APPLICATION OF SOFTWARE AGENT TECHNOLOGY IN POSTPAID BILLING SYSTEMS FOR REVENUE ASSURANCE IN TELECOMMUNICATIONS

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Abstract
The postpaid billing systems in telecommunication industry is becoming problematic to the industry by contributing to the overall loses each year as a result of some fraudulent activities by some billing and customer care centre staff, that cost a telecommunications company a loss of between 5% and 15% of its total revenue as shown by a research, couple with the inefficiency of some human personnel like the dispatch riders who dispatch or distribute bills. Another paper showed a loss of 5% of a telecom company's annual revenue on faulty billing alone. In order to minimize these problems, a framework is proposed in this paper. Software Agent Technology is used by identifying some of the areas and personnel liable to fraud and inefficiency and substituting them with Software Agents. The billing personnel and customer care centre staff are downsized to 50% and 25% respectively. Agent-based Software engineering as an extension to the traditional Object-oriented Software engineering methodology was used to come up with this framework. The framework after its implementation has shown a 70% reduction in fraud, which will be used by a company to create more job opportunities by network expansion to reach about 204 different communities in one year. This framework will help create more job opportunities for our teeming unemployed youth in our communities, thereby minimizing the security threats in our dear country.

Keyword: Software Agent, Telecommunication, Postpaid Billing System, Revenue Assurance, Revenue Leakages.

Introduction

Providing avenue for communication among people from one location to another is a service which will in turn attract some charges for the service delivery. It is obvious that telecommunications has touched the life of millions of people worldwide. A message that made people to travel long distance to deliver would be delivered using the telecommunications within few seconds, without having to take the risk to traveling especially on our dilapidated roads (Garko, 2008).

In this research, the postpaid billing is given a new direction by substituting some human personnel with Collaborative Software Agents to carry out some of the tasks, thereby minimizing fraud, maximizing efficiency and revenue assurance for the company.

Application of Agent Technology in Telecommunications

The telecommunication industry is changing its direction towards an open arena of information services where presently the goal is information

availability anytime, anywhere, and in any form (text or graphics) in today's world of Information and Communication Technology (ICT). Telecommunications infrastructures looking at their distributed nature across a given region, country or the entire globe are natural application domain for the static or mobile software agent technology (Magedanz *et al.*, 1996; Hayzelden and Bigham, 1999).

Currently, the main area of telecommunications services explored by the researchers in agent technology towards employing agents in carrying out some critical routine tasks is the telecommunications network management (Magedanz *et al.*, 1996; Nicklisch *et al.*, 1998; Bieszczad *et al.*, 1999; Baumer *et al.*, 1999; and Silva *et al.*, 1999). While most of the researchers were centered on network management, there are few that focused their attention to Internet and network protocol like (Kotz and Gray, 1999; Klusch, 2001; and Satoh, 2001).

For a very comprehensive overview of Agent Technology in Communication systems see (Rhodes, 1997; Bonabeau *et al.*, 1998; Hayzelden and Bigham, 1999; Jennings, 1999; Lipperts and Kreller, 1999; Poslad *et al.*, 1999; Stamoulis *et al.*, 1999; Pavlou, 2000; Papazoglou, 2001; Pham and Karmouch, 2002; Foster *et al.*, 2004; Spyrou *et al.*, 2004).

Billing Systems in Telecommunications

Ou *et al.* (2007) addressed some of the billing problems in mobile communication technologies from the roaming aspect for a customer that travels out of his or her home network. A proposal was designed for the other network to charge and bill the subscribers instead of billing subscribers' home network that solves the problem or dispute between the subscribers and their home network service providers. The subscribers after having access to the roaming facilities, the network that provides the services charges and bills the subscribers for the services they enjoyed.

Garko and Tijjani, (2009) highlighted many problems associated with both the prepaid and postpaid billing processes. The problems of the postpaid were many among which are:

i. Over billing
ii. Wrong posting of payments
iii. Failure for a customer to make payments promptly
iv. Revenue leakages
v. Cost of buying stationery
vi. Cost of employing dispatch riders
vii. General inefficiency in the billing processes

Stratus (2010) in one of their products called Emerging Networks Telecommunications Infrastructure Control Environment (ENTICE) proposes some solutions to some of the billing problems in telecommunications. ENTICE combines order processing, service activations, account management and customer support with real-time authentication and rating to create all-in-one solution for prepaid/postpaid applications. Even though, numerous benefits were stated among which are:

i. Realizing full revenue potential
ii. Fraud control
iii. Real – time Call Detail Recording

Another software Vendor that specializes in the design and development of billing systems, Zygo (2010), in one of their latest products *"New Generation Billing & Customer Care System"* proposes architecture of the billing system as shown in Figure 1.

