the Ugandan public, as compared to the existing methodologies. The basis of the whole idea being visible dissatisfaction expressed by clients in a tedious process to pay utility bills, the existence of related models that help effect money transfers by phone and generally, the Global Systems for Mobile Communications (GSM) infrastructure and it's data services available today. This provided a firm ground to be able to re-engineer the payment system in utility services.

Paying a utility bill in Uganda is still a time consuming venture, taking more time that the majority of clients would actually refer to time spent as "alot". In this research project, ideas from different frameworks of related models, all with principles of wireless transactions, were compared and edited, coming up with one that can solve the problem of paying utility bills with an SMS. The new model ensures secure data communication between operators, utility companies and the customers. It was also designed following the economic, service and mobility requirements by the clients and utility companies respectively. As may be in most developed nations, related literature to electronic commerce and it's applicability, face to face interviews and questionnaires, were all of substantial importance in the successful completion of the project.

Chapter 1

Introduction

Paying a utility bill in Uganda and most developing nations, is time consuming. It takes more than a quarter a day or more, to pay a utility bill in most of these nations with queues usually several meters long in any of these banks. Utility bills nowadays come when service providers have intentions to disconnect clients should there be no immediate payments made, no matter how able they were to pay, but were simply unable because of limited alternatives to enact payments and therefore causing long queues of clients waiting to pay bills in cash at the bank branch. This has substantially been a consequence of the insignificant participation of many developing countries in the global information society, largely because of perceived incompatibilities between cultures and technologies, an idealistic preference for self-reliance, and simple lack of economic or human resources to acquire and utilize the technologies [10].

Nevertheless, the challenge for service improvement is continually growing, and the problem is usually as a result of less pressure towards new service consumption channels. This similarly also comes from the less demand side for new and better services from the public, and as well being a result of limited choices.It should also be noted that the the links between the development of economic infrastructure and pro-poor growth are well-established and now better understood [3]. The competition between older and newer solution providers remains fierce though and with some casualties, but such competition has helped mobile operators keep costs down and ultimately benefiting subscribers.

Today, customers are becoming more demanding in terms of the level of service they expect and how they are able to access services when required. In [23], Michael states that there are many reasons why the mobile channel is receiving so much attention; the least of which is the

clear consumer demand for mobile content and services and the recognition that the mobile phone may also be a viable tool for facilitating payments for goods and services [23].

Clinton [32] also states that there is hope business transactions across the world will be completed in a mater of seconds. Without leaving home, consumers can pay bills without writing cheques, open new accounts, check existing accounts, and trade stocks [32]. Internet acquisition by 51 of 55 African countries between years 1995 and 1998 as stated by Davison in [10], was a very good confirmation and indication that populations in the developing world were also quickly going to embrace the fact that services enabled by information and communications technology, will make it possible for the customers to manage their money transfer or banking needs twenty four hours a day, seven days a week. Today consumers of services online can access them either through Internet with a graphical interface, or a proprietary network with a text based interface or SMS [22].

The Short Message Service (SMS) makes it possible to send and receive messages to and from mobile telephones. The messages can contain text or binary data. The text can comprise of words or numbers or an alphanumeric combination. A single short message can contain up to one sixty characters when Latin alphabets are used, and seventy characters when non-Latin alphabets such as Arabic and Chinese are used [24].

This project is primarily aimed at advancing ways of enabling payment for basic domestic services via a text based interface by sending an SMS from anywhere at any time, particularly with use of a mobile phone.

1.1 Background of the Study

The study was undertaken with consideration of the prevailing methodologies and service with particular emphasis on time spent in clearing a utility bill, versus value for money, and other major motivating factors being:

1. The explosive growth in mobile technology
2. Case studies and observations
3. The need to avoid the tedious utility paying time

4. Emergence of such services in other countries

Globally, there has been substantial attention to wireless technology due to the increased need to communicate and therefore, global concerns on costs of doing business, mobile networks, price falls for SIMS, emerging technologies and competition have all become favorites for innovation in this area. All the above facts are co-existing with paper based methodologies, in financially stable government institutions. The existence of a vacuum in the areas of telecommunications research has therefore caused the telecommunications infrastructure now substantially established in Uganda, not be put to full use for the benefit of the Ugandan societies. We believe that this infrastructure can be continuously utilized, with help of continuous research, to drive down costs of information communication and doing business as a whole. Most specifically, draw down the cost of completing service transactions with utility companies by our local societies.

As a requirement by the United Nations for countries to achieve the millennium development goals, the government of Uganda has translated these objectives into the Poverty Eradication Action Plan (PEAP) [27]. This has seen government projects such as Rural Electrification and Improved access to safe water and sanitation among top priority projects. As a result, connection fees to utility services were reduced, resulting into an increase in the number of connections from 60 to 100 per month by the year 2005 for the case of piped water [27]. Utility companies in Uganda, more specifically water and electricity, have therefore seen a dramatic increase in the number of customers and customer requirements due to this Government's campaign to extend essential services to the people.

In [22], however it's explained that this increase triggers a change in customers expectations in the way they access the services, resulting into increased demands of greater convenience and accessibility options to the services or their delivery mechanisms [22]. In [28], journal for the relationships between delays and evaluation of service, it is explained that this kind of increase is a direct attribute to causes of delays in service. Delay in service, is the time from which a customer is ready to receive the service and when the service commences [28].

Already in many developed countries like the United States and the greater Europe, the traditional branch-based retail banking that has been characterized by this kind of delay in service, including bill paying, has been bypassed by more technological service access methods like ATM and the Internet [31]. In these societies mobile and wireless technology is already changing the

way personal financial services are used by consumers. In the last decade, the development of mobile communications technology has been dramatic, including SMS, WAP and, most recently, 3G technologies. The high penetration figures of mobile phones indicates that the devices are an integral part of consumer's lives offering enormous potential for mobile service providers, application developers that make mobile solutions applicable for a variety of services [31].

Although, convenience and accessibility of the service ought to be value for money, it shouldnt be too cheap to compromise quality of service provision in any way or too expensive that the cost of accessing a service becomes an additional cost to the consumers, which essentially makes a basis for this research. The number of ways to pay a utility bill in Uganda is limited mainly to, clients physically visiting the nearest branch offices with cash and yet paying a utility bill by SMS is not a very old concept in the modern world. In [10], Davison attributes their invisibility in the developing world to lack of telecommunications infrastructure, although satellite services have the potential to change that [10]. However according to [5], the telecommunications channel has matured dramatically in the last six to ten years. With the emergence of high-speed wireless network technologies. the increasing market penetration of mobile phones and the global advertising industry's interest in using this medium as a means of marketing and communication is rising. However, in spite of the increasing number of companies investing in mobile marketing campaigns, there is as yet little academic research on this topic and the nature and implications of this channel are not yet understood fully [4].

Our main objective arose out of the concerns associated with providing improved billing and payment systems at any location with telecom network coverage, which can be utilized in favor of both utility providers and service consumers, by enhancing convenience on one side of customers and cost of collections or the cost of providing billing information on the other.

Each household needs to spend a significant amount of time to respond to numerous bills including utility bills. Typically, consumers often receive these bills depending on how many services the customer is being provided. Such bills are usually provided on paper to the customer. The customer then reviews the bills and sends a check or more commonly, cash to the nearest clearing branch of the service provider. However, according to Hogan [15], this method is very labor intensive and time consuming for clients, and yet it must be done on multiple occasions each month since the bills do not normally arrive or become due on the same date [15]. No matter how small or big a bill may be, the bank hall is becoming a single alternative to clearing

utility bills. On most days, halls at banks are filled with long queues of hundreds of individuals waiting to pay a range of these bills in cash. A lot of unproductive hours are spent queuing up to pay and also to make simple inquiries or receive responses. These reasons actually dominate the customers reasons for the branch visits, making the whole payment process needlessly complicated.

On the other hand, the utility company is also tasked to a greater extent with receiving, reviewing, tracking and manually clearing each bill, which is and continues to be a laborious time intensive undertaking. To cut costs, lately most utility service providers in Uganda have done away with owning branches to which customers have historically deposited cash, to bank-based payments where company-specific or personalized pay slips are provided. This however also has ended up shifting the burden to the banking system. As many economies move away from paper based transactions, in [2], it's urged that direct payments are more reliable and the only way to stay ahead of creditors. For African ICT performance, Kelly [17], explains that starting from the late 1990s, there has been a steep change in the performance of the African ICT market with the prime variable in this change being the rise of mobile communications [17]. Thus, Africa has been pushed to the forefront in a new information revolution. As telecommunications technology registers successes too, advancements in high-speed wireless network technologies as a means of marketing and or communication, is rising with communication by SMS technology, dramatic [4].

1.2 Statement of the Problem

Paying utility bills for such basic services like water and or electricity, still takes more than a quarter a day in Uganda and many other nations in and out of Africa. Customers to these utility companies have to spend very unproductive hours queuing to pay bills in form of cash at the company or correspondent bank branch. We attribute this to an unavailability of alternatives, complexity, vast minimum user requirements to use existing models, for example, ability to maintain an operational bank account, familiarity with mobile banking procedures and general uncertainty surrounding technological innovations. All these have for along time been reasons for not widely subscribing to most existing mobile services.
The collection mechanisms available are, cash or cheque which customers also stand a risk if unpaid, and as a consequence face high charges that may be up to more than half a week's

income [18].

With the existence of telecommunication systems, we believe that the bill distribution and collection mechanism can be improved electronically by involving the telecommunications infrastructure and expert knowledge in methods and methodologies in the field billing, to benefit the Ugandan societies, the telecommunications and the utility companies.

1.3 Objectives

1.3.1 Major Objective

The main objective of this research project was to design an architecture and model, which could be used to Implement a wireless platform for paying utility bills. The implementation was expected to be a subscription free, cost effective, twenty-four hours, pay-as-you-go service, for paying utility bills and make short instant bill inquiries using a mobile phone.

1.3.2 Specific Objectives

1. To investigate factors that may be of concern in implementing and using a complete data channel for information sharing between clients, the telecom company, the financial institution and the utility service provider.
2. To design an SMS based utility payment architecture and emulation model.
3. To test SMS model variables to fit a wireless environment.

1.4 Scope of the Study

The study covered MTN, Stanbic Bank and National Water and Sewerage Cooperation as the key inter-dependent service providers. Assistance was sought from the technical teams in their IT departments of Kampala region only, to obtain information for the SMS handling, basic principles of SMSC behavior in a wireless environment, facts on model designs, server placement, implementation process and the practical viability of the project.

Consultations also covered True-Africa, an authorised SMS broker. An SMS broker is an entity that provides SMS messaging services but is not a mobile network operator.

1.5 Operational and Research Assumptions

This research is primarily based on the following assumptions:

1. Subscribers to the utility service providers at least own a mobile phone handset for convenience purposes, subscribed on any one of the operating telecommunication companies. However, a subscriber can use a borrowed phone, since SIM identity does not matter, though it's also preferred that clients use own numbers to avoid misdirecting feedback to the client through a previousely used SIM ID at a later date.
2. The utility and the telecom companies own operating accounts, preferably in the same bank for convenience.
3. A payment can be made for an existing customer. No description for subscription process but rather subscription advise can be provided online.

1.6 Significance of the Study

The development of a wireless billing SMS model is expected to make the life of a utility-bill payer easy, by creating a direct link to the billing database of the utility company and therefore beneficial in the following ways:

1. The model is in principle expected to positively enhance the payment system for bills from utility companies. For example water, phone and electricity, and provide value for money for distant populations. Walking many kilometers to be able to access a banking service is inconvenient and costly for customers, so saturation of an area with the service is preferable to a wider, thinner distribution [9].
2. Increases service access and reduce customer-response-time. This is particularly helpful to the utility company when it receives timely payments and answer queries in time.

3. No more queuing to pay bills since geographic locality will be irrelevant. Bill transactions will be conducted via SMS anywhere, thus saving customers a lot of money and valuable time spent in banking halls.

4. We also hope that customers on low incomes will find paying bills by SMS, more affordable and quick to implement.

5. This research will presumably set a baseline precedence for improved and electronic billing methodologies in Uganda. Future researchers on this subject will find a better ground to make utility and other bills cleared in the shortest time possible, as our people move closer to electronic commerce on hand held devices.

1.7 Justification of the Project

This mobile billing initiative is a direct response to telecomunications and technological change experienced in Uganda over the past few years. The already existing infrastructure in Uganda has become substantial to accelerate development of electronic commerce and effect trade payments in the shortest time possible. Change is being driven by falling costs of technology, competition and the ability of electronic solutions to offer customers an enhanced range of services at a very low cost. It is also argued that electronic products might be attractive to the poor customers in terms of less cost implication, improved accessibility, affordability and ease of use [9].

