

**Computerized Billing System of the Global System for  
Mobile Communications. (GSM).  
A Case Study of M-Tel's Post-Paid GSM M-Tel Abuja**

**By**

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PGD/MCS/2003/1117**

**A Project submitted to the Department of  
Mathematics/Computer Science, School of Science and  
Science Education, Federal University of Technology Minna,  
Niger State.**

**November, 2004**

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**A Project submitted to the Department of  
Mathematics/Computer Science in Partial Fulfillment of the  
Requirements for the Award of a Post Graduate Diploma in  
Computer Science. Federal University of Technology Minna,  
Niger State.**

**November, 2004**

## **CERTIFICATION**

This Research project has been read and approved as meeting the requirements for the award of Post Graduate Diploma in Computer Science of Department of Mathematics/Computer, Federal University of Technology Minna, Niger State.

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**Dr Y.M Aiyesimi**  
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**Date**

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**External Examiner**

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**Date**



## **DEDICATION**

This project is dedicated to GOD Almighty who is forever faithful.



## **ACKNOWLEDGEMENT**

I am glad and thankful to GOD Almighty that I went through this program successfully.

I am also indebted to my supervisor, Dr Y.M Aiyesimi, whose guidance has succeeded in bringing out the best in me.

I am also grateful to my H.O.D, L.N. Ezeako, and all my lecturers who contributed to my academic performance in this school. I am eternally grateful.

For my classmates, I have had such a wonderful time with all of you; this is about the most cooperative team I have ever been a part of. Wish you all the best.

My qualified gratitude goes to my parents, Mr. and Mrs Ochu, my brothers Dan, Josh, Andi I love you all and thanks for all your support. Bobo your contributions cannot be forgotten; you are one of a kind.

Finally, I appreciate all the contributors to this project; David, Rosy, Amina, and especially Ms. O. Okwudishu who gave me the rights to her work and so many more who space will not permit me to acknowledge.

## **ABSTRACT**

An efficient and effective billing system is no doubt of paramount importance to the operation of GSM services worldwide, but of more importance to M-Tel, whose present billing system is still below standard. It has been discovered that although M-Tel's present billing system is computerized, it has a number of problems which include the fact that it is 'archaic', it does not accommodate the relational database management system, it is not user friendly and it is cumbersome and expensive to maintain. This new billing system is designed to take care of these problems.

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## **CHAPTER ONE**

### **BACKGROUND TO THE STUDY**

#### **0 INTRODUCTION**

Computers are increasingly becoming an integral part of the operations of an increasing number of sectors of the Nigerian economy. Today there is hardly any sector of the Nigerian economy that does not employ the new information and communications technologies. The computer has become a prominent feature of most offices. So also is the telephone, which is the catalyst for the new information and communications technologies in a technology driven economy. The world is fast becoming a global village and a necessary tool for this process is communication of which telecommunication is a key player. A major breakthrough is the wireless telephone system, which comes in fixed wireless telephone lines, or the Global System of Mobile Communications (GSM). The catalytic function of the telephone has increased in recent times with the introduction of the Global System for mobile Communications (GSM). Communications without doubt is a major driver of any economy, with the arrival on the scene of the GSM, things have not been and will never be the same again. It has changed the way business is done; it has changed the way services are paid for. This research project is an attempt to analyze the billing system of



the Global System for Mobile Communications (GSM) using M-Tel's post paid GSM as a case study.

Nigeria joined the GSM League of Nations in 2001 when Econet rolled out its GSM services. MTN followed in the same year. The Nigerian Telecommunications Limited (NITEL) rolled out in 2002. A fourth network, Globacom rolled out in August 2003 in the Federal Capital Territory (FCT).

This research project focuses on the billing System of NITEL's Global System of Mobile Communications (GSM). The NITEL GSM operates the pre-paid ('Rose' pre-paid package) and the post-paid ('Royal' post-paid package) services. This project is interested in the post-paid service, which is the service provided by M-Tel, a subsidiary of NITEL. The objective of this research project is to analyze the way customers of this service are billed. It will also design a computerized billing system aimed at improving the existing system and the services it renders. It is hoped that the result of this research project will be a more efficient Customer Care and Billing System (CCBS) than the current billing system.

## **1.1 HISTORY OF THE COMPUTER SYSTEM**

The abacus, which emerged about 650 BC in Asia Minor and is still in use today, maybe considered the first computer. In 1642, *Blaise Pascal*

(1623-1662), the 19-year old son of a French tax collector invented what he called a numerical wheel calculator to help his father with his duties. This brass rectangular box was called the *PASCALINE*. The drawback to the Pascaline of course was its limitation to function of addition. In 1694 *Goltfried Wilhelm Liebniz* (1646-1716) improved on the Pascaline by creating a machine that could multiply. Later inventors improved on and refined the calculator so that it could perform the four basic arithmetic functions of addition, subtraction, division and multiplication. These early inventors helped define the age of mechanical computation.

The real beginnings of the computer as we know it today, however, lay with an English mathematics professor, *Charles Babbage* (1791-1871). Frustrated at the many errors he found while examining calculations for the royal astronomical society, Babbage's first attempt at solving this problem was in 1822 when he proposed a machine to perform differential equations, called a *difference engine*. One of the few people who understood the engine design as well as Babbage was *Ausgusta Ada King*. She created the instruction routines to be fed into the computer making her the first female computer programmer. In the 1980's the U.S Defence Department named a programming language ADA in her honor.

The First-generations (1946-1959) of computers were developed with the onset of the World War II. Government's efforts to develop computers to exploit their potential strategic importance. First-generation computers were characterized by a major electronic component, which was the vacuum tube. It was programmed by connecting a lot of wires an example of this is the ENIAC (Electronic Numeric Integrator and Calculator), it was made of 18,000 vacuum tubes; the first computer to use the stored program concept.

The Second-generation of computers (1959-1965) were characterized by the solid state devices (Transistors which replaced the vacuum tube) and the magnetic core storage. It was the stored program and programming language that gave computers the flexibility to finally be cost-effective and productive for business use. The stored program concept meant that instructions to run a computer for a specific function (known as a program) were held inside the computer's memory and could quickly be replaced by a different set of instructions for a different function. Examples of these were the IBM 1400 series and UNIVAC III.

The Third-generation computers (1965-1970) had the Integrated Circuit system (IC) as their major components. The integrated circuit increased the speed of the computer by a factor of 10,000 over the previous computers. The Arithmetic operations were performed in microseconds; the



memory (Primary Storage Device) of the computer was greatly augmented. All these together with the fast I/O devices made a good and portable system. A good example was the IBM 360 series.

The Fourth-generation computers (1971-date) comprised of Microprocessors, which is a single miniature chip containing the circuitry and components for arithmetic, logical and control operations. These minicomputers as they came to be called came complete with user-friendly software packages that offered even non-technical users array of applications, most popularly word processing and spreadsheet programs. In the early 1980s, arcade video games such as PAC-man and home video game systems such as the *abari* 2600 ignited consumer interest for more sophisticated programmable home computers. In 1981, IBM introduced its personal computer for use in the home, office and schools. Asian computers continued their trend toward a smaller size, working their way down from desktop to laptop computers (which could fit inside a brief case), to palmtops (able to fit inside a breast pocket). As smaller computers became more powerful, they could be linked together, or networked to share memory space, software information and communicate with each other, using either direct wiring, called a *local area network* (LAN), or telephone lines. These networks could reach enormous proportions.