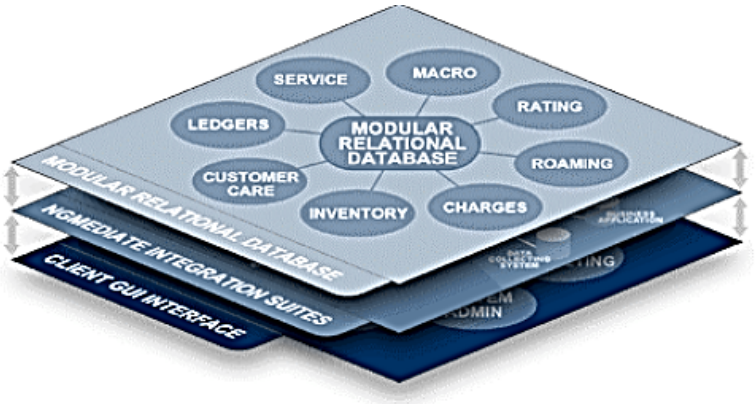

Figure 1: Zygo's Telecommunications Billing Architecture (Zygo, 2010)

Even though, as claimed by Zygo (2010) that, their product is very beneficial to the telecommunications company from the diagram, it can be seen that, many people (users) are involved in the day-to-day running of the system. This would of course, expose it to various form of revenue leakages as unnecessary delays and fraudulent activities are likely to go on in the system.

Billing and the Problem of Revenue leakages

It is very common for telecommunications companies to lose between 5% and 15% of the total revenue annually, if care is not taken on the various avenues of revenue leakages (Mills, 2002).

Mills (2002) identified some of the causes of revenue leakages as:

i. Provisioning
ii. Incomplete records
iii. Trouble tickets / repair
iv. Customer refunds
v. Call Detail Records
vi. Collections
vii. Fraud

Kumar (2012) has identified faulty billing as a contributor to a loss of about 5% of a telecom company's annual revenue, which is a huge amount of money that can be used for network expansion and improving the welfare of its personnel.

Overview of Software Agent Technology

According to Bradshaw (1996), *since the beginning of recorded history, people have been fascinated with the idea of non-human agencies. Popular notions about androids, robots, cyborgs, and science fiction creatures permeate our culture, forming the unconscious backdrop against which software agents are perceived.* Software agent technology has been a research area in Computer Science that deals with substituting human user by a group of computer programs that carry out the routine tasks autonomously with or without minimal human intervention.

What is an Agent?

Generally, agent is software that represents users in the same way the users would represent themselves. More definitions of agent can be found in (Dale, 1997; Bradshaw, 1996; Nwana, 1996; Griss, 2001).

Why Software Agents?

There are a number of reasons why software agents are employed to carry out day-to-day (routine) activities that are centered on efficiency and reliability (Poy, 1996). Another important reason is the benefit to be derived by applying agent to carry out some complex routine operations, for the agents easier to maintain, platform independence and above all concurrent tasks delegation in a network environment (Dale, 1997).

The benefits according to (Bradshaw, 1996; Poy, 1996; Dale, 1997) that can be derived as a result of software agent

technology application are: Easier maintenance and reusability, Platform Independence, Concurrent task delegation.

Classification of Software Agents

Many researchers in the field of Artificial Intelligence and Software Agent disciplines suggested various categories of software agents to belong to different classes. Some of the prominent ones as suggested by (Bradshaw, 1996; Nwana, 1996; Poy, 1996; and Dale, 1997) are:

I. ***Artificial Intelligence Agent***: In Artificial Intelligence, according to Lloyd, (2006) an agent is anything that can be viewed as perceiving its environment through Sensor(s) and acting upon that environment through actuators. A rational agent is one that maximizes its performance according to some performance measure and it does the right thing

II. ***The Information Agent***: Usually, agents are classified based on the roles they perform, especially if the roles are major ones. The information agent usually exploits Internet search engines like Google, Spider, and Yahoo etc. A typical Information Agent and its behavior is shown in Figure 2. These agents help in managing the vast amount of information in wide area network such as Internet. This type of agent may be static, mobile or deliberative (Nwana, 1996).