Convenience: Customers are becoming more demanding in terms of the level of service they expect and how they are able to access services when required. Demands of greater convenience and accessibility are reflected in longer branch opening hours and therefore the need to increase the choice of delivery mechanisms [31]. Payments are expected to be done anywhere, any time. Results in a research conducted on consumer value segments in mobile bill paying indicate that privacy and efficiency are the most valued item [31].

The increasing cost of leaving in Uganda is playing a significant role in widening the gap between the rich and less fortunate populations. This research is also aimed at reducing unbudgeted for travel expenses that would have otherwise been avoided, in an effort to pay down a utility bill.

Chapter 2

Literature

2.1 Overview

This section covers literature on the various works done by different researchers on the extent to which flexibility and mobility in clearing bills are effectively being realized, effectiveness review and where applicable, a theoretical cover of their models and methodologies. The extent to which they have been relevant to present research billing methodologies as explained by other researchers will be basically outlined.

In their evaluation of the intangible benefits of business intelligence, Marcus *et.al.* explain that, increases in IT expenditure have placed great focus on evaluation processes and techniques, and their effectiveness [14], and as a result, the world of telecommunications especially mobile communications, continues to evolve with innovative technologies and high-speed data services. In many economies, mobile phones have overtaken fixed lines [12].

The availability of village-level public cellular telecommunications services in rural South Africa is now widespread [29], Steve [21], however adds that mobile telecommunications such as voice telephony, SMS, WLAN (wireless local-Area network) technology, and personal digital assistants (PDAs) are being used by broader and broader sections of society, and that it is no longer unusual to see mobile phones being used in a wide variety of contexts. As a result of this increased usage of mobile-phones, there is a small but growing body of research that indicates that the use of mobile communications is influencing how people go about daily lives from both a social and economic perspective [21]. In an article of "The Role of Text Messages", Rettie [25]

urges that the mobile phone creates the opportunity to engage users any time about work issues at home, or about home issues at work [25].

In [23], it's pointed out that mobile commerce and usage of mobiles for marketing activities is incredibly complex, and little is understood or has been proven about how it really works or what influences consumer response and acceptance to use the medium [23]. Micheal [23], states that Bango, a global mobile billing enabler estimates that nearly 87 percent of the mobile content payments are billed to phone.

2.2 Mobile Phone and SMS Applicability

Dave in [10] points out that text messaging (SMS) has captured widespread interest and has an almost ubiquitous accessibility to mobile consumers, thus presenting enormous business opportunities, and presents a new and viable revenue stream. Additionally, Kim [19], explains that all new phones today allow consumers to send and receive text messages and most new handsets today, now come with access to the Internet. This has enabled a number of mobile possibilities in the communications world. Kim [19], further urges that the customers of the bank of America can be able to: check balances, pay bills and transfer money between their accounts all on their mobile phone. However, she recognises the challenges met in this set up of communication and urges that much as there are quite a number of advantages, mobile transactions face challenges as well like;

1. Higher cell phone bills
2. A dropped connection could leave a subscriber wondering whether a transaction was completed or not.
3. A number of viruses that are attacking mobile devices is on the rise making it risky to conduct financial transaction on the mobile phone.
4. Subscriber inability to open up new accounts as this needs face to face or hand written confirmations [19].

Nevertheless, in [20], Kenneth's analysis on the devices for wireless transmission suggests that the over all risk and cost of SMS use to complete transactions while at a distance is quite

advantageous in the following ways:

1. SMS messages can be sent and read at any time without any convenience,
2. SMS messages can be sent to an offline phone and are less disturbing to read while subscriber stays in touch.
3. SMS messages are supported by 100 percent by mobile phones and can be exchanged between different wireless carriers.
4. SMS is a suitable technology for wireless application to build on [20].

2.3 SMS Reliability Cost

In the journal of investigation and conceptual model of SMS marketing, Astrid *et, al.* [11], points out that seven experts identified technical barriers in sending text messages and outlined the following drawbacks. First, a text message may never arrive. The technology for text messages is a "best effort" service; there is no guarantee that the data arrive within the next minute. Two interviewees working for grid operators and four more experts, estimated probability of arrival of a text message on the users active mobile phone as high as 99 percent. A second technical barrier is arrival delays. The text message should arrive a few minutes after sending, but delays of a couple of hours are possible according to the experts. This is a major problem for time sensitive content such as changes in the customer account. Nevertheless, it is urged that SMS marketing can be more cost effective than other media as it's main cost is buying cell phone numbers and handsets [11].

2.4 SMS and the GSM Network Structure

2.4.1 Overview

An SMS uses a store and forward messaging technique and is delivered through SS7 signaling 140 bytes data (160 7 bit characters) from anything that interfaces to a SMSC like a cell phone,

a GSM modem. The GSM short message service provides a connectionless transfer of messages with a low capacity and low time performance [30]

SMS Transmission Architecture in GSMs

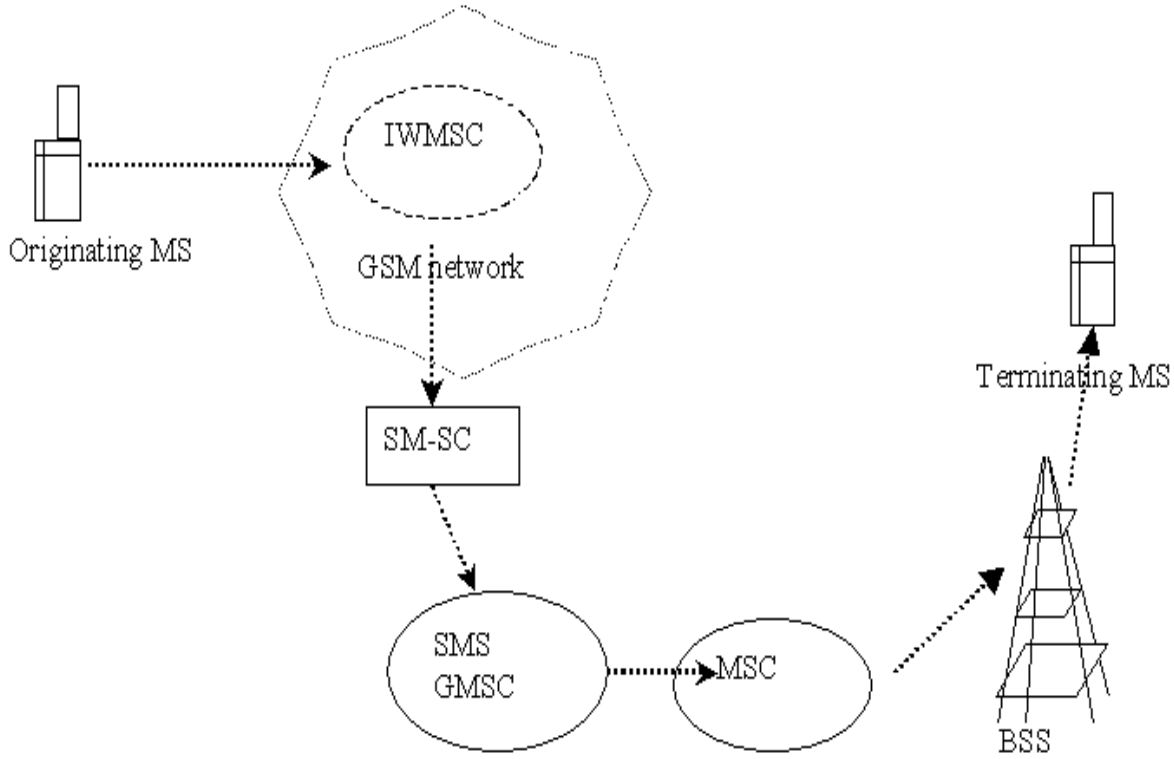

Figure 2.1: SMS and the GSM network support structure [26]

2.4.2 GSM SMS Transmission

The short message is first delivered from the message sender, the MS. The short message-service center (SM-SC) is connected to the GSM network through a specific GSM-MSC called the message service gateway. The message service center may connect to several GSM networks and to several SMS GMSCs in a GSM network. Following the GSM roaming protocol, the

GSM MSC locates the current MSC of the message receiver and forwards the message. The MSC broadcasts the message to the base station systems and base transceiver station page the destination mobile station [26].

2.4.3 The Mobile Station

An SMS traversing a cellular network begins from the mobile station. The mobile station (MS) consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. By inserting the SIM card into another GSM cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services [8].

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI), identifying the subscriber, a secret key for authentication, and other user information. The IMEI and the IMSI are independent, thereby providing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number [8].

2.4.4 The GSM Network

A GSM system has two major components: the fixed installed infrastructure (network) and the mobile stations (MS). The mobile subscribers use the services of the network and communicate over the radio interface.Global System for Mobile (GSM), therefore acts as the information transimission media from sender to receiver thereby enabling communication from one point to another. It is a second generation cellular standard network developed to cater for voice services and data delivery using digital modulation.

The GSM network is a cellular network, each cell being served by a base transciever station (BTS). The GSM base station is basically a radio station. Several base stations are connected to the Base station controller(BSC). The BSC is controlling all the calls in all the connected base stations [8].

2.4.5 The MSC Functionality

Acting as the heart of the network that manages communication between GSM and other networks. It does the call setup function and basic switching, call routing, billing information and collection, mobility management, registration, location updating and inter BSS and inter MSC call handoff. MSC does gateway function while it's customer roams to other network by using home location register(HLR) and VLR.

2.4.6 Base Station Subsystem Functionality

The BSS directly interfaces with the mobile station. It encodes, encrypts, multiplexes, modulates messages and feeds the radio frequency signals to the antenna. Additionally, the BSS does frequency hopping, communicates with mobile station and BSC, manages radio resources for BTS, assigns frequency and time slots for all MS's in it's area, Handles call set up, transcoding and rate adaptation functionality, handover for each MS and communicates with MSC and BTS.

2.5 The Utility Billing System

This system describes an online bill clearing method. The utility billing, access and payment and utility provider consolidated billing system, relates to computerized billing and payment authorisation methods and systems and computerized bill consolidating and payment authorisation methods and systems, with a methodology as described below. The relationship model between the billable and the billing entity is as follows:

1. A database is defined in the host computer. Stored in the said database, is information associated with the client of a utility provider and from whom payment authorisation is to be received. Historical billing data for the said customer is also stored.

2. Received into the host computer regularly, is the billing information from the utility provider pertaining to a customer including the bill amount that the client has to pay.

3. The client is provided with remote billing data via electronic access to the said billing information through some sort of an interface.

4. When the client receives the billing information, he can then authorise the payment.

5. Before client is provided with the billing information, an audit of the data is performed against pre-determined tolerance parameters and determine whether the said billing information satisfies said tolerance parameters

6. Remote electronic access is provided through a remote computer linkable with the said host computer [13].

2.6 Rwanda's Utility Payment System-By SMS Media

This system allows customers throughout Rwanda to pay their utility bills using cash power cards of various denominations produced by SMS media Rwanda. Based on scratch card technology, a consumer will send an SMS message to the electrogaz server with the meter serial number and validation number on scratch the card. They will then receive an SMS message with a 20-digit credit voucher for their bills if the client provided a phone contact [7].

2.6.1 How Rwanda's UPS Works

1. The consumer comes to vendors to purchase electricity and specify the following: Amount to be purchased, the electricity meter number and mobile phone number.

2. Then the vendor sends an SMS to SMS Media short number "123" specifying PIN Code, the consumer meter number, the amount of electricity to be purchased and consumer cell number if any.

3. The transaction is confirmed as complete by an SMS sent to the vendor mobile phone with the 20-PIN voucher; if the client has given in a phone number, the same message is received. If not, the vendor writes the 20-digit PIN voucher on the receipt and hands it over to the client.

2.6.2 Rwanda's UPS and Similarity with the Proposed Model

1. Both models use mobile phones as the prefered payment channel.

2.6.3 Rwanda's UPS and Differences with the Proposed Model

1. The proposed model does not use a prepaid system. This is a very convenient method most especially to the rural poor who may not affort to pay lumpsum deposits.

2. Rwanda's utility payment system uses a 14 digit PIN number that represents the amount of money the client would like to pay while in the proposed model, the amount to be paid is determined and specified by the payer. It must be part of the total credit on the mobile station. This increases customer satisfaction in that clients never fill cheated as a resulted of paying for a service they have not consumed. Client can also decide to pay in phases as long as the indebitedness does not go beyond the acceptable date.

3. In the proposed model, an exact amount can be paid to the service vendor, while in the Rwandas UPS, only a predetermined amount can be sent at a time.

2.7 The mPAY Service

2.7.1 Overview

The mPay service enables clients to various utility companies to pay for quite a number of bills including T.Mobile bills using mobile phones. It is also used to make purchases and as well, for m-banking [30].

2.7.2 How mPay Service Works

1. Client receives a notification message about a due bill and it's amount.

2. When the client wants to pay, a reply message is sent back stating it as; *From: [number] You have received a [service] bill for [date]. The amount is [amount(space)financial institution descriptor]. Due date [date].*

3. As soon as a client replies to the received SMS, The customer receives another SMS requesting customer-specific mPIN number as:
   From: (Destination number) Amount[amount(space)financial institution descriptor]. Bill for (date) [beneficiary company descriptor].