A global web of computer circuitry, the internet, for example, links computers worldwide into a single network of information. The most popular use today for computer networks such as the internet is *Electronic mail*, or E-mail, which allows users to type in a computer address and send messages through networked terminals across the office or across the world. Many advances in the science of computer design and technology (especially the Japanese technology) are coming together to enable the creation of a Fifth-generation computers.

Fifth-generation computers (present and beyond); are mainly characterized by:

- Artificial intelligence
- High level decision making
- Voice recognition
- Robotics
- Natural language processing

Though still under development but gradually emerging with great advancement two such engineering advances are parallel processing, which replaces *Von Neumann's* single central processing unit design with a system harnessing the power of many CPU's to work as one. The second super conductor technology, which allows the flow of electricity with little or no

distance, thus greatly increasing the speed of information flow. Computers today have some attributes of fifth-generation computers. For example, expert systems assist doctors in making diagnosis by applying the problem-solving steps a doctor might use in assessing a patient's needs.

It will take several more years of development before expert systems are in widespread use. (Jones, 2001).

## **1.2 OVERVIEW OF THE GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM).**

During the early 1980s, analog cellular telephone systems were experiencing rapid growth in Europe, particularly in Scandinavia and the United Kingdom, also in France and Germany. Each country developed its own system, which was incompatible with every one else's equipment and operation. This was an undesirable situation. Because not only was the mobile equipment limited to operations within national boundaries which in a unified Europe were increasingly unimportant, but there was a very limited market for each type of equipment, and so economies of scale, and the subsequent savings could not be realized. The Europeans realized this early and in 1982 the Conference of European and Telegraphs (CERT), formed a study group called the "Group special" mobile (GSM), to study and develop



pan-European public land mobile system. The proposed system had to meet certain criteria:

- good subjective speed quality;
- low terminal and service cost;
- support for international roaming;
- ability to support hand held terminals
- support for range of new services and facilities; and
- ISDN (Integrated Services Digital Network) compatibility.

In 1989, GSM responsibility was transferred to the European Telecommunications Standard Institute (ETSI). Phase 1 of the GSM specifications, were published in 1990. Commercial service was started in mid-1991, and by 1993 there were 36 GSM networks in 22 countries, with 25 additional countries having already selected or considered GSM [DS93]. This is not only an European standard; South Africa, Australia and many middle and far East countries have chosen GSM. By the beginning of 1994, there were 1.3 million subscribers worldwide. The acronym, GSM, now aptly stands for “Global System for Mobile” telecommunications. The developers of GSM chose an unproven (at that time) digital system, as opposed to the then standard analog cellular systems like the advanced mobile phone service (AMPS) in the United States and total access



communications system (TACS) in the United Kingdom. They had faith that advancements in compression algorithms and digital signal processors would allow the fulfillment of the system in terms of quality and cost. (Scorias, 1994).

### **3 HISTORICAL BACKGROUND OF M-TEL AND GSM SERVICES**

In 1992, NITEL was commercialized following a tripartite agreement between it, the Government and the then Technical Committee on Privatization and Commercialization (TCPC). In January 1996, NITEL Mobile Telecommunications Limited (M-Tel) was established. It was established as a public enterprise under the supervision of the Ministry of Communications. On May 21, 1996, M-Tel was incorporated as limited liability company under the companies and Allied Matters Act, and expounded its cellular network capacity from 10,000 lines in 1996 to 20,000 lines in 1998. (NITEL's Management Information System, 2002).

#### **1.3.1 Milestones**

1. Increase in customer service centers from one in Lagos in 1993 to six in various parts of the country by 1998.
2. The cellular network in Areas 1 and 2 were upgraded to ASA software for increased connectivity and enhanced features.

Administrative offices and staff quarters were established in Abuja, Lagos, Enugu, Kaduna, Kano and Minna.

4. Implementation of national cellular network rehabilitation and expansion to provide additional 10,000 lines in Lagos and also extend services to the omitted parts of the South West, South East, South South, North Central, North West and provide services to the North East.
5. Implementation of the Area 3 (Abuja) network project by rehabilitating the infrastructure and replacing the 5,000 lines MSC (Mobile Switching Centre) with a 75,000 line MSC.
6. Implementation of the billing system in 1998.
7. Sustained revenue generation growth of about 100% per annum from 1996 to 1999.
8. M-Tel was licensed to provide GSM services.
9. M-Tel was admitted to the GSM Association as a full member in 1999
10. M-Tel was re-merged with NITEL and re-designated as the NITEL *Mobile communications directorate* in January 2001.
11. NITEL re-licensed to operate GSM in February 2001.
12. NITEL signed contracts for 118,000 GSM lines infrastructure in 2001.
13. NITEL submitted application for GSM Association Membership in 2001.  
(NITEL's management information system, 2002).

## **OBJECTIVES OF THE STUDY**

The purpose of this research project was to automate by *alternative design* a full computerization of the existing billing system that is expected to be cheaper.

In line with M-Tel's corporate objectives of providing cellular services (GSM) to the citizenry as well as generating revenue for the Federal Government of Nigeria, M-Tel needs an efficient customer care and billing system (CCBS). This research project will help to achieve these objectives because the bedrock of M-Tel services is the provision of well documented statistics, beginning with the subscribers' bills which have to be very accurate at all times.

M-Tel operates a policy, which ensures that no matter the customer base size, only 5% of them will be provided with the postpaid service. This is largely because of the high cost of running the postpaid service and the lack of trustworthiness of some customers; this has led to the provision of the postpaid service to trusted customers and companies like the NNPC and CBN offices.

It is expected that the creation of an alternative computerized billing system instead of the contracted one will be cheaper. Also, it is hoped that



problems involving fraudsters, misappropriation of funds by subscriber companies and security will be tackled.

## 5 SCOPE / LIMITATION.

Due to the technical nature of the project, it was limited to the basic features of any typical billing system.

A typical GSM service provides two types of services, a *Pre-paid* service, which is the type of service provided by all the GSM service providers. With the pre-paid service, users are expected to buy a voucher card or a credit card. There is also the *Post-paid* service, which is the type of service provided by MTN and which was provided by M-Tel (still to be continued), whereby the users obtain their bills at the end of the month. The charging Data Record (CDR) monitors the user's call. The scope of this project is limited to the latter. The program design will compute this billing system with a view to improving on its performance.



## **RESEARCH METHODOLOGY.**

The information used to carry out this project study will be obtained from three major sources.