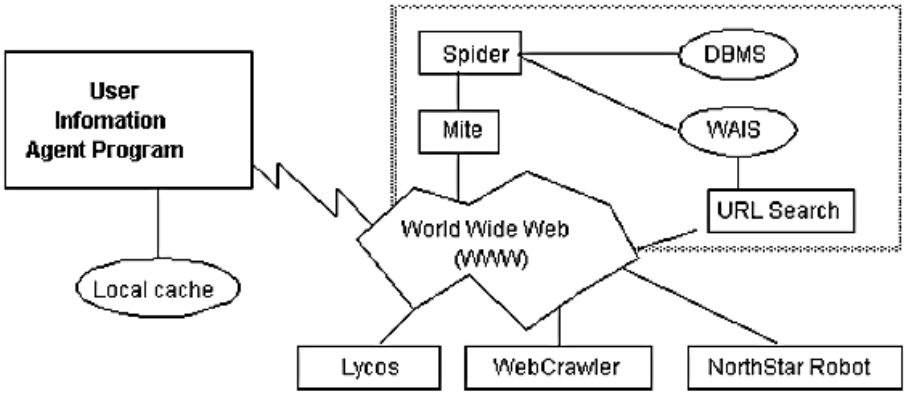

Figure 2: A view of how Information Agents Work (Nwana, 1996)

III. ***The User Interface Agent***: This type of agents uses learning and autonomy in order to execute tasks for their owners. A good example of this kind of agent shown in Figure 3 is just like a personal assistant who works with the user in the same work environment (Nwana, 1996)

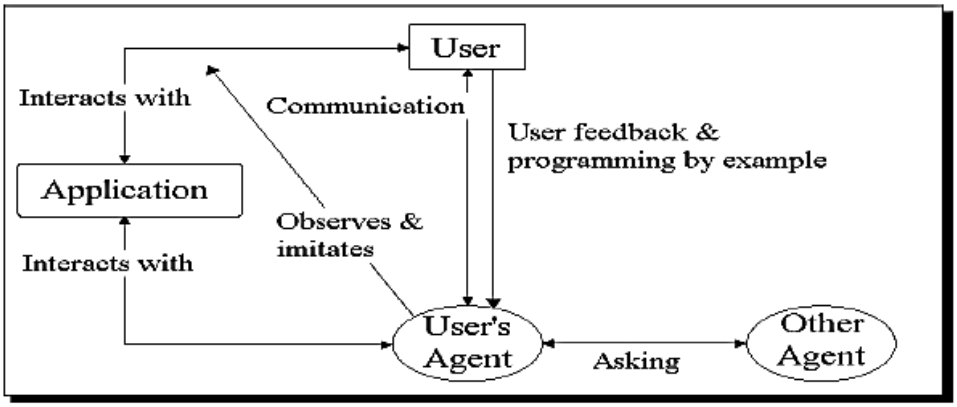

Figure 3: How Interface Agents Work (Nwana, 1996)

IV. ***The BDI Agent***: The Belief, Desire, and Intention (BDI) agents are software agents that are constructed based on certain mentality attitudes or notions like belief, desire and intentions (Nwana, 1996).

V. ***The Distributed AI Agents***: The Distributed Artificial Intelligence (DAI) is a branch or sub-field of Artificial Intelligence (AI) which is most concerned with a group or society of problem solvers or a community of agents collaborating or interacting with one another to solve one complex problem together that cannot be solved by a single agent. This society where different agents come together to solve one problem is called Multi-Agent System (MAS). The problem solving technique performed in MAS is termed Distributed Problem Solving (DPS) and it involves research in the areas of coordination, negotiation, and communication (Griss, 2001).

Properties of an Agent

Nwana (1996), Poy (1996), and Griss (2001), suggested that not all pieces of software are regarded to be called agent; rather, for an agent to answer its name, it needs to have at least three of the following properties (Nwana, 1996). These are:

i. ***Autonomy***: The degree to which an agent is responsible for its own thread of control and can pursue its own goal largely independent of messages sent from other agents (Griss, 2001). According to Nwana (1996), Autonomy refers to the principle that agents can operate on their own without the need for human guidance.

ii. ***Cooperation***: For agents to cooperate they need to possess social ability, that is, capacity to interact with other agents or human users via a communication language (Nwana, 1996). That means it's possible for agents to coordinate its actions without cooperation (Nwana, 1996)

iii. ***Learning***: Agents usually learn to better assist its user in four ways (Maes, 1994)

1. By observing and imitating the user (i.e. learning from the user);
2. Through receiving positive and negative feedback from the user (learning from the user);
3. By receiving explicit instructions from the user (learning from the user);
4. By asking other agents for advice (i.e. learning from peers).