4. The customer appends mPIN to the above message and sends back.

5. By entering client-specific mPIN number, client confirms the transaction against own account from financial institution with whom client and beneficiary company hold accounts.

6. Customer receives an SMS confirming the transaction:

7. Customer receives a success notification as: *From: [destination number] Transaction was successful! Amount [amount(space)financial institution descriptor], bill for [date] [beneficiary company descriptor]. Date: [date]. Confirmation number: 123456. MID: 12345678* [30].

2.7.3 mPay Service and the Proposed Model

The existing mPay system and the proposed model have some working similarities as well as differences. Both models suggest a possibility of completing a bill-clearance transaction by use of mobile phones. The utility company account balance information is sent by SMS to which the customer responds. However in the mPay service, both the client and utility company, hold accounts with a financial institution through which a cash transfer is completed online. By providing a requested personal ID, the client confirms the electronic cash transfer from his account in favor of the utility company. In the proposed model, funds transfer is only from the telecom to the utility company accounts, an amount which is a fraction of the total payments enacted by phone in consideration of the mutual understanding on the cost of service provision to the utility company.

Chapter 3

Methodology

3.1 Overview

MTN Uganda is one of the telecom companies with the widest mobile telecommunications network coverage and a significant number of subscribers. It offers a variety of services on subscriber mobile phones from the services sub menu including; news, forex, gossip, entertainment movies, TV schedules, radio stations, inspiration, financial services Email etc. Paying utility bills by SMS, with the proposed services-menu-item as "BILLS" was to be added onto the existing services list of MTN by the end of implementation stage of this research.

This project proposed a model design of an SMS, which could be used as a means of clearing a utility bill payment. This chapter therefore describes the approaches and methods which were used to design a new Mobile payment model and a tool used to test the model's functionalities. In one aspect, a host system includes a database, in which information associated with a billable entity from which a payment is to be received, is stored.
This section further explores and demonstrates the means and methods that were used to achieve the specific objectives of the study. To a high degree, the model design involved architectural modification of the already existing models and payment methods so as to come up with a complete new design. With help of respondents from the telecom technical teams, with whom we had question and answer sessions, parameters that were used in the correct design of the short message and the model's flow structure were identified. The SMS contains parameters that define it's fixed sequence; including: the account number, the payment amount as a representation of the amount of money a customer would wish to pay, and the company

or message descriptor text. The emulation program was used to confirms the strict application of the above variables.

The SMS design format is very similar to that of commonly used mobile advertising SMSs sent to subscribers, in which a subscriber sends a preformatted SMS to a specified server address. Literature on model design approaches and online or mobile payment methodologies, plus other required information on design and implementation procedures were obtained by the following methods;

1. Reference to the SMS server guides like the Ozeki Server guide
2. Conducting one to one interviews with the technical teams in the MTN IT department (including the productt sales mamnager) and field-work personnel SMS broker companies including Africa on line.
3. SMS billing parameters were got from the domestic bills due for clearance, presented in homes
4. Conducting one to one interviews with the billing and product managers of National Water and Sewerage Corporation

Existing models and relationships between parameters were reviewed, and through modification or otherwise, a new model was generated. It was suggested that implementation on a real wireless platform takes into consideration the existing security guarantees provided by the telecommunication systems in as far as communication by SMS is concerned.

3.2 Current System Study and Analysis (NWSC)

The existing electronic bill payment methodologies are all art and initiations of other service providers including banks and the utility service companies themselves. This is in an attempt to get and retain customers who find electronic clearances an added transactional convenience and of course safe guard themselves from frustrations of the trends of technology. These systems

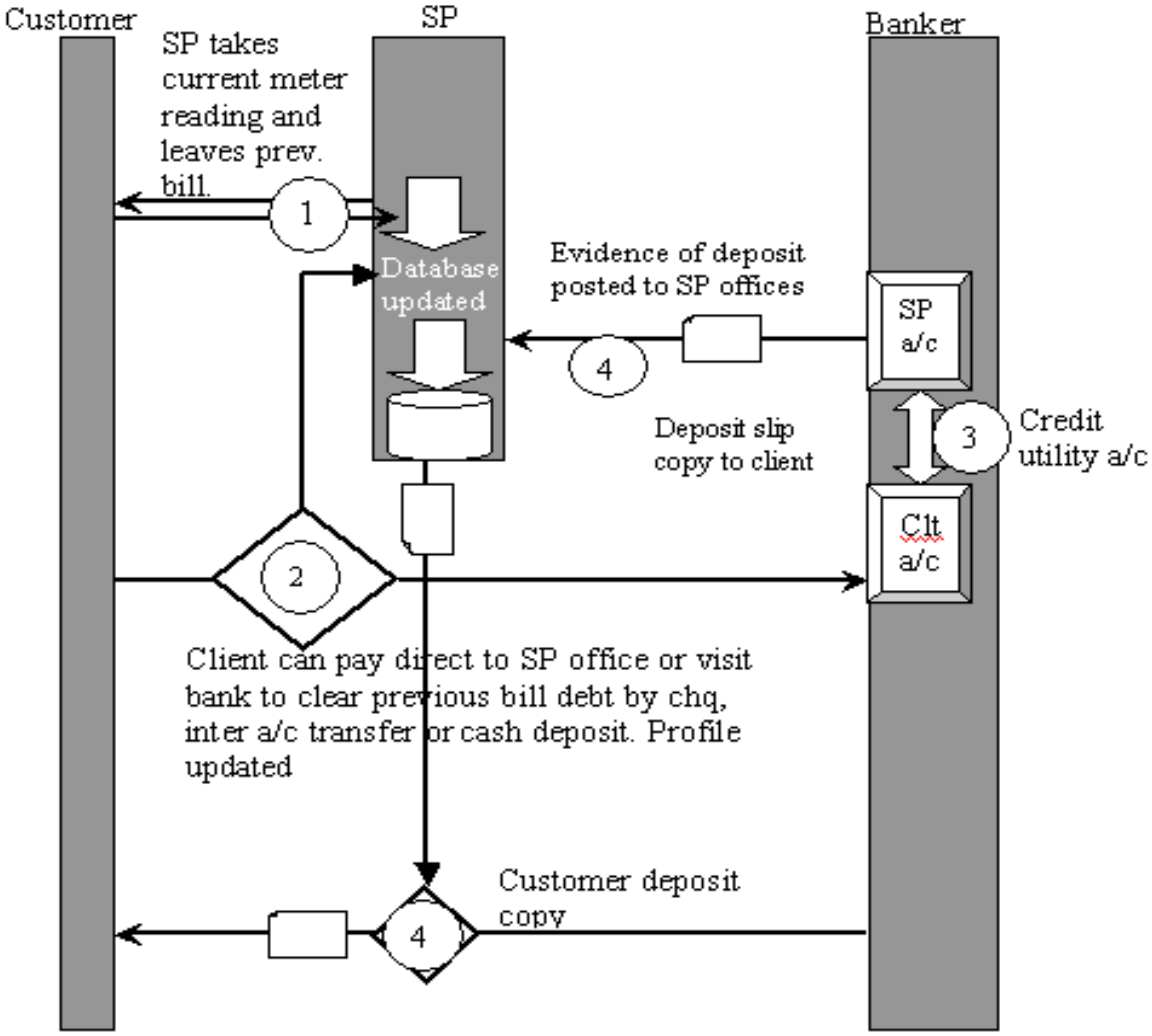

Figure 3.1: Information flow for the paper based model for NWSC

have however not yet attained any substantial popularity. The majority of Ugandans still prefer to use the traditional system in which cash deposits are presented at the regional office counter, or the service providers banker where a carbon copy bank slip is issued as proof of payment.This is attributed to quite a number of reason including less confidence in the use of technology at their disposal. An available method today involves wiring of funds by use of an SMS directed to client's banker but individuals still prefer to carry cash to the banks. At the bank cash is credited to the company account and the bank pay slips delivered to the company for reconciliation and confirmation purposes. Ideally, the banks act as cash collection agents, which can possibly suffer a loss on behalf of the utility company due to wrongly conducted transactions. Customer information is continuously updated and maintained at the utility

company database to manage customer inquiries locally. The inefficiency of this kind of system is that, at any one point in time, the customer has always used more than what both the consumer and the service provider are aware of. Much as the consumer is in position to know the current number of units used at any one time, computing the total current cost may not be known.

National water of Uganda uses a manual methodology to both collect and update it's clients profiles. Figure 3.1 shows the processes of it's payment model, which explains a rather comprehensive method although too paper based. Bill clearance is mainly a four steps process to updating of individual profiles.

Step one
The service provider travels to the client premises, takes the current meter reading and leaves a bill charge-sheet that relates to the previous reading. In essence, if the billing was done monthly, the client would be responding to a utility charge of a month before the previous month. In the proposed system, the service provider travels to the client premises and using the administrator's and INQNW functions, the client balance details can be upated and accessed immediately. So the client would be responding to the most recent outstanding bill.

Step two
The client can optionally travel to the nearest Service Provider (SP) offices where the subscriber account is updated directly, or enact payment from a bank, a correspondent of the utility company. Personalised payslips are filled and presented to the bank counter. Clients who own accounts with the same bank, do not necessarily carry cash as their accounts are directly debited in favor of the service provider. The bank is tasked with collecting together and sending all presented payslips to the utility company for database updating.

In a wireless enviroment, payment procedures and processes are reduced to a single SMS. No travel expences are incurred by clients, neither are any bank charges. From the client premises, a direct payment from a mobile phone using loaded airtime, can made to the utility company through a telecom company.

Step three
Inter account transfers are simply transacted for clients whose accounts are domiciled in the correspondent bank by debiting the client's account and crediting the utility account (a/c) as

explained in step two, while in the proposed model, a clients account at the utility server is credited with the paid amount and debited by the consumed cost of service.

Step four
In both options in step 2 and 3, the client is given a pay voucher indicating evidence of payment for the specified amount. Step 4 is the final evidence to reduction of the client's balance brought forward that would appear on the billsheet on the next billing process.

Contrary, a payment made using the proposed SMS model activates an automatic message that includes the client indebitedness status, date after which action may be taken or whether the client's balance reading is currently positive. This message note would act as post payment evidence in this wireless enviroment where clarity may need to be sought in future. Although the shortfall with such a message is ability to maintain messages on a mobile phone, it can be decided that a message responce is only useful within a period of two month.

In contrast, according to [13], in Gerry's Invention for Modernized Billing, the billing information is consolidated and made available electronically through a utility database, to which access, is initiated by the customer. Preferably the systems and methodologies of the invention are implemented in connection with the multiple user computer networks such as the Internet.

3.3 Proposed System Design Process

Figure 3.2, which is restricted to customer functions for paying and inquiry sequences as in step two of this section, shows the proposed model's conceptual processes and program diagramatic engineering between the key participating companies, namely: the customer, a telecom company (MTN), a utility company (National Water) and a financial institution (Stanbic Bank).

Step one
A subscriber to a utility company loads airtime to mobile station. Conceptually, it is assumed that the money is credited to the telecom company account directly. This marks the first stage of the payment process in which cash belonging to the utility company, shifts from client to telecom company.

Step two

Optionally, the subscriber can inquire on the outstanding amount from the utility company client database server, specifying the account number and a balance indicator. The SMS is sent to the SMSC of the telecom company which directs a copy to the SMS server of the utility company. This inquiry too, has a pre-formatted SMS sequence outline of a fixed length, depending on utility company applicable variables. The following format was applied to cater for balance inquiries for national water.

COMPANY ID(space)ACCOUNT No(space)BAL; written as INQNW ACCOUNT-No. BAL
However, it was decided that the format for general inquiries be written as that for balance inquiries excluding a BAL indicator or replacing BAL with an inquiry string of maximum length one hundred characters.For example INQNW ACCOUNT-No. 'what happened to my connection?'

Step three
On inquiry, the utility SMS server auto responds to the subscriber with the outstanding balance as at date when the last meter reading was loaded into the utility database. Uploading of a meter reading automatically updates the balances field, the previous meter reading value and the date the bill must have been paid.

Step four
Following step two above, in a pre formated SMS, a client specifies an amount of own choice to be deducted from phone credit balance. This SMS definition sent to the SMSC is directed to the relevant server based on the SMS descriptor and address used. The SMS is decoded at the SMSC such that the amount to be paid, the account number and descriptor differentiating the messages by purpose, are determined and details maintained. A comparison request is sent to the utility server to determine the existence of the specified client variables. For an existing account, the payment is confirmed and dropped for a non confirmed or inexistent account. An error message is returned to user indicating an un found account error.