- i. **Face-to-face interviews:** Those interviewed were staff from the Public Relations Office and the Computer Office of M-Tel. The issues discussed were the history of M-Tel, the mode of operation of the existing billing system and the benefits that would be derived from improving on this current system.
- ii. **Direct observation of the technology in question:** The GSM phone using the post-paid service was observed; its operation and how customers are billed.
- iii. **Record review:** Information was also gathered from books, related research materials obtained from the Internet, individual researchers and M-Tel on GSM.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

#### **2.0 BILLING SYSTEMS**

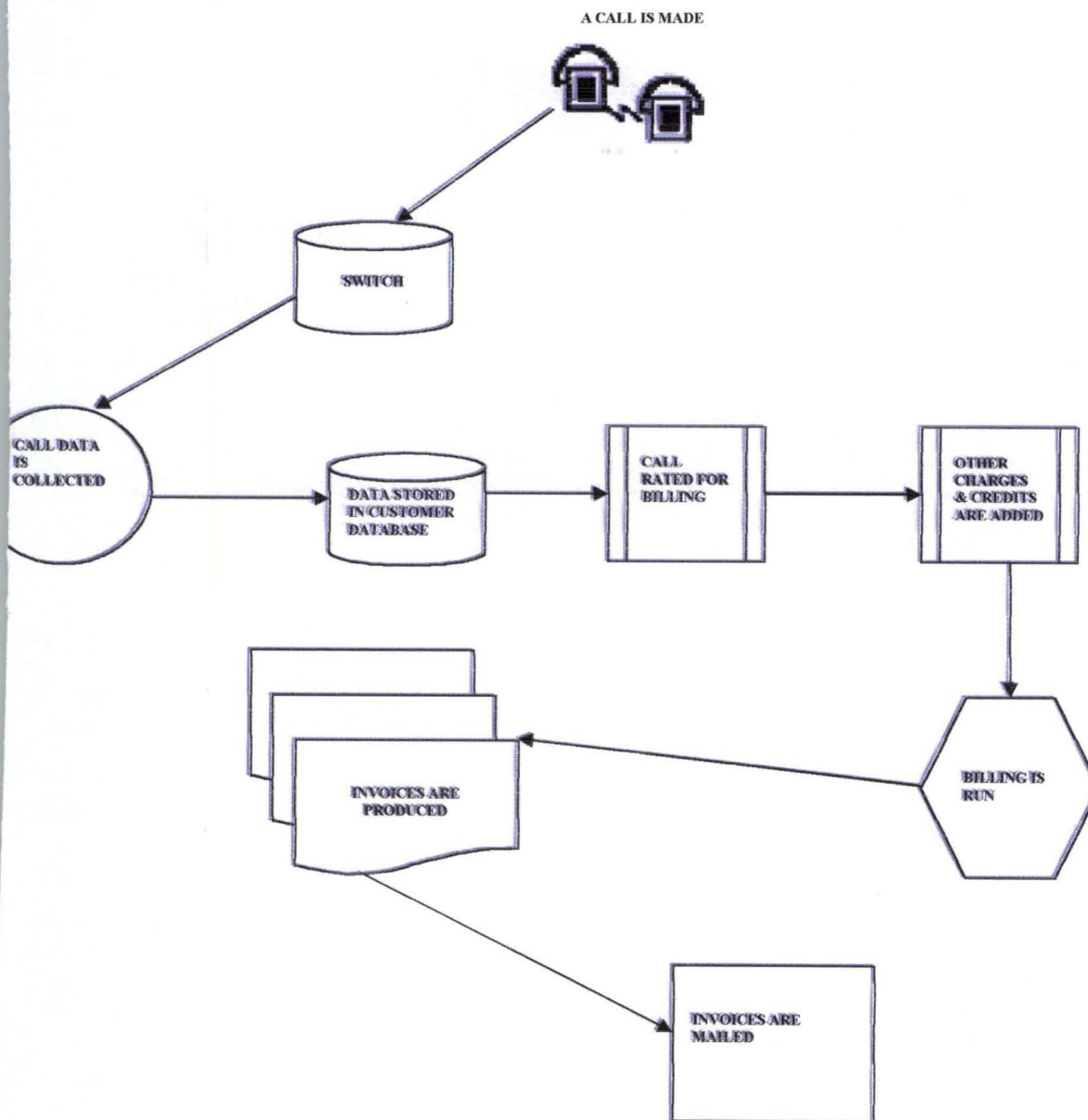
According to Ellis (2002) billing is so vital and so vexing. It is vital because most billing systems do so very much more than billing. It is vexing because billing systems are always among the top three reasons why such and such a new service can't be launched more quickly.

In telephony, billing involves gathering data for customer use and the provision of features, calculating costs and invoicing for payment. In order to be competitive, companies will need to improve the operational processes they use to provide these new services. The demand for new and more sophisticated products and services and the provider's time-to-market will drive the marketplace. More than ever, service providers will also need to focus their attention on understanding customer's needs and providing higher-quality services. A company's ability to represent and bill accurately for these newer and more complex services will become a bigger challenge over the next few years.

## 2.0.1 BASIC FUNCTIONALITY OF BILLING SYSTEMS

Billing systems collect, rate, and calculate charges and then invoice for the products(s) or service(s).

Figure 1 depicts a simple billing system and is an overview for how a basic billing system works.





According to IEC (2004), Figure 1 shows that after a call is made, a collector gathers data from the switch and builds a call-detail record (CDR). This CDR must contain the *Caller id, the Receiver id, and the Start and Stop-times*. The CDR is then stored until it can be rated. To rate the call, the CDR is examined to see if the call is, for example, an '800' number, a local call that is covered by a local-area calling plan, or a toll call. Information such as the time call was placed and the distance between callers is also used to calculate the bill for the call. Once each call is billed, this information is stored until the invoice is run, usually once a month. When the invoice is run, other non-usage charges can be applied to the bill, such as volume discounts or monthly fees. This information is then prepared so that it can be printed in readable form. Finally the envelope is printed, stuffed with enclosures, and mailed. Call data is also shared between companies to handle calls that originate, terminate, or are transported on another company's network.

Several options are available that change the nature and capability of the billing system. For example, if calls are rated and stored, then accurate current bill total can be quoted to a customer.

Issues that must be addressed when managing the billing system are many. These are reliability, accuracy, and readability, are basic needs. Data



formats, especially among different billing system components, are a significant source of complexity and expense in any system. Data that is shared is particularly sensitive to compatibility issues. The ability to bill many different services (local and international) on a single bill has proved difficult; the logic for handling wireless-call billing is very different from the logic of regular fixed-line billing. IEC warns that Integrating this logic into a single application is quite complex and requires skills in all media. Increasingly, this capability will be a differentiator in billing solutions over the next few years.

## **2.1 COMPONENTS OF A BILLING SYSTEM**

A billing system is composed of a series of independent applications that, when run together, are referred to as the billing system. Its major components are identified as follows:

- CDR – this is used to record the details of the call. Usual information on a CDR includes start time of call, stop time of call, duration of call, caller id, and receiver id. The CDR is stored until time of billing.
- Guiding – This matches calls to customer calling plans. The application used the start and end number and the duration and time of

call to decide what the change should be, based on the calling plans on the customer's record.

- Rating application – This program applies the rate for the individual guided calls. Rating gives the call a value to be charged at the time of billing (not including any promotions, discounts, or taxes).
- Billing – This is usually performed once a month. This job collects all of the rated calls that have been stored over the past 30 days. The program adds any promotions and discounts that are associated with the customer account. For example, if customers have called over a certain number of minutes, they might get a volume discount. In addition, taxes and credits are applied.
- Invoicing - When the billing job is complete, a file is created that includes all of the customer's information. This file is sent to a print house to be converted to paper invoices. These invoices are then stuffed into envelopes, along with specific inserts targeted to the customer. Many companies will also create electronic statements and send customers their invoices through diskette, tape, or even e-mail; alternative, billing practice is especially common for business customers. (IEC: Telephony billing, 2004).