Methodology

The Agent-oriented software engineering as an extension to the conventional Object-oriented technique is a new field under Software Engineering discipline that employs the idea of software agent technology as a technique for developing complex software system. This technique as suggested by experts in agent technology involves three (3) stages that represent Agent-based software life cycle as:

i. ***Decomposition*** – This means breaking or splitting the complex system into various simpler sub-systems.

ii. ***Abstraction*** – This involves the process of defining a simplified model of the system that emphasizes some of the details or properties, while hiding others. In this stage of Agent-based software life cycle, the concept of Unified Modeling Language was used to come up with different Agent-UML designs as models of our Agent-based system.

iii. ***Organization or Hierarchy*** – After decomposing the complex postpaid billing system into various simpler sub-systems as: Pre-billing, Main billing, and Post-billing, and having identified the required number of software agents on the three sub-systems, the next step in the agent-based software life cycle was coming up with a hierarchy of agents as

problem solving components. This process involved identifying and managing the inter-relationships between these software agents. The ability to specify and enact organizational relationships helped us tackled the system complexity in two ways:

a. By enabling us to group a number of basic components together and treated the group as a higher-level unit of analysis.
b. By providing a means of describing the higher-level relationships between various components.

The Agent system was designed following the above mentioned stages of the Agent-based software life cycle. After the agent system designs, then comes the Object-oriented designs, where all other objects identified in our new system were identified and designed using the Unified Modeling Language (UML) diagrams. Some of the activities are described by using pseudo code (Algorithm).

Agent-Oriented Modeling Method – Some Assumptions

When modeling a real world application domain using agent-oriented approach the following assumptions are made:

i. Agents and objects can co-exist and have mutual relationship.
ii. An active object can be regarded as an agent.
iii. Agents act asynchronously.
iv. Interactions among the software agents take place through exchanging messages.

Some of the designs using these assumptions are shown in Figure 4 and Figure 5.