PAYNW(space)YYYYY(space)ZZZZZZZ as PAYNW ACCOUNT-No AMOUNT

Step five
On executing step four above, the subscriber receives a confirmation message on successful forwarding and receiving of the SMS into the utility server. Every successfully sent SMS is expected to cause an auto receipt confirmation that is sent back to the originating SIM number.

This acts as a post confirmation that the payment was confirmed sent and registered and the current outstanding balance. Any other subsequent communication or additional communication to the SMS sender, is not instant as some inquires may be investigatory and therefore need an administrator to intervene manually.

Step six
The SMS log at the telecom company and the SMS log at the utility company server are reconciled and compared. The number of paying SMSs and the amount implied there in, is computed for a specified time period. It was suggested that the cost of delivering this service be a percentage of the funds collected or as may be agreed upon by the two cooperating parties, the telecom and the utility company.

Step seven/eight/nine
Cash transfer from telecom company to utility company account is effected upon agreement, and this can be accomplished using the Internet banking service in Stanbic Bank, by cheque or with a transfer request.

3.3.1 Consideration of Type of SMS

According to [5], there are two types of SMS messages that are associated with premium billing; the mobile originated SMS message where a message is sent from a mobile phone to the service provider, and the mobile terminated message where a message is sent from the service provider to the mobile phone, all of which a service provider encodes a price to the message. In this project, both types of messages will be used since investigatory messages of the inquiry type as described in Section 3.2 need manual intervention. The mobile terminated messages however, do not necessarily have a specific format and are taken as ordinary messages.

3.3.2 SMS Variable Considerations

To test the conditions upon which the application of the architecture in figure 3.1 could work effectively, an emulation program was written assuming a real life wireless environment. This consisted of a text messaging server depicting a mobile equipment, a telecom SMSC to which various servers could be connected, serving as decoders for various SMS services, and a utility

SMS server. This is the end point of the payment process where client database details are maintained, retrieved and updated.

The servers took into consideration, the operating principles and variables of the existing system. These included, account numbers, property numbers or IDs that uniquely identify a subscriber, and assumed a fixed length string or numeric representation of various constants and variables as used in the utility company. For example, all account numbers for clients of national water are five characters in length.

3.3.3 The SMS Descriptor String

PAYNW*(followed by a single space)* can be a word or an abbreviation of a company's choice. It was described as a unique word that can be used to identify destination of the message by purpose or destination. This is selected based on whether it suitably represents the organisation and reflects the purpose. An example of an SMS descriptor used today in Uganda with MTN is the M2U's "GIVE", used to transfer funds from one source SIMID to one destination SIMID specified in the message. For the case of National water, the researcher adopted a five character variable as "PAYNW" for demonstration purposes.

Written as "GIVE 0771234567 3000", the M2U process transfers credit worth 3000 from message originating SIM to the SIM whose ID is specified in the format. On arrival at the SMSC, message decoder identifies message beginning with a 'GIVE' string while satisfying conditions of the next two variables, diverts it to a standby server which decodes off the beneficiary/destination SIM address and the amount. The server interpretes a set of commands that involve debiting sender SIMID and crediting receiver SIMID. The standby server sends a reply command to the switch, which in turn informs recipient as having been given credit by message originating SIMID.

3.3.4 The Account Number String Considerations

From step four of section 3.2, YYYYY*(followed by a single space)* represents the customer account number and a fixed numeric variable of five characters for the case of national water. It is a unique personal identity for each customer and is used to identify or locate subscriber data and against which payments are made. The number and size of client variable was left un

changed so as to avoid diversification with many aspects of the existing system. There should be as many active account numbers in the system as there are registered subscribers.

3.3.5 The Billable Amount

Bill amount represented as "ZZZZZZZZ" is the amount of money a client is indebted or is willing to pay to the utility company as the cost of utilities consumed. This amount is expected to be paid off directly from credit loaded onto the subscriber's mobile phone, by sending a message indicating a billable amount whose value can be less than loaded credit by the cost of an SMS. A sent SMS causes a message decoding module to execute, reading off the values in the variables for use in the search and implementation process. This runs causing deduction of funds equal to "AMOUNT" from the sender mobile station in favor of the utility company.

3.3.6 Model Architectural Considerations and Obejectives

Since programming this concept on a real wireless platform for educational purposes seemed unsuccessful to achieve from an a willing telecom operator, it was decided that to make up a conclusive emulation of a wireless environment where use of a mobile phone to pay bills is depicted, the following concepts must test successfully:

1. Non substitution of a chosen SMS descriptor. No other descriptor should work other than the chosen one even if all other variables were input correct.
2. Non substitution of the chosen SMS format sequence.
3. Reduction of credit balance by an amount equal to ZZZZZZ, plus value of the SMS charge
4. System ability to respond to balance inquiries automatically when a definite sequence was used
5. System ability to update client records in case of a payment order.

To archive the above restrictions, the program was written following a process flow with a diagrammatic illustration as in figure 3.1.

Following numbers marked by 1-8, step one explains exchange of cash from clients to the telecom company. The client takes an air time serial card loadable on a mobile phone and tops up phone credit. In step two, an inquiry message is sent to the utility company server through the SMSC decorders which accepts or rejects the message depending on the server requirements to use the wireless option. These requirements include, sender's credit balance as sufficient, message destination address, correctness of the message format etc. Part three represents a responce from the utility server with the balance figure and the message sent date.

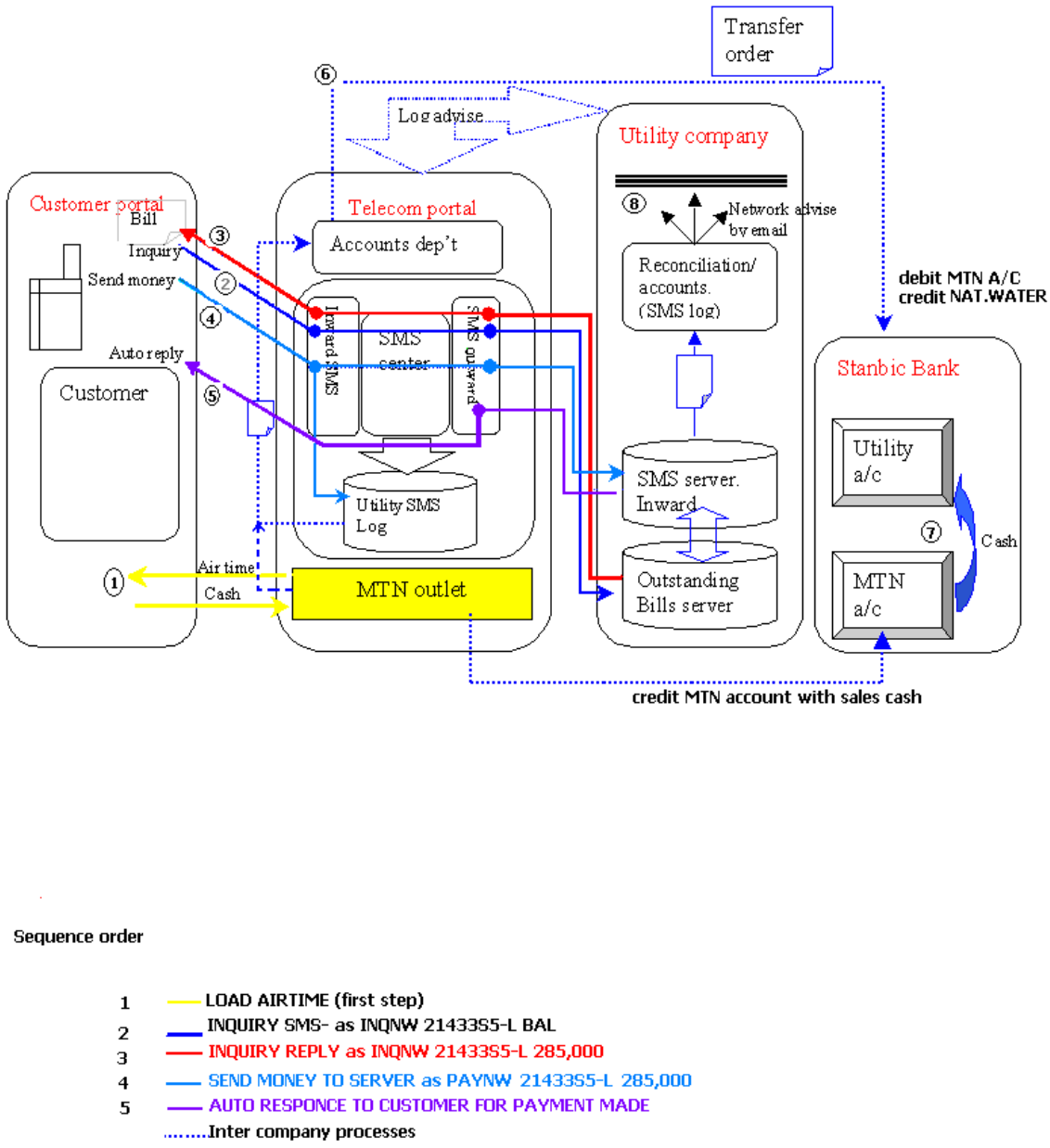

Figure 3.2: The program architecture

This stage is optional as the client can otherwise pay directly to the compay without first inquiring. In Step four, the client sends a preformated message to the utility server. This action, activates telecom decorders for this particular service and minmum requirements are tested at the telecom server. Also, the client credit is reduced by the indicated pay amount. The message is then forwarded to the utility server at which client search for the specified account number is done and details includidng the balance and the expirely date updated. In step five, the client receives an automatic message as future proof of payement indicating whether the client is still indebited to the utility company or otherwise. After a time period after which considerable payments have been made, a reconciliation between the telecom and the utility server is done for all payments and a cash transfer request signed, allowing an inter account transfer in favor of the utility server. In Step seven, the actual money transfer is effected. To have a cordinated system with interbranch operations, an E.mail is sent to confirm payments made to all branches of that region,(part eight).

The SMS server inward in the utility company is a combination of two databases, namely: the inquiries and payments databases. However a single interface is used to access both databases. Interlinking both databases enables access to client data, for example balances to be accessed and displayed in the message pane.

3.4 Design Tools

The design process required possesion of a laptop computer. The model principles were studied by designing a computer program which emulated a wireless enviroment. Home bill sheets for national water were also required to study the client variables and constants taken into consideration and principles of utility charges applied.

Chapter 4

Presentation and Discussion of Results

4.1 Overview

The mobile billing methodology model was based on the information obtained from the review of the different methodologies and criteria used for other purposes with rather quite different functionalities but having common operational principles. These included the Me2U for air time sharing, Rwanda's utility payment system methodology. Also quite useful was the expert knowledge that was provided by the IT consultants in MTN and True Africa with whom we had group discussions. It was concluded that the payment process ought to be much more related to principles of today's SMS advertising and to illustrate the concepts of the proposed model, a program was written.

4.2 The Phone Server

Figure 4.1 shows the mobile equipment software interface with text messaging functionalities including the ability to change SIM identity. On the text editor, is a payment procedure. As a text messaging equipment, the mobile server can be loaded with an air time amount against a specified phone number under the Settings/Hide menu item. Depending on the SMSC server settings for a particular connected service, an amount specified in the message and the cost of service are deducted off the credit balance, and the specified amount credited onto the client's specified account number when the message is received at the utility server. As an emulation of a mobile phone, the phone server originates the transaction and receives all

message correspondences.

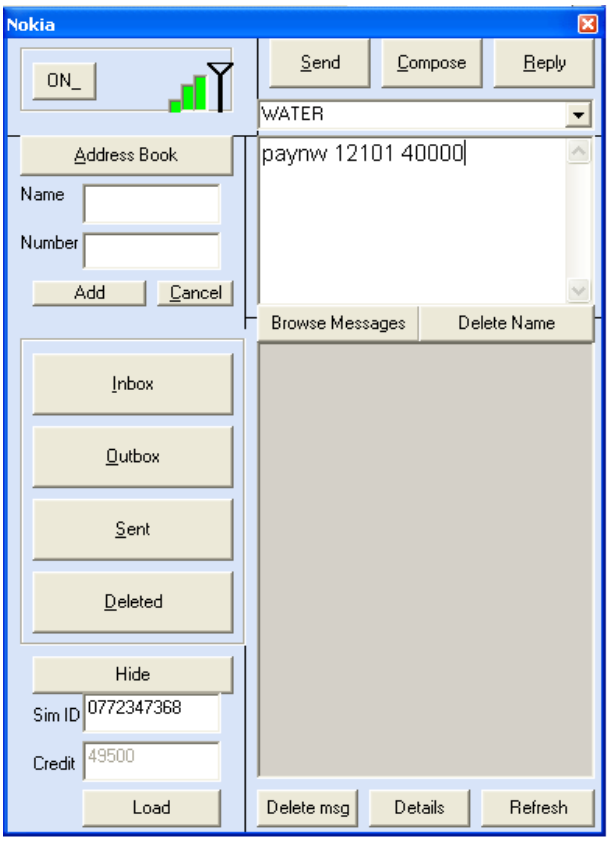

Figure 4.1: Text messaging Server-Mobile Phone

4.3 The SMSC Server

The short message service center in this model is a database of a collection of all short messages sent by subscribers and was set up with the following capabilities; Ability to accumulate all messages in their order of arrival, detailed with the originating number, destination address, the message body, arrival and sent time of the message. Ability to limit changes on the message or it's attributes with an administrative password. Also settings of per-message charges, acceptance rules and incoming SMS logs are maintained at the SMSC. The SMSC is also a connection point for various SMS decoders. In this project, three decoder servers have been attached to the SMSC namely: NWSC, POWER and PHONE. The general MTN server comprises of the SMS database with the general and server-specific messages.