## **2.2 SERVICES PROVIDED BY THE GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS (GSM).**

The International Telecommunications Union (ITU), divided telecommunications services into three categories:

- Bearer Services
- Tele-services
- Supplementary Services

### **2.2.1 Bearer Services**

The digital nature of GSM allows data, both synchronous and asynchronous, to be transported as bearer service to or from an integrated services digital network (ISDN) terminal. Data can use either the transparent service, which has a fixed delay but no guarantee of data integrity, or a non-transparent service, which guarantees data integrity through an automatic repeat request (ARQ) mechanism, but with a variable delay. The data rates supported by GSM are 300bps, 600bps, 2400bps and 9600bps.

### **2.2.2 Tele-services.**

The most basic tele-service supported by GSM is *telephony*. There is an emergency service, where the nearest emergency service provided is



notified by dialing three digits (similar to 911). Recommendation T.30 is also supported by the use of an appropriate fax adaptor. A unique feature of GSM compared to older analog systems is the Short Messaging Service (SMS). SMS is a bi-directional service for sending alphanumeric message (up to 160 bytes) in a store and forward fashion. For point-to-point SMS, messages can be sent to another subscriber to the service, and an acknowledgement of receipt is provided to the sender. SMS can also be used in a cell-broadcast mode, for sending messages such as traffic updates or news updates. Messages can be stored in the SMS card for later retrieval.

### **2.2.3 Supplementary Services.**

Supplementary services are provide on top of tele-services or bearer services, and include features such as caller identification, call forwarding, call waiting, multi-party conversation, and barring of outgoing (international) calls among others. (J. Scourias, 1997).



## 2.3 GSM TERMINOLOGIES

- **AUC** – This stands for *authentication center*. A unit that provides authentication and encryption parameters that verify the user identity and ensure that confidentiality of each cell. In other words the main function of the AUC is to authenticate subscribers attempting to use a network. It protects network operators from different types of fraud found in today's cellular world. It is a database connected to the home local register (HLR).
- **VLR** – This stands for *visitors location register*. This database contains temporary information about all mobile subscribers that is needed by the mobile switching center (MSC) to service all visiting subscribers. The VLR is always integrated with the MSC.
- **HLR** – The *home location register* is a centralized network database that stores and manages all mobile subscriptions belonging to a specific operator. Such information includes subscriber's: identity, supplementary services, location information, authentication information.
- **EIR** – This stands for *equipment identity register*. This is a database containing mobile equipment identity information, which can be used to detect and block stolen unauthorized or defective MSC's.

- **MSC** – This stands for *mobile switching center*. This performs the telephony switching functions for the mobile network. It controls calls to and from other telephone and data systems. It also performs such functions as toll ticketing, network interfacing, common channel signaling and others.
- **BSC** – The *base station controller* manages all the radio-related functions of GSM networks. It provides functions such as MS-hand-over, radio channel assignment and collection of cell configuration data.
- **BTS** – This stands for *base transceiver station*. This controls the radio interference to the MS. The BTS comprised of the radio equipment such as transceivers and antennas.
- **OMS** – *Operations and maintenance subsystem*. This is a computerized monitoring center, which is connected to other network components such as MSC's and BSC's through data network lines.
- **NMC** – *Networks management center*. This offers centralized control of networks. NMC staff can concentrate on long-term system wide issues, whereas local staff can concentrate on short-term regional issues.
- **MS** – *Mobile station*. This consists of a mobile terminal and a SIM.

- **INTERNATIONAL ROAMING** – This is one of the main advantages of the GSM standard and is applied when a mobile station moves from one public land mobile network to another.
- **CELL** – This is the basic unit of a cellular system and is defined as the area of radio coverage given by one base station antenna system.
- **LOCATION AREA** – This is a group of cells. The identity of the LA in which a mobile station is currently located is stored in the *Visitors location register* VLR. When a mobile station crosses the boundary between two cells belonging to different location areas it does *Location updating*, but occurs only in the idle state.
- **MSC SERVICE AREA** – This represents a number of *location areas* and represents the geographical part of the network controlled by one MSC.
- **PLMN** – *Public land mobile network* the area in which an operator offers radio coverage and network access.
- **GSM SERVICE AREA** – An area in which a subscriber can gain access to a GSM network.



## 2.4 FUNCTIONAL OVERVIEW OF A GSM BILLING SYSTEM: A CASE STUDY OF EPPIX (ERRICSON) CCBS

To understand the functionality of a billing system, the concept of *mediation* must be understood.

The integration of various network nodes that produce charging outputs in one form or the other is an issue that is resolved with the aid of *mediation* devices. A mediation device from telecommunications point of view can be defined as a device that serves as an intermediary between two or more network elements. A popular mediation device (with particular regards to GSM billing) is the *Ericcson's bgw*. This allows customer administration systems to exchange information with network elements to produce charging data.

GSM networks are usually complex especially with the introduction of newer services and functions such as messaging centers or mobile data-com.

The billing gateway is a single point, uniform interface connection between the networks that produce charging information and the administrative of billing system. The billing gateway not, only collects, processes and distributes billing data automatically and online but also

provides other features such as billing and alarm handling. The key functions of the billing gateway include:

- Collection and distribution of charging data records (CDR)
- Hot billing
- Flexible processing of billing data
- Flexible filtering
- Flexible formatting
- Consolidation of partial CDR's
- Rating
- Charging data record (CDR) archiving
- Alarm handling
- Graphical user interface supervision and configuration. (Ericsson radio system AB, 1999)

## 2.5 BASIC FEATURES OF A TYPICAL GSM BILLING SYSTEM: i.e. EPPIX

- **Call rating** – This can be based on time of day, day of the week, region of call, and day of the year, type of call.
- **Minimum duration** – possibility of setting a duration below, which calls are free.
- **Call length** – possibility of charging for calls based on total length of a call.
- **Tap processing** – possibility of producing reports showing monies owed mutually between roaming partners.
- **Bundling** - Capability of attaching free talk time to a tariff.
- **Fraud management** – possibility of exercising controls especially between roaming networks. Each network typically possesses upper threshold limit for their subscribers while roaming.
- **Invoicing** – i.e., invoice production for services rendered.
- **Convergent/divergent invoicing** – possibility of separation or combination of subscriber invoices.
- **Friends and families** – This is usually subscriber-specific. It allows subscribers to define dialing numbers that are frequently called and on which special discount can be applied as agreed.



- **Credit limit control** – Ability to control credit limits.

Other functions include:

- **SIM management**
- **Dealers management**
- **Front office administration** – such as activation, de-activation, account swap, PIN and super enquiries.
- **External interfaces** – Such as banks and dealers. (Ericsson radio systems AB, 1999).

## **CHAPTER THREE**

### **SYSTEM ANALYSIS AND DESIGN**

#### **3.0 PROBLEMS OF THE EXISTING BILLING SYSTEM**

This chapter describes the problem of the existing billing system and analyzes its mode of operation and how calls are charged.

System design is concerned with solving some, if not all the problems of the existing billing system. It is concerned with the development of specifications for the proposed new billing system.

To assume that the billing system of the Global System for Mobile Communications (GSM) of M-Tel's post-paid service is manual, is not a credible assumption. This is because all GSM operations, world wide, come computerized. The present billing system of the M-Tel GSM, although computerized, is not a standard billing system, (plans are being made to standardize this system presently). This is mainly because the billing system is adapted from the billing system of the landline, i.e. the service provided by NITEL. This billing system is associated with a number of problems. Some of the problems are:

1. It is Archaic. The present billing system is old and substandard. This is mainly because it has not been adapted to new billing technologies and

changes and therefore, it is not robust. In other words, it cannot handle a large amount of billing.