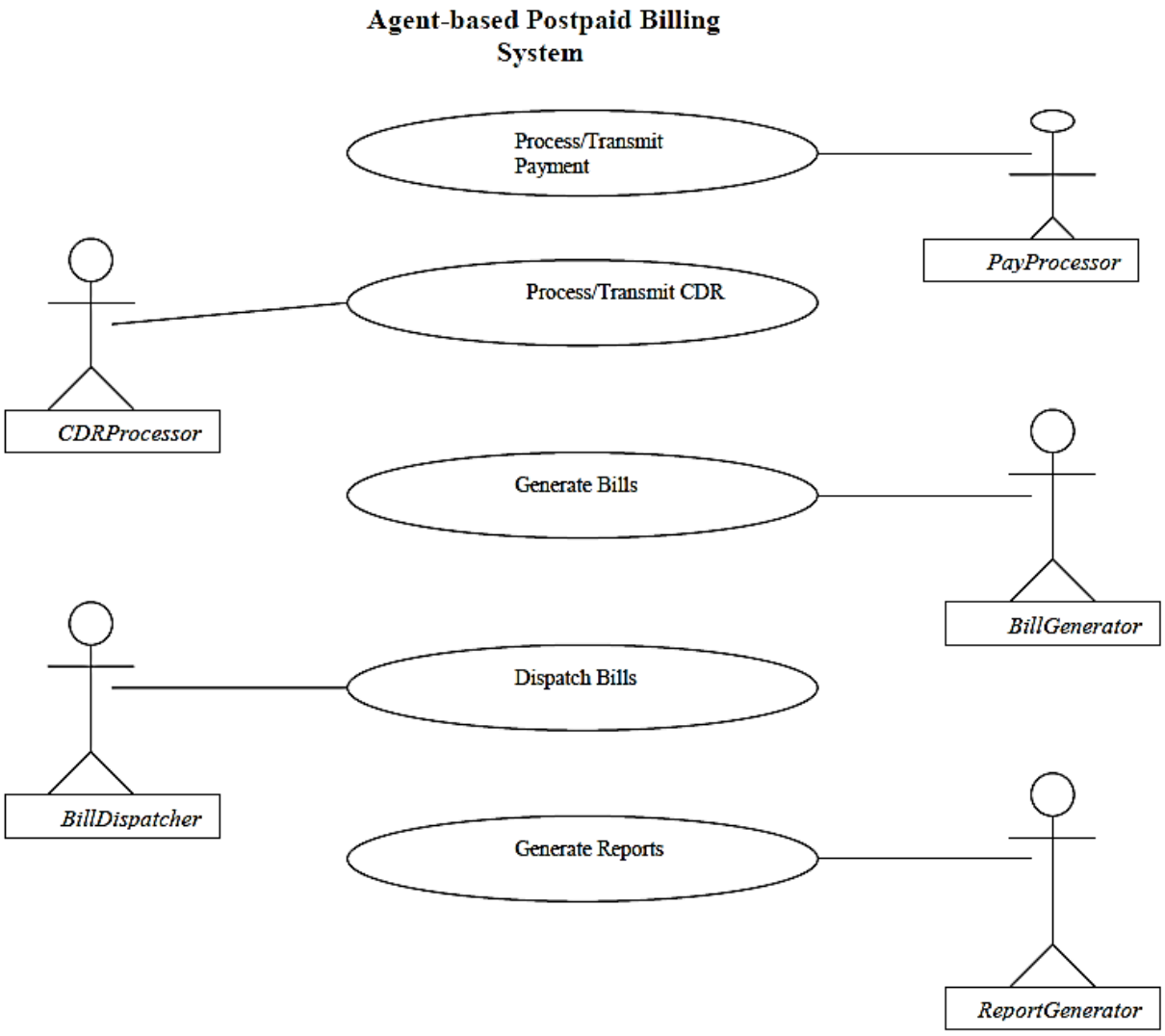

Figure 4: UML Use-Case Diagram for the Agent-based Postpaid Billing System.

Activity Diagram for the Postpaid Billing System

Another diagram of interest to this research is the activity diagram. This diagram shows the procedural flow of control between two or more agents while executing an activity. The UML activity diagram for our proposed Billing system is fully described as shown in figure 5.