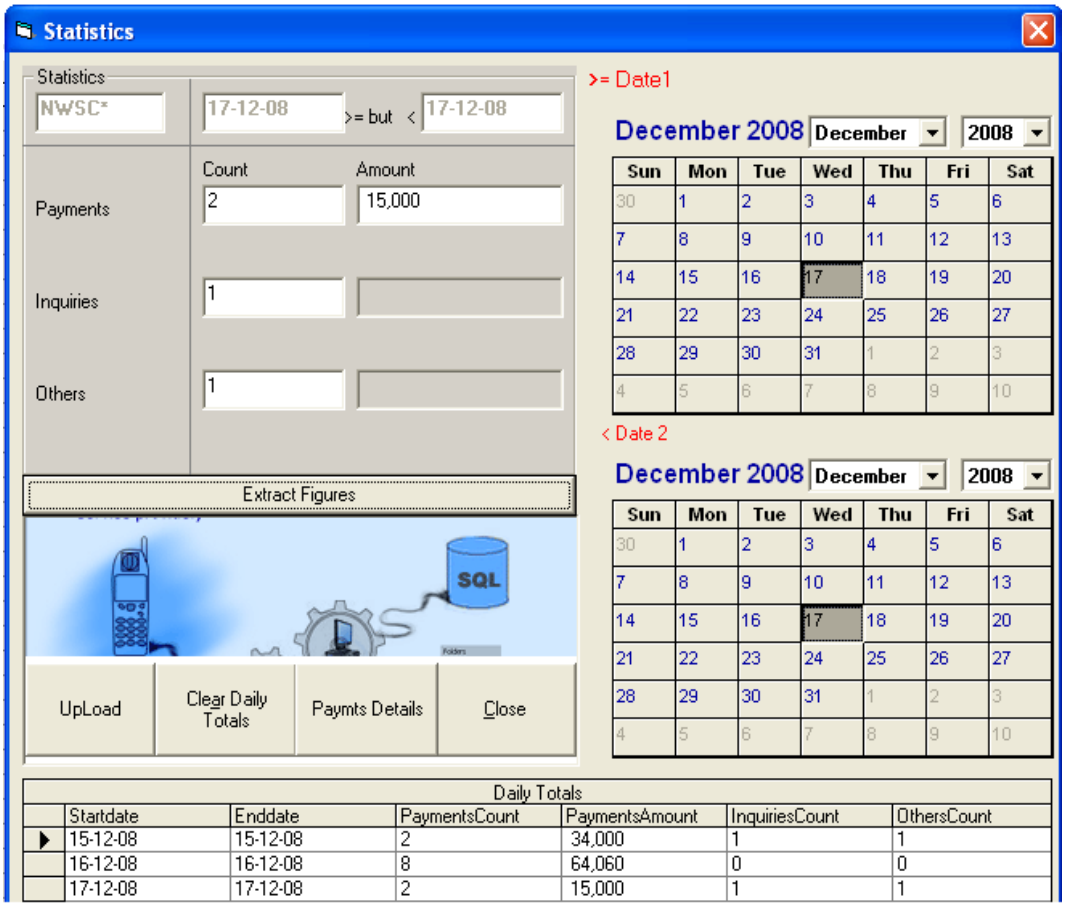

Figure 4.2: Uploading SMS statistics for a given period

The right most pane of the SMSC window is a summery of server specific information. The decoder of the selected server filters and decodes SMSs into the following programmatically usable components: date, sender address, account, amount, message descriptor, message arrival time and time sent as shown in figure 4.3

To maintain payment statistics over a specified period of time, figure 4.2 shows the basic functions of the data management functions for upload.

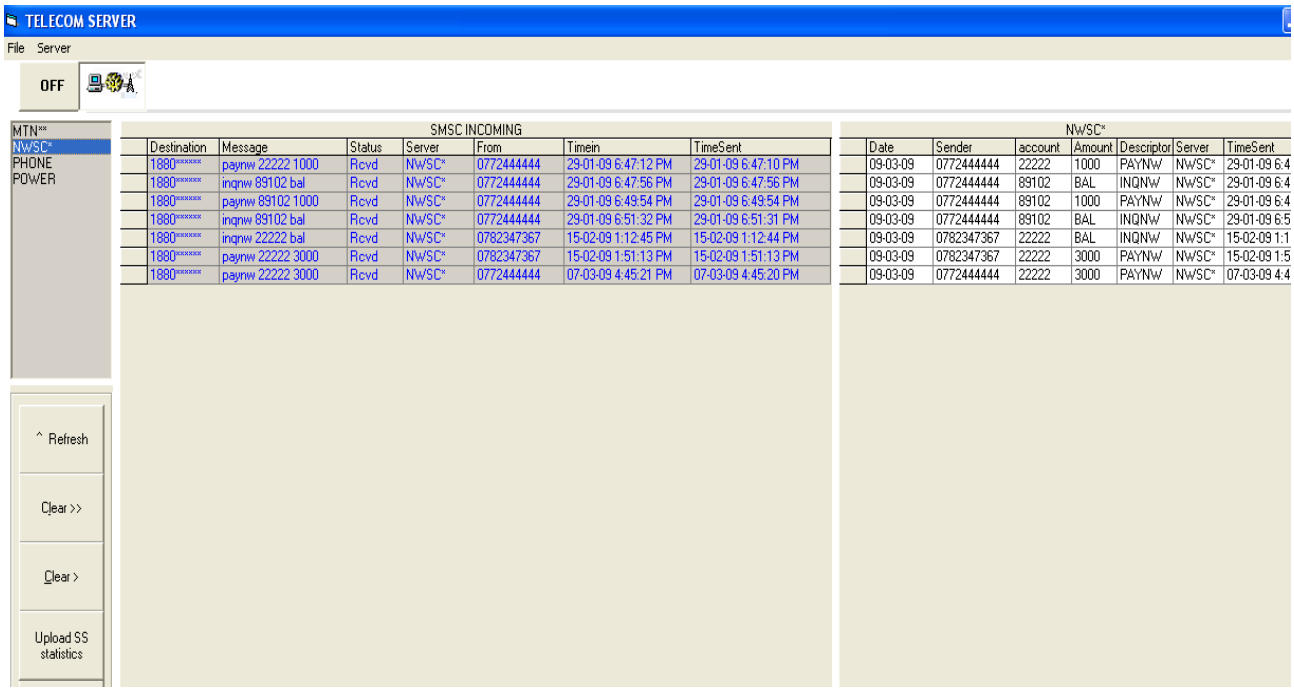

Figure 4.3: The SMSC server window

4.4 Utility Server

The utility server has the following capabilities: Under the file menu item; a client database window shows all clients of the utility company. An online-payments window showing payments made from phones by clients, inquiries, upload data (a summery of payments between two dates) and a list of remote updates which administrators/field workers initiate from the field. Others include a text messaging facility to manage correspondences to clients, a facility to post bills manually, a facility to adjust the cost of service settings as in figure 4.4, plus a locations table. The locations table shows the available locations by zone or village, region and districts in areas of operation.

The utility server is the end point of all server specific messages. In this regard, the utility server receives all decoded messages destined to the NWSC server as shown in figure 5.5, and automatically updates client accounts and sends a post payment confirmation for paying SMSs.

The utility server comprises primarily of client inquiries, paying messages and functionalities to manage responses to client.

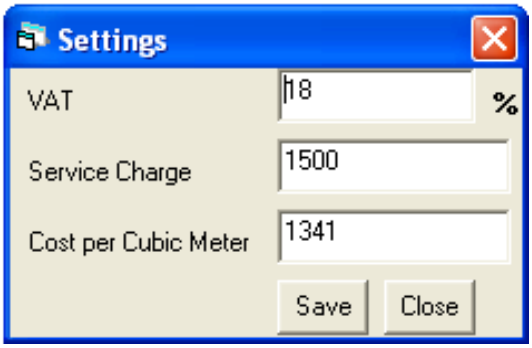

Figure 4.4: Showing adjustable constituents of cost of service

It has the following main databases: The client locations database, the online payments database and a clients details database.

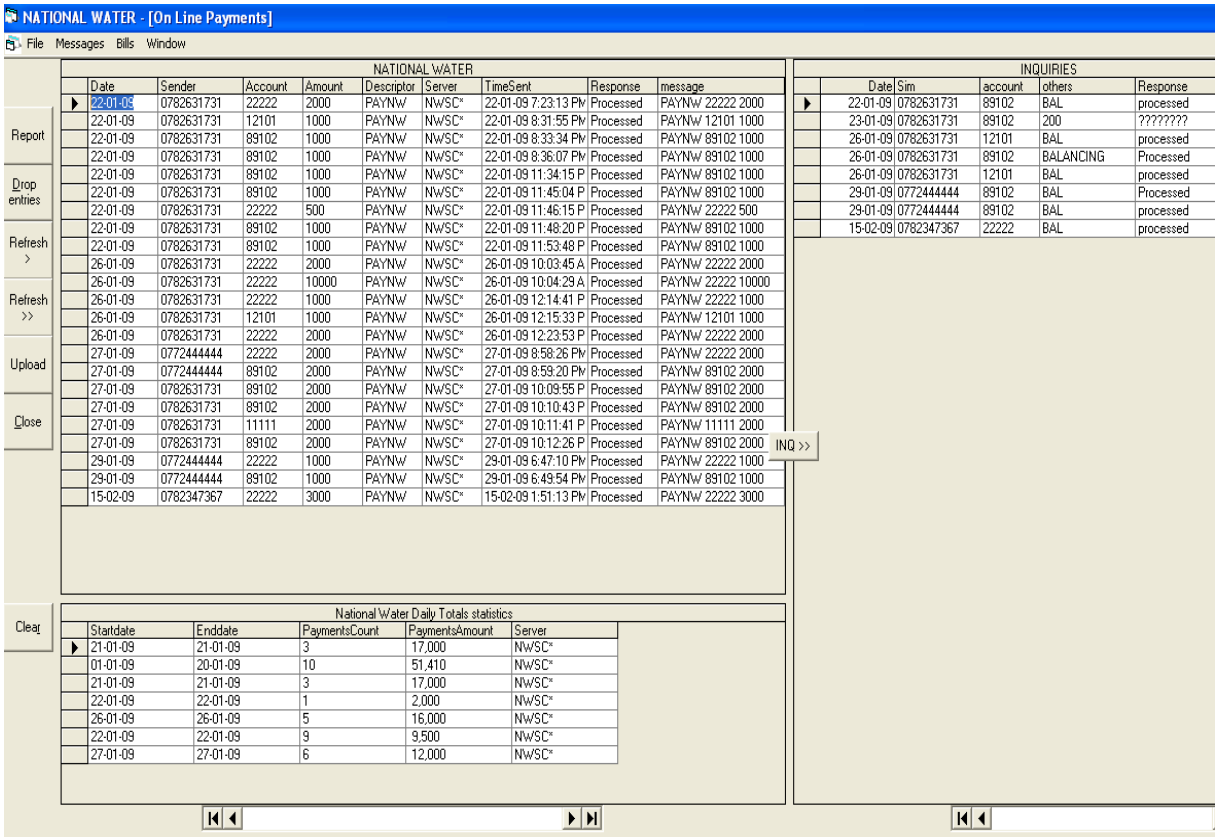

Figure 4.5: The Utility Server Window

The online payments database is a collection of all messages whose first string indicates a payment effected. From file, the online payments menu item activates a window of payments,

client inquiries, administrator field updates and a summery of payments between a two specified dates.

The client details database comprises of all national water clients. Figure 4.7 shows specific fields of the database including the outstanding client balance.