2. It does not accommodate the relational database management system, which is the most appropriate database that can be used in the process of computerizing this type of billing system.
3. It is not user friendly. Because of this, when customers run into problems, they have trouble solving them.
4. It is cumbersome and expensive to maintain, because it is bulky and burdensome.

### 3.1 SYSTEM ANALYSIS

This section gives an overview of how the present billing system is operated and how calls are charged. Obtaining information at this stage was a little problematic because of the sensitivity of the issue at hand; i.e. billing. Also the expatriates invited to come and solve the company's (NITEL) problems also proved very secretive.

When a call is made from a *mobile station* (MS) i.e. (the handset), the request is sent to the *Base Transceiver System*, (BTS), which then sends the request to the *Base Transceiver Station Controller* (BSC). The BSC contains



the *Gateway Mobile Switching Center* (GMSC). The *Mobile Switching Center* (MSC), and the *Home Location Register* (HLR).

The GMSC collects processes and distributes billing data automatically online and also provides other features such as hot billing. It produces charging information. The MSC performs the telephony switching functions, while the HLR stores and manages all mobile subscriptions belonging to a specific operator. Such information include:

- The subscriber's identity
- The subscriber's supplementary services.
- The subscriber's location information.
- The subscriber's authentication information.

At the receiver's end the same transition takes place until the end connection is made. When the call gets through, an Intelligent Network (IN) component starts the charging at the intelligent network. The charging is performed and received in a hexadecimal format. It is then sent to the billing gateway, where it is translated into a readable, billable format on the Charging Data Record (CDR). From there it is sent to the billing system which charges the call and gives out reports.

This analysis describes an already computerized billing system which, was written as a network program, and describes what happens at the billing

gateway. Although computerized, this billing system has a few problems. System design involves the design of a new system to replace the existing system.

## **3.2 SYSTEM DESIGN**

System design is concerned with the development of specifications for the proposed new system, which seeks to achieve the requirements detailed during the analysis phase. It should be noted that the system designed in this project would need a few modifications to meet the standard expected of industrial program design.

The new design monitors what happens as soon as a customer picks his/her handset to make a call, up to when the customer hangs up. The customer is then billed accordingly.

### **3.2.1 Preliminary Studies**

The researcher took various steps towards the actualization of the project. Information of GSM operations and billing system was gathered from journal articles and other relevant publications. The Visual Basic 6.0, a dialect of the standard BASIC, was used because it is an object-oriented programming language, suitable for the design in question. Visual Basic 6.0

makes use of objects called textboxes, command buttons, combo boxes, etc. to each of these objects, codes are assigned to make them functional.

Some tutorial in the Visual Basic 6.0 programming language was required by the system designer to be able to carry out this research work.

### **3.2.2 Aims behind Designing the System**

In designing the system, the following were considered to be very important. The system must be:

1. User Friendly: this involves making sure that any user can make use of the system without encountering any difficulties.
2. Error Capability: this involves making sure the system provided the facility for handling errors that could occur in the course of using the system, e.g. typing alphabets in the box for caller id.
3. Aid Solving Problems: the system should have the capability to solve all the problems of the existing billing system.
4. Interactive: there should be a level of interaction between a user and the system, e.g. when a user hangs up his/her handset, a message box appears asking the user if he/she wishes to make another call. The user is then expected to click 'Yes' or 'No'.

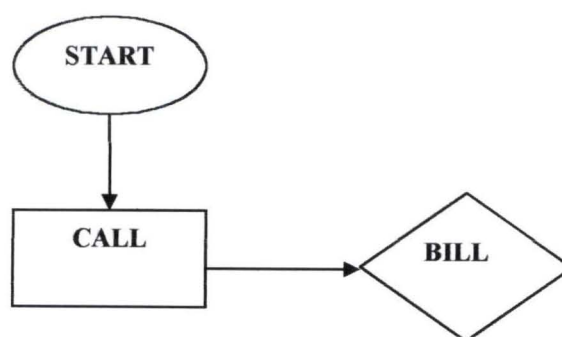


### 3.3 SOFTWARE DESIGN

A set of programs and subprograms put together with which the hardware (CPU) is made to perform a specific task or even produce a specific result is called software design. In designing software, the main objective or goal is to plan and design it in such a way that the result or final payment is the proposed one. An algorithm of the software being developed is usually the first step in software design. It is the step-by-step plan of action that if followed will solve the problem. In this chapter the algorithm for simplicity will be presented graphically in the form of a Flowchart.

#### 3.3.1 Flowchart

The graphical representation of an algorithm is called a flowchart. It usually consists of boxes (squares or otherwise), which represent an operation, an operation, and directed lines (arrow headed lines), which show the direction in which a particular instruction is carried out. The system flowchart is shown in figure 3.1. This flowchart is a general outline of the system. A more detailed flowchart will be shown later on in this project.



### **3.4 OUTLINE OF DESIGN**

#### **3.4.1 Input Design**

The program written for the system was highly mathematical and therefore most of the characters required for input were numeric.

#### **3.4.2 Output Design**

The output displayed by the system is a Visual Basic screen, showing the Visual Basic objects or the billing grid depending on the stage you are in.

#### **3.4.3 Process Design**

This is usually controlled by the system design. The various inputs accepted from the user are processed to produce the bill.

### **3.5 THE MAIN PROGRAM**

The system is mathematical in nature and the program is object-oriented programming.

#### **3.5.1 Procedures for Billing**

A customer's call has to be monitored from when he/she picks up the handset to make a call and gets through, up to when that customer hangs up the handset. Accordingly, the customer is billed according to the number of minutes spent.

The billing system involves several stages, which are represented by Visual Basic screens referred to as forms. These forms will be explained briefly. However a full discussion of these subprograms or modules and others will be taken care of in the subsequent chapter.

**3.5.1.1 OPENING SCREEN FROM:** This form is the opening screen, which contains the topic of the project and the name of the programmer. When a user gains access to the program this is the first screen that appears. Figure II shows the opening screen.

**3.5.1.2 MAKING A CALL SCREEN FORM:** The program for this screen allows a user to type in a Number for *caller id* and a number for *destinations id*. The user then indicates whether the call about to be made is “local” or “international” by clicking any of the option boxes. The program has been written so that from when a customer starts making a call, up to when the customer hangs up, the “start time” of call and the “stop time” of the call are recorded and the customer is billed in *Naira* according to the number of minutes spent. Figure III shows the making a call screen



**3.5.1.3BILLING GRID SCREEN FORM:** This program was written to generate information on the call just made. This billing grid is a relational database. It was created using Microsoft Access and the programming language used to connect to the Visual Basic program is the SQL programming language. The customer's billing information is obtained by typing in the phone number in the *caller id* box and clicking on *bill*. Figure IV shows the billing report. This program was written, to make it possible to see all the calls that have ever been made by a customer. With this billing system, when a customer's bill has been seen, the program enables this bill to be printed out for the customer. To obtain specific information like *caller id* or the number of calls that have been made so far, all the user needs to do is click on "General Bill".

## **CHAPTER FOUR**

### **IMPLEMENTATION**

#### **4.0 SYSTEM IMPLEMENTATION**

This chapter deals with the implementation of the system taking into consideration the hardware, software, and other things necessary for the implementation of the system. Further explanation on the modules of the system and the way they are related will be given.

#### **4.1 HARDWARE CONSIDERATION**

To develop a suitable package, adequate attention must be given to the hardware components of the computer used in the implementation. The hardware is made up of the CPU – microprocessor. The hardware configuration should be as follows:

- Hardware configuration should be nothing less than Pentium 400Maz,
- Atleast 10 mega bytes of memory space
- 32 mega bytes of random access memory (RAM)
- operating system should be either windows 98, windows 2000, and windows XP

## 4.2 SOFTWARE CONSIDERATION

Many languages exist for the development of a system. In practice the choice of a suitable language is often inhibited by programmatic constraints. The architecture of the application, the languages available and the skill of the programmer may influence the decision. With due consideration of these facts, Visual Basic was used because it is an object-oriented program and most suitable for the topic in question, *billing*. Also Microsoft access was used to construct the *billing grid*, which is the database in this design SQL was used to link the database to the rest of the design.

## 3 MODULES OF THE SYSTEM

This section looks at the various modules that make up this system and the way they relate together to produce the general effect of the whole system.

**4.3.1 Users' manual:** To enter the system, first put on the computer and load the operating system. When you have loaded the operating system, follow these steps:

- Insert the source disk (or diskette) in either drive A or B depending on the number of floppy drives the CPU has
- Click on start, choose programs from the pop-up menu, then choose windows explorer from the adjoining pop-up menu. When windows



windows explorer is opened, click on the drive with the disk (e.g. 3<sup>1/2</sup> floppy A). The icon chosen depends on the name given to the design.

#### 4.3.2 Modules

When a user accesses the system, he first sees a back screen after which the opening screen comes up by clicking the mouse bearing the title of the project and the programmer's name. About 1 minute later the next screen, which is the *login* screen for the main screen. This is where the main programming is. It contains a tool bar which is where the user can choose from the options '*Call*', '*Bill*' And '*Administrative*'.

- Call: When the user clicks on the *call* command he gets a drop down list that gives the options *Make call* or *Exit*. The *make call dropdown* shows a new screen that contains two (2) option buttons, which have identity of the type of calls made (i.e. if the call is local or international). It also contains six (6) text boxes, which have the *caller id*, *destination id*, *call date*, *timespent*, *start time*, *stoptime*, *duration* and *call cost*. There are four (4) command boxes which have the identity of *send/ok*, to make a call, *end call/stop*, *new call*, *done* (to exit). A frame (*Call Activity*) holds the *start time*, *stop time*, *duration* and *call cost* text boxes.

- Bill: Which brings out the General and Individual reports of all calls made, especially when any call(s) need to be monitored. It contains data buttons, and a command button that has the printer icon on it for printing out such reports
- Administrative: this drop down option accesses the *call cost update* screen; you have a login screen which contains two (2) text boxes for accepting user name and the password, and two (2) command buttons *ok* and *cancel*. Once the administrator's password is accepted a next screen is opened, which is the *call cost update* which contains three (3) text boxes *Current Call Cost / Second*, *International Call cost / Minute*, *Date*. It also contains two command buttons *update* and *cancel*, a horizontal and data scroll bar.

When a caller picks up a mobile phone and dials a number and a connection is made, it is equivalent to clicking on the '*send/ok*' button. This is after the caller has typed in the number of the person he wishes to call, i.e. *Destination Id*. It is assumed that if this system design is made a *network* program, once a subscriber picks his/her handset to make a call the billing system is automatically activated. So the subscriber's number i.e., *caller id* is immediately shown. But for the purpose of this project, the billing system is such that, in the *caller id* will have to be typed in.

Precautions were taken in the course of writing this program to prevent it from crashing in the process of using it. For example if a user types in a different *caller id* from that of the operating network (M-Tel – 0804-xxxxxxx) a message box comes up saying “*Wrong Number*”. If a wrong number (less than 11 or greater than 11 characters, or a text) is entered into the *caller id* text box an error message “*enter valid phone number*” is displayed.

To view the documented bill or the report the user clicks on the *Bill* drop down option and then clicks on the ‘General Bill’ or the ‘individual’ to view the report, the user also has an option to print out the report for further documentation, the bill contains information like *caller Id*, *Destination Id*, *call duration*, *time spent*, *call cost* etc. This particular option allows better customer care, for instance, if a customer comes to complain about an irregular billing the administrator then prints out a report about the activities of that particular number to verify the complaints; this is a feature that is not readily available in the M-Tel service.

To terminate the program click ‘*done*’ on the make a call form which takes you to the beginning of the screen where you then click the ‘*call*’ drop down option then ‘*exit*’ to exit the program.



#### 4.4 PROGRAM TESTING

This section looks at the testing of the individual programs that have been written to make sure they have been correctly written and that the system as a whole will work, i.e. the link between the programs in suite.

To this end the systems analyst provided the necessary test data as follows:

- a) Program testing: Test data designed to ensure that all possible contingencies were catered for by the programmer, were supplied.
- b) Procedure testing: The aim of procedure testing was to ensure that the whole system fitted together as planned. This involved, input, processing and output procedures. Overall timings were also under scrutiny.

#### 4.5 MASTER FILE CONVERSION

It is necessary to convert the existing master files into the new form or possibly load their data into a database. The stages of file conversion will depend on the method currently used for keeping the files, which in this case is manually. This will likely involve the following steps:

- a) Transcription of all “standing” data (such as phone numbers, bills etc) into the input document, which in this case is the *making a call* form.

- b) Insertion of all new data required onto input documents e.g. *Type of calls*, where non-were used previously.
- c) Transcription of data from documents to magnetic media. This could be a major task in this case, because of the large manual system.
- d) Verification of transcribed data.
- e) Data is then used as input to a "file creation run". A specially written computer program procedures the master records in the required format.
- f) Printing out of files for comparison with old files.
- g) At a date immediately prior to changeover, variable data is inserted in master files.

#### **4.6 CONVERSION PROCEDURES**

There are two basic methods of changing over to a new system:

- Parallel Procedure
- Direct Procedure

The parallel procedure is most appropriate for this system. In this case the old and new systems are run concurrently, using the same inputs. The outputs are compared and reason for differences resolved. Outputs from the old system continues to be distributed until the new system has proved satisfactory. At that point the old system can be discontinued and the new

one takes its place. This method is appropriate for this system because the outputs from the old system and the outputs from this new system can be reconciled. Also the use of this parallel conversion gives the management of M-Tel the facility of fully testing this new system whilst still retaining the existing system.

#### **4.7 REVIEW AND MAINTENANCE**

Once the new system has become operational it will need to be examined to see if it has met the objectives for which it was designed. For example the costs and benefits will be compared with the estimates produced at the system's inception, i.e. Post-auditing.

The system will also need to be reviewed and maintained periodically for the following reasons:

- 1) To deal with unforeseen problems arising in operation, e.g. programs may need to be modified to deal with unforeseen circumstances.
- 2) To confirm that the planned objectives are being met and to take action if they are not.
- 3) To ensure that the system is able to cope with the changing requirements of business
- 4) To use the results of system review in future systems analysis.