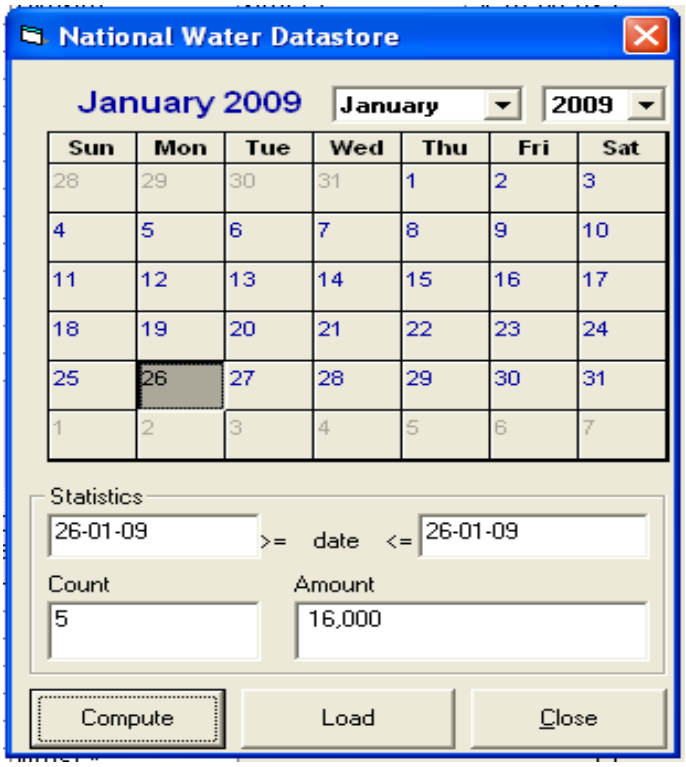

Figure 4.6: Window Showing Data Upload Functions

The composition of clients details is a collection of variables that are used to individually identify clients. As depicted from bills presented at home, clients are identified by the following variables among others: Customer number - This is a five character string. In this model, it was assumed that all client accounts are five characters long and anything that differed would be treated as invalid returning an *Account Not Found Error*. From the general SMSC server settings in figure 4.12, under sequence, the acceptable account number length is dictated by the length of "XXXXX". On addition to the client account, every client has a unique property number. This relates to the clients premises and is an eleven string character. The property number variable in this project was taken as reflected on the bill sheet and not used to

programmatically or uniquely identify clients since the customer number is a direct substitute of the property number.

NATIONAL WATER - [Client accounts]

Accounts

	CustomerNo	PropertyNo	Client	Balance	MeterSerial	location	Contact	ChargeBasis	As at Date	PMR	MR	Exp date
▶	89102	9/18/245(4)	ASUMAN N	-10739.04	ARAP/P-05-154310	KANYANYA	0772111111	METERED DOMESTIC	23-01-09	16	18	22-02-09
	12101	7/18/235(8)	KAGINGO UMAR	-27045.7	ARAP/S-67-111211	NALUMUNYE	0772347367	METERED DOMESTIC	27-01-09	6	15	26-02-09
	22221	7/43/434(0)	MUKWANO INDUSTRIES-MUI	-25505.7	ARAP/I-98-123451	KIBULI	0772333333	METERED INDUSTRIAL	23-01-09	18	33	22-02-09
	76543	7/43/774(7)	STANBIC BANK	-14616.66	ARAP/I-00-127651	MAKERERE	0772444444	METERED BUSINESS	21-01-09	5	7	11-02-09
	11111	9/18/444(8)	MAKERERE UNIVERSITY IT	1065.24	ARAP/2-77-321455	MAKERERE	0772555555	METERED BUSNESS	14-01-09		2	11-02-09
	22222	8/33/245(4)	FACULTY OF IT	10778.1	ARAP/M-88-321677	MAKERERE	0772666666	METERED	23-01-09	3	5	22-02-09

Figure 4.7: Window showing a composition of client details

The client name - This is a string describing identity of ownership. specification of an account number must necessarily tally with the correspondent property number but not the name given that ownership can change or be similar to another set of details.

Balance - This numeric column comprises of client's outstanding balances as at date specified in the *As-At-Date* data column. A negative balance figure shows how much money the client owes the utility company and depending on the amount or "As-At-date" column, the client account is listed on the defaulter list.

PMR - This column contains the most recent meter readings just before the most recent reading in the MR column. The meter reading is the display number on the meter at the time of physical visit to the client premises.

4.5 Computing the Cost of Service

The total cost of service is the sum of VAT and a product of the difference between the previous and the current meter readings and the per unit cost of the service; measured in cubic meters. From figure 4.4 both VAT and per unit cost of service can be pre set.

4.6 Post Payment Evidence

To pay a bill, the message in the text editor of figure 4.1 is sent to a specified destination address, represented by water on the addresses list.

On payment, the client is updated with the outstanding balance. This is an automatic message generated by the utility server to the client as a confirmation for successfully updating the client's balance.Figure 4.8 shows the format of such a response, that can be used as future evidence of a payment made incase of doubt.

The message comprises of the three sections namely; a text message, the outstanding balance indicator and a deadline date before which the client should have paid. Failure to comply by the expiry date, the client's contact number is included on the defaulter's list and will there after receive all defaulter messages that may include disconnection warnings.

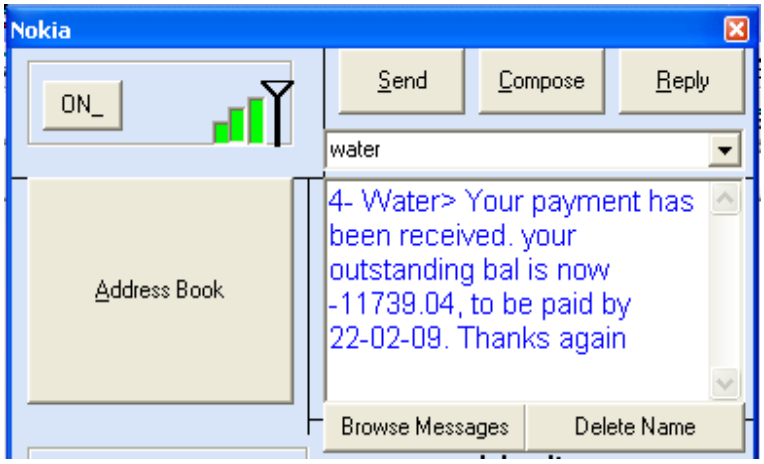

Figure 4.8: Automatic response to a successful payment

4.7 SMS Parameters and Payments Procedure

The SMS format comprised of three string variables with alpha numeric characteristics, namely company identifier (descriptor), customer account number and the amount of money the subscriber intends to send to the utility company. The contact telephone was automatically included as the message-originating ID when an SMS was sent. The pay amount, a fraction of air

time outstanding onto a subscriber's mobile phone was directed to the utility server specified in the destination address for the SMS. The credit transfer from subscriber mobile was expected to take advantage of the existing Me-To-You module on a real wireless platform.

MTN's Products and Solutions customer service center manager commented that the SMS size and composition could remain subject to change as it could be necessary in future to accommodate more functionality to the model and enhance efficiency in terms of SMS data management. e.g. analysis of incoming SMSs with different functionalities could depend on the SMS descriptor provided. It was also pointed out that future efficiency requirement can be dictated by future server system demands like changes in server software or even hardware. The size and order of the message format were to remain of fixed length (with respect to a particular decoding server), with the exception of the last string, which represents the amount in the case of the NWSC's SMS decoder server. The decoding process was accomplished by the code extract in Figure 4.9

4.8 The SMS Decoder Module

From Figure 4.9, the *msgleft*, that is, left most part of the sent string, is the descriptor string that must match the server address settings to which the message was sent. Depending on the nature of *msgright*, the credit is reduced for a numeric and message rejected for a non numeric *msgright*.
msgmid, is an extract of the account number, or the unique subscriber identifier that is used to identify return values from the utility server databases or ensure accurate data updating.

```
messagein = Trim(telecomserver.datserverlist.Recordset!message)

msgleft = Left(messagein, (InStr(1, messagein, " ")) - 1)

msgmid = (Mid(messagein, ((Len(msgleft)) + 2), ((InStr(((Len(msgleft)) + 2), messagein, " ")) - ((Len(msgleft)) + 2))))

msgright = Mid(messagein, (Len(msgleft + msgmid)) + 3, (Len(messagein)))
```

Figure 4.9: Module showing the decoder function for splitting text

Given the length of the whole string, the account number starts at length of *msgleft* plus two, and ends when a second occurrence of a space is detected. In the event that two or more spaces are inserted after *msgleft*, *msgmid* returns an empty account, the format becomes unapplicable and the message is rejected by returning a message format error.

msgright represents the amount of money a subscriber intends to pay to the service provider and can be any amount as long as it's less than the current credit on the mobile equipment by the cost of the SMS and greater than zero.

4.9 Managing Correspondences

To reduce system human interventions, an inquiry sent with a case insensitive *msgright* as "BAL" triggered off a database-search for balance and latest updates on client details pertaining to indebtedness with help of the values in *msgleft*, *msgmid* and *msgright*. If successful, an auto message is generated and sent to the originating SIM ID as "89 - Water: National Water: Your bal is -259500; As at 10-12-08. Recvd on 08-01-09". Numbers 1 to 5 from figure 4.10, show the composition of the SMS auto reply. 1 indicates the SIM ID of the message sender. In this case, the emulation program was configured to show "Water" for national water. 2, 3 and 4 constitute the complete message, however 3 indicates an unformatted figure representing an amount as the currently outstanding balance from the balances database. 4 is the date when the balances database was last updated for that particular account. Finally, 5 indicates the date when the reply message was sent back. This date should ideally be the send date of the inquiry, however non *msgright* equal to "BAL", inquiries may necessitate investigations that may cause a difference in send and reply dates.

4.10 Field Administrators Function

The field administrators function enables field workers to update the balance and sent date (identified as "As at date") fields of a particular record in the utility clients database remotely.

The utility database is a collection of all client accounts combined with the general client profile per record. The administrator's function replaces a manual system of data entry at the central

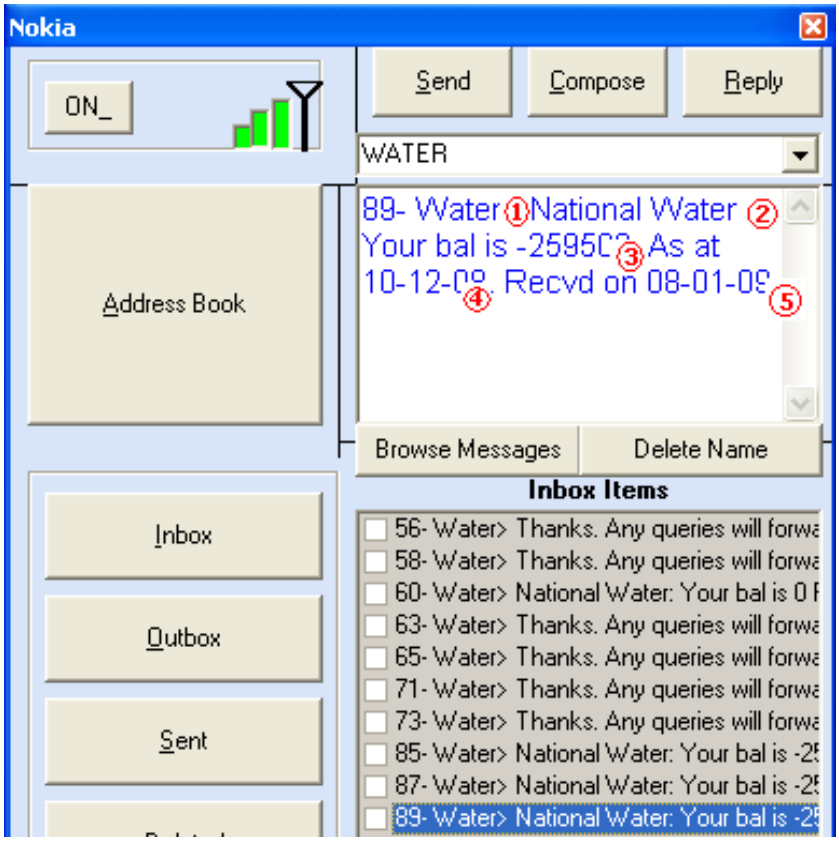

Figure 4.10: Format of response for a balance inquiry with rightmost string as "BAL"

offices, where meter readings from the field are collected and entered into various regional computers. However, this function may be costly if each single update is charged by the telecom company. Figure 4.11 below shows how to use the function of the administrative sequence to accomplish remote updating. Administrator descriptor as marked by (1), is used to identify administrator variables like the cost of sending administrative data to the head office and is also an identifying string that enables the update of client balances remotely. Part (2) of the sequence specifies the client account number, and part (3) is the current meter reading as read from the client premises.