## CHAPTER FIVE

### SUMMARY/CONCLUSION

#### 5.0 SUMMARY

The aim of this project was to automate by alternative design a computerization of M-Tel's existing billing system. This was done by understanding the problems of the existing billing system and taking care of them in the design of the new system. The result is a more efficient, user friendly and standard billing system.

The *manual system* of the M-Tel post – paid GSM billing system might have its advantages. However, the demerits of the *manual system* far out-weigh any advantages it might have.

Billing is an important factor in the operation of GSM services all over the world including Nigeria. Past journals and articles on GSM billing were reviewed. The designer had little time, when factors such as learning the programming language, applying it to the topic in question (billing) are taken into consideration. Also the sensitivity of the topic did not allow the designer to obtain certain information. However the project has tried to introduce more efficient methods of operation for the M-Tel (post-paid) GSM *billing unit*, while at the same time holding more accurate records. The problems of the existing billing system were taken into consideration.

## 5.1 RECOMMENDATIONS

It is hoped that this work will serve as a reference guide for further computerization, so that the design will be upgraded, to an industrial design. In general, the computerization of M-Tel's billing system is an exercise, which can be achieved through a thorough and in-depth study of its billing operations. The achievement of this task will go a long way to increasing the speed and efficiency of M-Tel's billing system. The VISUAL BASIC programming language was used to develop the software due to its flexibility and use friendliness. Some of the recommendations include the following.

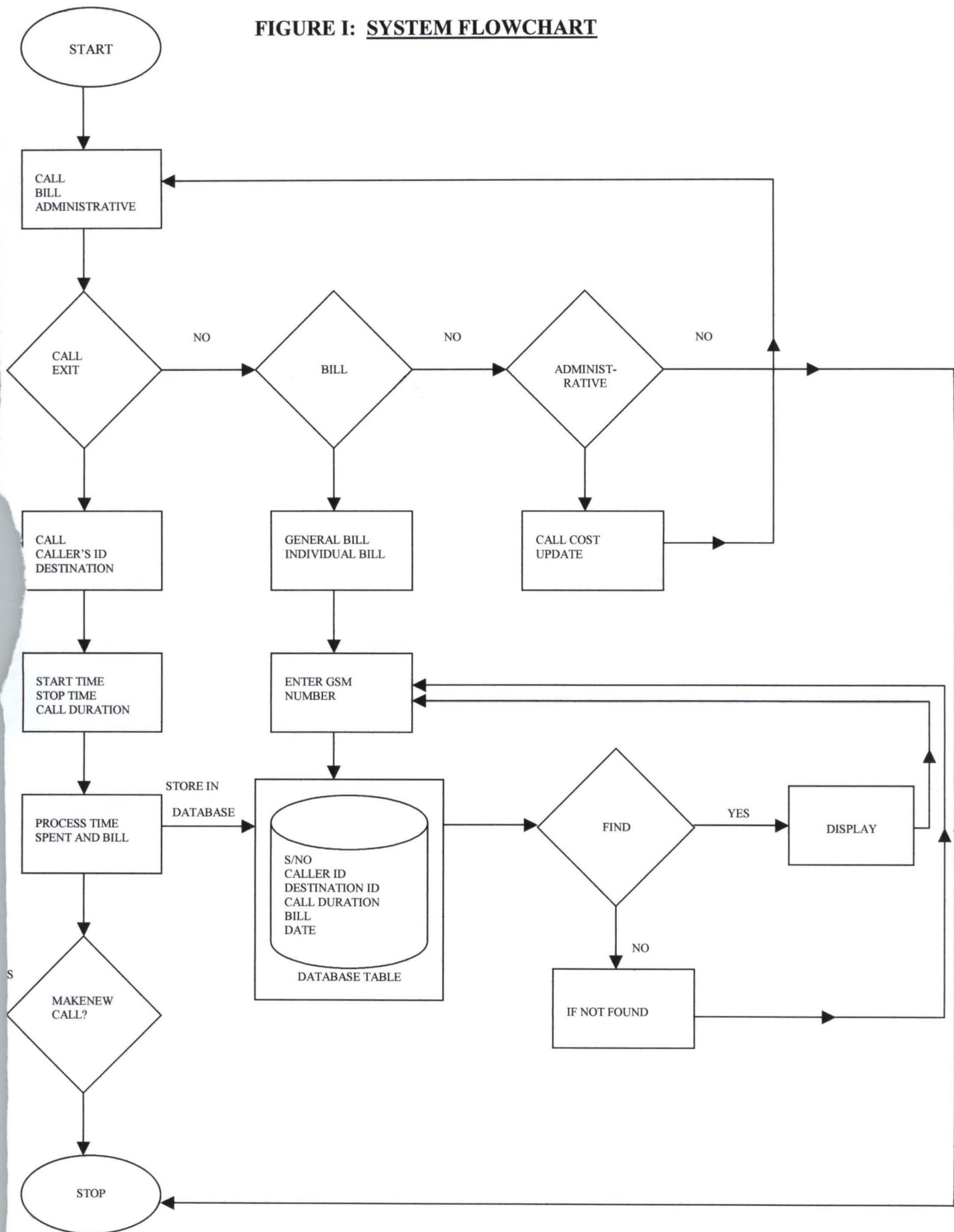
- ❖ That the software be modified from time to time
- ❖ That M-Tel update their billing services
- ❖ That the parallel conversion strategy be adopted in the event that this billing system is to be used.

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**FIGURE I: SYSTEM FLOWCHART**

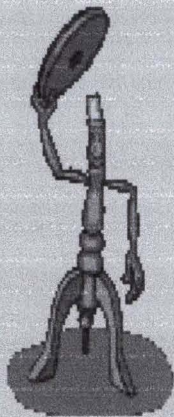


GSM BILLING SYSTEM



# GSM BILLING

(A CASE STUDY OF M - TEL)



DEVELOPED BY:  
THOMAS OCHU

DEPARTMENT OF MATHEMATICS / COMPUTER SCIENCE  
FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

Enter **HERE** >>

NOVEMBER, 2004

FIGURE II: Opening Screen Form



The image shows a software window titled 'S' with a standard Windows-style title bar. The window contains a form for making a call. The form is organized into several sections:

- Caller ID:** A text box containing '08044110417'.
- Call Date:** A text box containing '11/27/04'.
- Destination ID:** A text box containing '093147831'.
- Call Activity:** A large rectangular area containing:
  - Start Time:** An empty text box.
  - Stop Time:** An empty text box.
  - Duration:** An empty text box.
  - Call Cost:** An empty text box.
- Call Type:** A section with two radio buttons:
  - Local
  - International
- Buttons:** Several buttons are scattered throughout:
  - 'Send / Ok' is located below the Destination ID field.
  - 'End Call / Stop' is located below the Call Date field.
  - 'New Call' and 'Done' are located at the bottom right of the form.