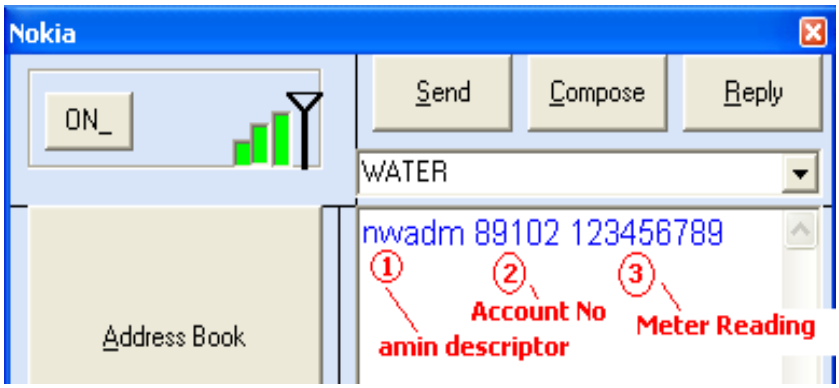

Figure 4.11: Updating the outstandings database from the field

4.11 Utility to Client Interaction

Any sent inquiries whose rightmost string was not BAL was assumed investigatory by the system and awaited user interaction with the server. On arrival, this type of inquiry was tagged with "???????" indicating a pending inquiry. Shown as (1) in figure 4.13. The same figure shows three stages to accomplish a manual reply. On double clicking a particular record, the inset window marked as (2) for text messaging, appears with account and destination address in the 'Account' and 'To' fields respectively. By clicking details, the text editor is automatically filled with other client details as in (3), including the outstanding balance upon which investigations can be based. The Send function sends the response to indicated SIM ID

4.12 SMSC Servers Settings

From the Add server menu item on the SMSC window, new server settings can be added, deleted or altered. The success of message deliveries depends on SMSC server settings. The SMSC is the central point of attachment for all servers with different routing and decoding functionalities. Generally, the SMSC contains rules that will apply, depending on the rules of the attached server, when none ordinary SMSs are sent . Figure 4.12 below shows attached server settings for national water and sewerage cooperation. As a differentiating factor, it was assumed that the number of characters of every address of an attached server, be at least one but less than ten characters which represents a count of an ordinary subscriber number. Taking ten as the maximum number of character an ordinary number can have, server addresses are therefore made ordinary in character count by appending to the inserted address, a *, as shown

in the address field of figure 4.12.

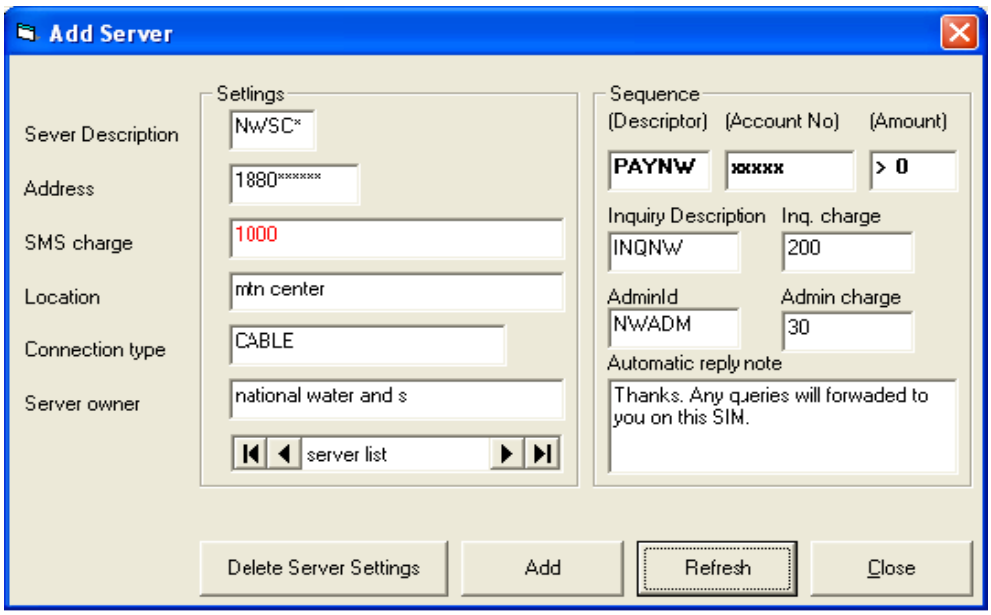

Figure 4.12: SMSC general server settings

4.13 Data Security and Ownership

The GSM system provides solutions to a few important aspects of security: subscriber authentication, subscriber identity, confidentiality of voice and data over the radio path. The user information such as short messages, is transferred in a connectionless packet mode over a signaling channel [8]. In addition to the above constraints, this section explains the measures that were put in place to ensure security of client data at specific end servers.

Although this project assumes specific ownership of a mobile equipment, their are no resultant limitations to this, as third parties can effect payments on behalf of away friends and families. Also, flexibility of the model dictates that a client can use a friends mobile phone to make a transaction. Nevertheless, all immediate communication to any effect, are directed to the originating SIM number, and later communication is directed to contact number attached to client profile. This may result into inefficiencies in information dissemination. Apart from software hardening and the existing data security measures on individual telecom platforms, network security provisions were considered as ultimate during SMS transmission.

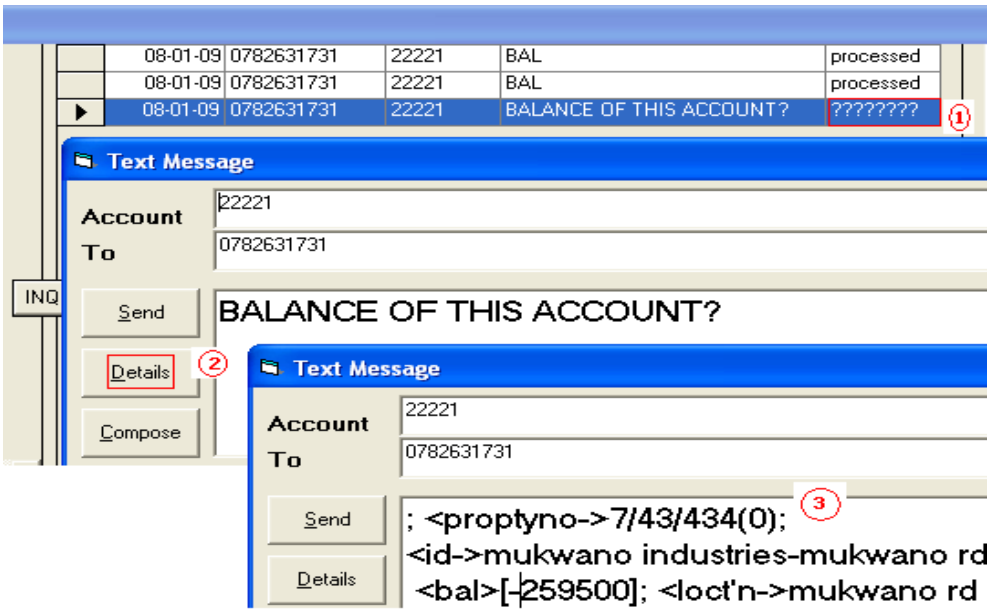

Figure 4.13: Interaction with the utility server for non 'BAL' inquiries

4.13.1 Security by Design

Despite limited time and resources to accomplish this project, little time was vested in investigations for possible security measures that can be integrated into the message format to ensure client data is at all times authentic and accessible by the real owner. However, since the system does not involve alteration of client records remotely, it is not expected that personal information can be altered for selfish purposes. Any changes must be accompanied by a confirmation signature by the client in hard copy form.

The purchase of air time ordinarily allows safe exchange of cash from one client to telecom company. By this method, it is expected that a hundred percent of banking errors or delays in service are avoided.

4.13.2 SMS Routing, Security and Business Liability

Two possibilities to accomplish routing on an actual wireless platform were provided. One to one discussions with a senior programmer in True Africa suggested that, routing of such an

SMS could be done either at the telecommunications service provider to the utility company SMS server, or an SMS broker assumes responsibility and legal/technical liability to conduct a function of routing and managing all such SMSs destined to a particular server. However the former alternative was said to be quite expensive if server equipment was purchased to serve one client or entity. In this project, no assumption of SMS brokers was made. The SMSC was programmed to do the SMS routing to the destination servers. A copy of the SMS was generated and forwarded to the utility server, such that any alteration of information at the SMSC, does not alter the original data in the recipient database. Secondly, any data alterations on the SMSC server was governed by an administrative password. This included, truncating or deleting any SMSs in the SMS database.

4.13.3 SMSC and Utility SMS Logs

The SMSC and the utility server maintained SMS logs. These logs are for future comparison purposes or reconciliation. On selection of a particular server on the SMSC, the decoders for that server are activated and all messages for which it is the destination, are decoded. The upload function, for a chosen period, computes the sum and counts off all those SMSs with the predefined *'paying'* descriptor, given that the 'Amount' column contains a numeric value. The SMSC maintains messages both destined for particular servers and ordinary telecom clients. Figure 4.2 shows the SMSC data upload window to accomplish this. For a selected server (NWSC*), a date range of 'Time Sent' greater than or equal to 'Date1' and less than or equal to 'Date2' respectively, statistics are extracted and uploaded into a 'statistics' database and details of payments maintained in the 'uploadpayment' database by default. The 'Daily Totals' pane constitutes individual upload summaries for a specific periods. To decongest the SMSC database, details of the upload can then be dropped off the SMSC database since they are automatically maintained under 'Payments Details' for evidence purposes until the next reconciliation is done.

4.13.4 Authenticity and Data Sharing

To create data independence between the telecom and the utility company, the SMSC was programmed to just maintain a copy of the sent message. Any alteration of the data at the SMSC would not affect the copy forwarded. However it was noted that on a real wireless

platform, loss of signal between the telecom SMSC and the utility server may not necessarily cause loss of data but rather reconciliation imbalances, with the telecom server having more payments than the utility server.

4.13.5 Table Relationships

There is a one to many relationship between the locations and the clients tables. One location can actually have many clients although a single client can practically appear in many locations too. The clients and accounts have a one to one relationship. It was assumed that every client has a single operational account in the application development of this project.

4.14 Total Payments and Cash Transfer

There are several funds transfer methods and transfer by Internet banking, which is available in Stanbic Bank, was most prefered for convenience and risk reasons. According to step four of Section 3.2, all air time is directly credited to the telecom company account. Therefore the total deposits on the telecom account is the sum of all air time bought and used for ordinary purposes plus credit loaded and paid as bills by utility clients. Depending on the agreement for the cost of delivering the wireless service to the utility company, an amount is debited off the telecom account and credited to the utility company account, considering the cost of service.

4.15 The Model's Cost and Benefits Analysis

1. All customers with mobile phones will be able to transact electronically without a bank account.

2. Payment can be done by a third party for friends and families far away from each other.

3. The model will indirectly encourage use of more air time on behalf of the telecom company at the same time offering value for money for time conscious clients .

4. The model enables a centralised funds collection service, which enhances business planning and puts service providers slightly ahead of consumers.

5. The centralised funds transactions management adversely controls utility network fraud and embezzlement by staff if most customers were paying by SMS.

6. There will be reduced staffing for the utility company thus cutting the costs to employee maintenance.

7. The system eliminates bureaucratic behavior towards customer queries reducing service-response time.

8. The model enables minimum supervision at minimum costs by the utility company

4.15.1 SMS Model Vulnerabilities

Conceptually, flooding, where a large number of messages can be sent to an SMS server is one likely shortfall. These messages may either be valid or invalid but in one way or the other, useless.
Nevertheless, all messages are charged on sending and therefore constitute income to the telecom operator, but on the other hand lead to system freezing and under utilisation of expensive memory resources on all transit servers. Such messages can be client originated in form of an attack, and may include those that are sent with the minimum acceptable amount of money say 1 shilling, and those destined to a none existent account.

4.15.2 Secrecy Deficiency

The fact of convenience in this model is a direct trade off of extreme secrecy. Given knowledge of account numbers, any one can potentially and illegally find out outstanding balances of the given accounts. However, apart from possible attacks to the system, tests results have not shown any other risks involved that may affect client data apart from accumulating credit on an account. Also, misuse of the administrative functions as shown in section 4.8, may cause malicious individuals to update client accounts with negative values by sending incorrect meter readings. This in turn ends up distorting the trend of the previous meter reading and the would be current meter reading.

4.16 Main Challenges

The development process of this model had quite a number of challenges, as well as opportunities to extend it's functionalities. The models guarantees on security were not investigated satisfactorily as well exploiting it's full potential because of time. The findings in this project can thus be used by future researchers and implementers, to additionally emphasize areas of security and user authentication where confidential information needs to be communicated to and from the client.

SMS security regarding funds transfer currently depends on the security basically provided by the telecommunications company. During credit transfers, we were not able to confirm any guarantees that server modules responsible for decoding may not be edited to do any internal credit diversion for personal benefit and that the security protocols are appropriate enough to carry out this service.

4.17 Audits

The system relies on in built applications security and physical security as may be provided by the telecommunication organization. The applications security demands that an administrative password be provided for deletion of any in-coming SMSs. The deletion is required for relieving the databases in this application, however for ordinary SMSs, dropping those whose retention period is maximum, automatically does relieving.

In this application, at both the telecom center and utility company, automatic deletions are restricted to ensure backup of client information is done, or inward data between any two dates is compared. These back-ups are compared and reconciliation is done to ensure similarity of client data on both servers.