FIGURE III: Make a Call Screen Form



**Billing Grid**

Caller ID:

Month:

This is your Bill:

CallerID	ReceiverID	Date	StartTime	EndTime	TimeSpent	Bill	Type

FIGURE IV: BILLING GRID

## SOURCE CODE FOR MAIN FORM

```
Private Sub callcost_Click()  
frmadmin.Show  
End Sub
```

```
Private Sub exit_Click()  
End
```

```
End Sub
```

```
Private Sub Form_Load()
```

```
End Sub
```

```
Private Sub general_Click()  
FRMGENERAL.Show  
'CrystalReport1.Dsr  
'mainreport.Show  
End Sub
```

```
Private Sub individual_Click()
```

```
'section to open the open the database  
Dim dbo As Database  
Dim rsk As Recordset  
Dim rsg As Recordset
```

```
Set dbo = OpenDatabase(App.Path & "\calldatabase.mdb")  
Set rsg = dbo.OpenRecordset("indtable")
```

```
    If rsg.RecordCount <> 0 Then  
        rsg.Delete  
    Else  
    End If  
rsg.Close  
dbo.Close  
Menow = 0  
Set dbo = OpenDatabase(App.Path & "\calldatabase.mdb")  
Set rsk = dbo.OpenRecordset("calltable")  
Set rsg = dbo.OpenRecordset("indtable")
```

```
    itest = InputBox("Enter GSM Number to View Report")
```

```
    With rsk  
        .MoveFirst  
10    If .EOF Then GoTo 100
```

```
If UCase(Trim(itest)) = UCase(Trim(!callerid)) Then
```

```
    rsg.AddNew
    rsg!calleridt = rsk!callerid
    rsg!Callcostt = rsk!callcost
    rsg!Calltypet = rsk!calltype
    rsg!Calldatet = rsk!calldate
    rsg!durationt = rsk!Duration
    rsg!destinationt = rsk!destinationid
    rsg.Update
    Menow = 1
    'section to display the result
Else
End If
    .MoveNext
GoTo 10
```

```
100 If Menow = 0 Then
```

```
    MsgBox ("Record Doesn't Exist"), vbCritical
```

```
Else
```

```
    FRMINDIVIDUAL.Show
```

```
End If
```

```
rsk.Close
```

```
rsg.Close
```

```
dbo.Close
```

```
End With
```

```
End Sub
```

```
Private Sub make_Click()
```

```
    frmcall.Show
```

```
End Sub
```

```
Private Sub QUICKVIEW_Click()
```

```
    frmquickview.Show
```

```
End Sub
```



## SOURCE CODE FOR CALL FORM

```
Private Sub Command1_Click()
fnum = UCase(Trim(Text1.Text))
  If fnum = "" Then
    MsgBox "PHONE NUMBER CANNOT BE BLANK", vbInformation
    Text6.Locked = False
    Text7.Locked = False
    Text6.Text = ""
    Command1.Enabled = True

    Text1.SetFocus

  Else
    Command1.Enabled = False
    Command2.Enabled = True

    Text4.Text = Time

  End If
End Sub

Private Sub Command2_Click()
'section to open the open the database
Dim newcost As Single, calloption As String
Dim totalcost As Single
Dim dbo As Database
Dim rsme As Recordset
Set dbo = OpenDatabase(App.Path & "\calldatabase.mdb")
Set rsme = dbo.OpenRecordset("cost")
  With rsme

    .MoveFirst
    If .EOF Then
      rsme.Close
      dbo.Close

    Else
      newcost = Val(!localcost)
      intcost = Val(!intecost)
      rsme.Close
      dbo.Close
    End If
  End With
Text5.Text = Time
'section to trap the text from the text box
```

```

a = Trim(Mid$(Text4.Text, 4, 2))
If Trim(Mid$(Text4.Text, 5, 1)) = ":" Then
    a = Trim(Mid$(Text4.Text, 4, 1))
Else
End If

b = Trim(Mid$(Text5.Text, 4, 2))
If Trim(Mid$(Text5.Text, 5, 1)) = ":" Then
    b = Trim(Mid$(Text5.Text, 4, 1))
Else
End If

c = Trim(Mid$(Text4.Text, 7))
If (Trim(Mid$(Text4.Text, 8, 1)) = "P" Or Trim(Mid$(Text4.Text, 8, 1)) = "P" Or
Trim(Mid$(Text4.Text, 8, 1)) = "A" Or Trim(Mid$(Text4.Text, 8, 1)) = "a") Then
    c = Trim(Mid$(Text4.Text, 7, 1))
Else
End If

d = Trim(Mid$(Text5.Text, 7))
If (Trim(Mid$(Text5.Text, 8, 1)) = "P" Or Trim(Mid$(Text5.Text, 8, 1)) = "P" Or
Trim(Mid$(Text5.Text, 8, 1)) = "A" Or Trim(Mid$(Text5.Text, 8, 1)) = "a") Then
    c = Trim(Mid$(Text5.Text, 7, 1))
Else
End If

j = Trim(Mid$(Text4.Text, 1, 2))
If Trim(Mid$(Text4.Text, 2, 1)) = ":" Then
    j = Trim(Mid$(Text4.Text, 1, 1))
Else
End If

k = Trim(Mid$(Text5.Text, 1, 2))
If Trim(Mid$(Text5.Text, 2, 1)) = ":" Then
    k = Trim(Mid$(Text5.Text, 1, 1))
Else
End If

l = Val(j) * 60 * 60
m = Val(k) * 60 * 60
e = Val(b) * 60
f = Val(a) * 60
g = Val(c)
h = Val(d)
startseconds = l + f + g
stopseconds = m + e + h
Duration = stopseconds - startseconds

Text6.Text = Duration

```

```
If Option1.Value = True Then
totalcost = newcost * Duration
calloption = "Local"
Else
    totalcost = intcost * Duration
    calloption = "International"
End If
```

```
Text7.Text = totalcost
```

```
Text6.Locked = True
Text7.Locked = True
```

```
'section to open database and writw into it
```

```
Set dbo = OpenDatabase(App.Path & "\calldatabase.mdb")
Set rsk = dbo.OpenRecordset("calltable")
    With rsk
        .AddNew
        !callerid = UCase(Trim(Text1.Text))
        !destinationid = UCase(Trim(Text2.Text))
        !calldate = UCase(Trim(Text3.Text))
        !calltype = calloption
        !starttime = UCase(Trim(Text4.Text))
        !stoptime = UCase(Trim(Text5.Text))
        !Duration = UCase(Trim(Text6.Text))
        !callcost = UCase(Trim(Text7.Text))
        .Update
        rsk.Close
        dbo.Close
```

```
End With
```

```
End Sub
```

```
Private Sub Command3_Click()
Command1.Enabled = True
Command2.Enabled = False
Text7.Text = ""
Text1.Text = ""
Text2.Text = ""
Text6.Text = ""
Text4.Text = ""
Text5.Text = ""
Text1.SetFocus
End Sub
```



```
Private Sub Command4_Click()  
Me.Hide
```

```
End Sub
```

```
Private Sub Form_Load()  
Dim dbo As Database  
Dim rsme As Recordset  
Set dbo = OpenDatabase(App.Path & "\calldatabase.mdb", , dbOpenDynaset)  
Set rsme = dbo.OpenRecordset("cost", dbOpenDynaset)  
Command1.Enabled = True  
Command2.Enabled = False  
Option1.Value = True  
Text3.Text = Date  
rsme.Close  
dbo.Close  
End Sub
```

```
Private Sub Text1_LostFocus()  
If Mid$(Text1.Text, 1, 4) <> "0804" Then  
MsgBox ("Wrong number"), vbCritical  
Text1.Text = ""  
Text1.SetFocus  
Else  
End If  
End Sub
```

```
Private Sub Text2_LostFocus()  
If IsNumeric(Text2.Text) = False Then  
MsgBox ("enter valid phone number"), vbCritical  
Text2.Text = ""  
Else  
End If  
End Sub
```