Despite various and unavoidable network failures on the communication channel, its assumed that predicted points of failure are between the client portal and the SMSC and between the SMSC and the utility server. At both points, its also assumed that information sent may not reach the destination server if:

1. The sender (client) receives a failure message and credit amount has not been reduced.
2. The message was send successfully and is residing at the telecom server but did not reach the destination server.

Chapter 5

Summary and Conclusion

The resultant model to pay utility bills, is one of it's kind in Uganda. Along side the simulation program, the model demonstrated successfully as a tool that could be used to develop a payment mechanism for mobile phone users who, from time to time make payments to utility companies. The differentiating fact between this and the existing models being none involvement of a banking institution as a major channel for making payments, and full involvement of the wireless service to accomplish transactions which make it fully flexible and easier to adopt. In this model, the involvement of a banking institution is between the telecom company and the utility company which may occur once a month, to transfer cash proceeds resulting from air-time sales used for individual client transactions. The reconciliation statements provide evidence and details of cash transfers to settle utility debts against the telecom account. By complete use of this service, the count of client visits to banks to settle utility bills is thus reduced to none.

With the existing model, the biggest problem to utility subscribers was, by observation and conducting one to one interviews, the difficulty to get responses when inquiries are lodged in, or delivering urgent information to the utility office at the most least cost possible. The bureaucratic nature of the existing manual system was said to increase the time taken to resolve a query and send feedback to clients or offer a quick service. Thus decision making and service delivery becomes a problem in processes where centralised query management is lacking.

Therefore the model in this project provides a break through for most common day to day problems met in utility payments. These include:

1. Inability for long distance subscribers to pay bills with ease and at the cheapest cost possible

2. Delayed query resolution due to bureaucratic behavior and use of regional offices as a management system. If there is a utility subscriber with more than one station in different delineated regions, it may necessitate movement from one region to another to clear different bills belonging to the same company.

3. enormous loss of client documents in transit after a client has paid or inquired

4. Repetitive 'balance brought forward' as a result of delays in paying the previous bill. This results into inflation of the current bill, demoralisation and failure by the subscribers to manage their own bills.

5.1 Implementation Constraints

Due to involvement of more than one stake holder, efforts to implementation of this automated SMS service seemed futile in the short run. It called for immediate corporation of both service providers to agree on terms and conditions for service provision. The MTN's product sales manager explained that the telecommunications company may do the routing at a high price, taking into consideration, the costs involved in purchase of specialised servers just for that purpose, or the SMS broker does it at a business rate.This meant that the telecommunications company ordinarily routes the SMSs to the indicated destination server address without taking any responsibility. On the other hand, national water at the time of contact had more other proposal to consider and test before it could make a final decision.

5.2 Cost of Service

The cost of service was purely an understanding to be reached by the telecom and the utility companies. However the MTN service manager hinted that this would be governed by the mode of business which determined the extent of involvement of the telecom company, amount of traffic involved or bandwidth requirement to keep the business running at all times etc. The income analysis of the utility company can be determined by periodically comparing a set of

received SMSs reconciled against the SMS outward log at the telecommunications SMSC server or SMS broker server. Depending on the terms of service, a fraction of the total collections is taken as the cost of service against the utility company in favor of the telecom company. According to the program architecture in figure 3.2. section 3.5, a broadcast of the reconciliation statement showing incoming payments, is sent to all utility offices for purposes of action against defaulters or otherwise.

The telecommunications company (MTN) also being a purely business driven organisation, interpreted this model as selling and buying it's own product which defeated own business objectives. However the idea was still at the lower levels of discussion with the most likely ideal conclusion being use of an SMS broker to man the service and take up liability.

5.3 National Water Implementation

It was suggested that it is good practice to have a parallel run of the current system, and the proposed automated payment system, in the event that it is adopted, until market desirability and familiarisation on use by the public was substantial. Past experience indicates that a change in established norms may result in resistance if the change is not fully understood or appreciated beforehand [6].

Therefore, such a system requires that implementation be done logically and with much care. This may necessitate training at various levels in order to build an adequate amount of awareness and understanding of the system first within the organisation, then to the clients. The training would not only educate employees of the organisation in the techniques and tools that are used in SMS billing, but will also address attitude change to the success of this electronic billing methodology.

5.4 Future Research

As the public interest in consumer-driven electronic health care applications rises, so do concerns about the privacy and security of these applications. Achieving a balance between providing the necessary security while promoting user acceptance is a major obstacle in large-scale deployment

of applications [16]. SMS has proven to be the industrys most successful non-voice service. Globally, SMS is expected to remain the most widely used messaging format for several years to come but no guarantees on it's security mechanisms.

Congestion of the network also becomes a concern when there is a sudden flood of messages coming into the network from individuals, bulk messaging providers, rogue operators, or from legitimate traffic caused by radio or television promotions or voting events. In fact, there have been reports of spoofing cases where messages are sent disguised as telecom operator prize winning announcements to subscribers. With the introduction of 3G wireless communication systems, in [1] it's explained that when the cellular network is involved with Internet then several kinds of Internet attacks can also be launched in the cellular network because of the existing security holes. Therefore the security guarantees in this service initiative remain uncertain.

5.5 Conclusion

Paying utility bills by SMS is a very viable project. Economically, the Ugandan society would benefit by having a payment method that is value for money. Also, there is a great deal of convenience yet avoiding time and travel expenses. The utility company would have a centralised funds collection, quick and easy service delivery and easily be ahead of creditors. Increased public participation and utilisation of the facility would automatically increase sales of telecommunications products like air time and through cost of service provision. In conclusion, spearheading implementation of this project is simply worthwhile.

Bibliography

[1] A. Akramul, A. Anwarul, and Q. Ashequl, "Exploiting vulnerabilities and security mechanism in internet based sms capable cellular networks," *International Journal of Computer Science and Network Security*, vol. 7 No.11, November 2007.

[2] D. Alston, "Direct deposit/payment can make a big difference for small firm," *Houston Business Journal*, 2006.

[3] S. N.-N. Ashong, "Financing of africas energy infrastructure: Challenges and feasible options?" *Background paper for F4D Conference, Accra*, May 2007.

[4] H. H. Bauer, S. J. Barnes, T. Reichardt, and M. M. Neumann, "Driving consumer acceptance of mobile marketing: A theoretical framework and empirical study," *Journal of Electronic Commerce Research*, vol. 6, p. 181, 2005.

[5] M. Becker, "Developing an understanding of mobile commerce," *A Review Billed to Phone Payment Methods*, March 12 2006.

[6] D. R. Cain, B. S. Liebesman, S. Memberi, and W. E. Martin, "The quality improvement process in telecommunications," *The IEEE Journal on selected areas in communication*, vol. 6, No.8, October 1988.

[7] CePRC, "Tiga awards for technology in governments in africa."

[8] P. Chengyuan, "Gsm and gprs security," *Telecommunications Software and Multimedia Laboratory, Helsinki University of Technology,Tik-110.501 Seminar on Network Security*, 2000.

[9] D. Cracknel, "Electronic banking for the poor panacea, potential and pitfalls," *Small Enterprise Development*, vol. 15 No.4, December 2004.

[10] R. Davison, V. Doug, H. Roger, and J. Noel, "Technology leapfrogging in developing countries," pp. 1–5, 2000.

[11] A. Dickinger and P. Haghirian, "An investigation and conceptual model of sms marketing," *Proceedings of the 37th Hawaii International Conference on System Sciences*, 2004.

[12] B. Fraunholz and C. Unnithan, "Critical success factors in mobile communications: A comparative roadmap for germany and india," *International Journal of Mobile Communications*, vol. 2, No. 1, pp. 87–101, 2004.

[13] C. Gerry, G. Janna, E. Arnhold, and J. Battisa, "Methods and systems for computerized bill consolidating, billing and payment authorisation, computerized, utility bill access and payment and utility provider consolidated billing systems," 1999.

[14] M. Gibson, D. Arnott, and I. Jagielska, "Evaluating the intangible benefits of business intelligence," 2004.

[15] E. J. Hogan, "System and method for bill delivery and payment over a communications network," *A United States Patent 5699528*, December 1997.

[16] K. Isac and M. Kenneth, "Wireless technology infrastructures for authentication of patients: Pki that rings," *Journal of the American Medical Informatics Association*, vol. 12, No.3, pp. 263–268, May-June 2005.

[17] T. Kelly, "Changing ict rankings of african nations," *Journal of African Telecommunication Indicators-ITU 7th edition*, May 2004.

[18] E. Kempson, A. Atkinson, and O. Pilley, "Policy level response to financial exclusion in developed economies," *Lessons for developing countries; Rep. Commissioned by Financial Sector Team, Policy Division*, September 2004.

[19] J. J. Kim, "Mobile banking shifts to a higher gear - moving money, paying bills is getting better, what about dropped calls?" *The new wall street Journal*, February 21 2007.

[20] K. C. Laudon and J. P. Laudon, "Managing a digital firm,ninth edition, prentice hall," 2006.

[21] S. Love, "The mobile connection: The cell phones impact on society," *The International Journal of Technology and Human Interaction*, vol. 1(4), pp. 101–104, October-December 2005.

[22] N. Mallat, T. Dahlberg, T. Saarinen, and V. K. Tuunainen, "Efficient service production and consumer choice of delivery channels," *e-Everything: e-Commerce, e-Government, e-Household, e-Democracy - The 14th Bled Electronic Commerce Conference Bled, Slovenia*, pp. 25–26, June 2001.

[23] B. Michael, "A review billed to phone payment methods-prepared for the global mobile marketing association," *Developing an Understanding of Mobile Commerce*, March 2006.

[24] Ozeki, "The ozeki message sever 6 product guide," p. 18/185, March 2006. [Online]. Available: http://www.ozeki.hu/attachments/419/Product guide 2006 03 16.pdf

[25] R. Rettie and M. Brum, "M-commerce: The role of sms text messages," *COTIM Proceedings From E-Commerce to M-Commerce*, 2001.

[26] I. Robert, "Wireless and mobile network architectures, newyork," 2001.

[27] A. Sekayizzi, C. Odonga, and J. Amayo, "Maximizing the benefits from water and environmental sanitation," pp. 251–253, 2005.

[28] T. Shirley, "Waiting for service: The relationship between delay and evaluation of service," *Journal of Marketing*, 1994.

[29] A. Skuse and T. Cousins, "Managing distance: Rural poverty and the promise of communications in post-apartheid south africa," *Journal of the Asian and African studies, Sage publications*, vol. 42(2), p. 185207, 2007.

[30] T-Mobile, "Pay your bills with an sms message," 2006. [Online]. Available: http://www.t-mobile.hr/eng/2/20-10-50-10-00.asp

[31] L. Tommi and K. Teuvo, "Consumer value segments in mobile bill paying," *Proceedings of the Third International Conference on Information Technology.New Generations ITNG*, 2006.

[32] U.S.G.P.O, "The internet tax freedom act," *Hearing before the Subcommittee on Telecommunications,Trade, and Consumer Protection of the Committee on Commerce, House of Representatives, One Hundred Fifth Congress, First session on H.R. Washington, D.C. 1054*, July 11 1997. [Online]. Available: htttp://www.cs.Virginia.edu/Jones/tmp352/projects98/group4/bib.html

Appendix

The Program Pseudocode

```
Main()
[
    AIRTIMELOADING ();
    INQUIRYPROCESS ();
    PAYPROCESS ();
]


AIRTIMELOADING()
[
    Customer loads airtime
    If airtime serial is incorrect, then
    Customer is advised of an incorrect airtime serial.
    End if
End process.
Else
    Customer advised of successful loading of airtime.
End process
]


    INQUIRYPROCESS() eg. (INQNW accountNumber BAL)
[
    Customer sends SMS inquiry to utility server
    If tolerant parameter are o.k e.g correct SMS format, then
    send sms to the utility server.
    Perform a server search of the client details.
    If customer is non-existent then
[
```

Error: Account does not exist.
End if
End process
]
else
error: Incorrect SMS format.
End if
Else
If SMS sent to wrong address then
Error: Address error
End if

Else
Return reply to customers balance inquiry
End process
]

PAYPROCESS ()

Customer attempt to send funds
If SMS format incorrect then
Error: incorrect sms format
End if and process
If credit is less than pay value then
Error: insufficient funds on your phone
If destination address incorrect then
Error : Destination incorrect End if
End process
If non-existent customer, then
Error: non-existent customer information error
"Please apply for this service."

End if

End process

Else

Utility server receives the sms.

Return auto message for successful money transfer including balance and due date.

]

RECONCILIATIONPROCESS ()

[

Parties, i.e. telecom and utility companies compare inward and outward SMS logs

Which are principally supposed to be the same

If inconsistence detected then

Customer contacted for possible clarification

Else

outward log at telecom-center taken as reference point.

End if

]