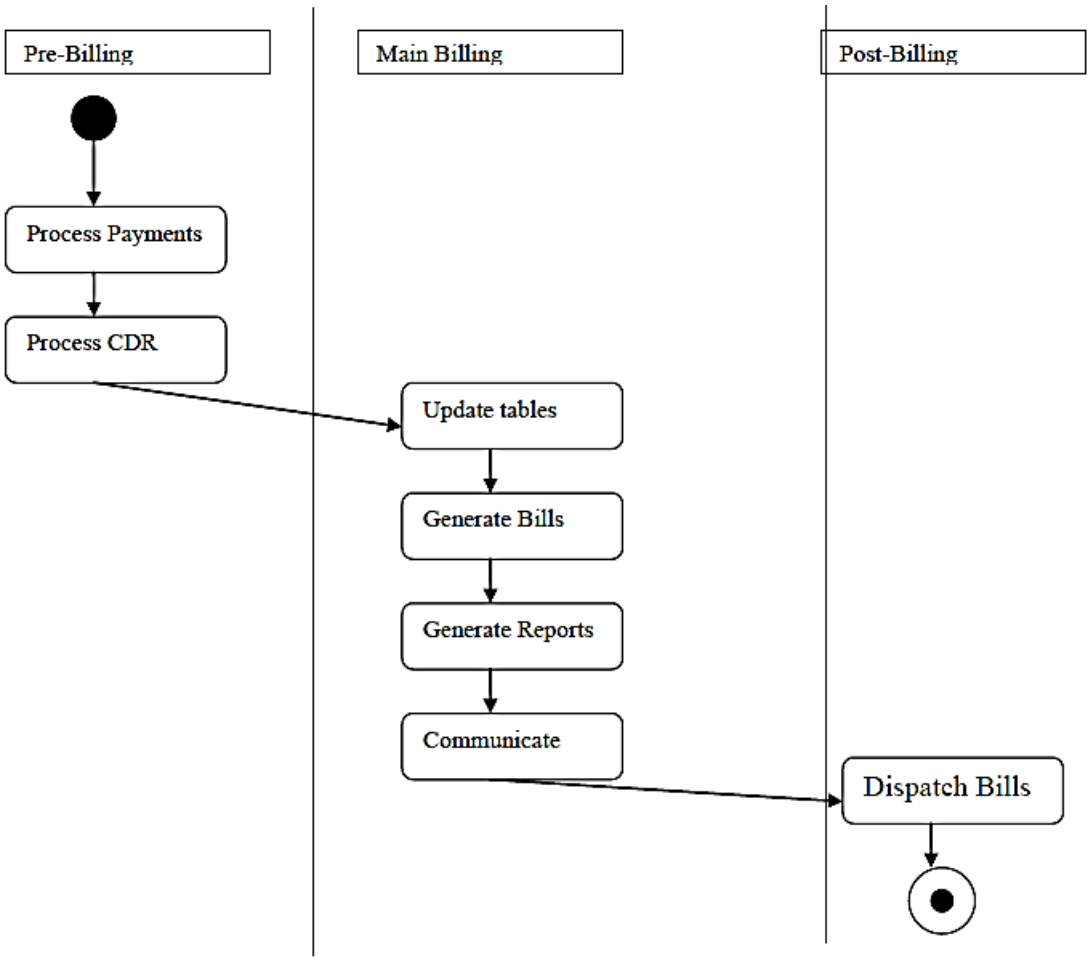

Figure 5: UML Activity Diagram for the Postpaid Billing System

System Requirements

In carrying out the system implementation, some components in form of hardware and software were required. The experimental environment used was comprised of a local area network (LAN) with four computer systems. The following are what we considered to be the minimum requirements as far as the billing system is concerned, considering the volume of data that is involved in billing activities.

Software Requirements

Having highlighted on the hardware requirements of our new system the remaining component that manipulates the hardware is the software. The software requirements for our new system are as follows:

- Java programming language : J2SE 1.6 was used to implement the agent system
- Visual Basic 6.0 was used to implement almost all the processes from CDR and payment processing to bills generation and distribution.
- Mysql RDBMS was used as our back-end to develop and manage all our database tables
- Macromedia Dreamweaver and PHP scripting language were used together with Mysql and Apache to implement the customer settlement portal.

System Development

This involved setting up the components highlighted above in form of LAN and writing codes to implement the various designs and algorithms in our new system.

Figure 6 is one of the interfaces used by a customer to view and settle his/her bill. As mentioned earlier, Mysql 5.0 was used as a relational database management system (RDBMS) to house the various database-tables.

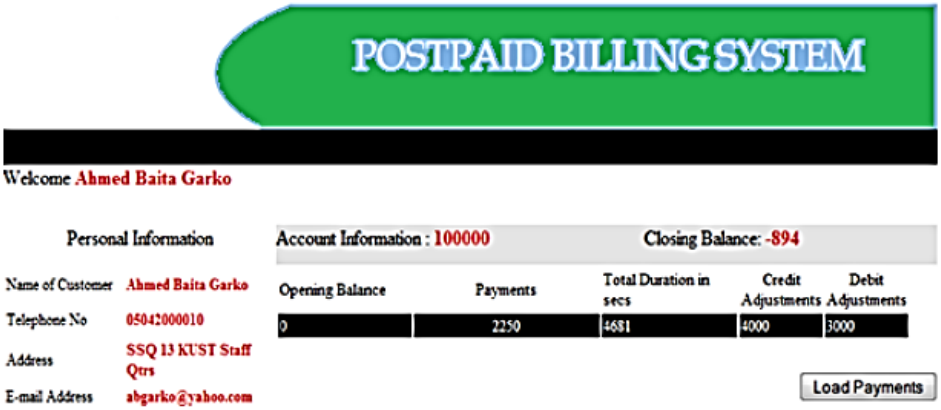

Figure 6: Customer Bills Settlement Portal

Results and Discussion

After coming up with the results of implementing our framework, we tried to compare them with what is currently obtained or practiced in some four randomly selected telecommunication companies in Nigeria. The comparisons are shown in some tables and graphs under this section of the thesis. The results revealed the advantage of implementing our proposed framework as it will help a telecommunication company in minimizing fraud as the billing personnel are reduced to half (50%), Customer service centre staff reduced to one quarter (25%), and also maximizes revenue by the same factor and improves efficiency in the overall operations in the postpaid billing system. The telecommunication companies are named: Company 1, Company 2, Company 3, and Company 4. Our framework is represented as "Agent_based" on the various tables and graphs that follow.

Company 1 and Agent_based framework compared:

The tables 1, 2 and 3 are drawn from the data obtained by interviewing some billing personnel and compared the data with our results from the Agent_based framework.

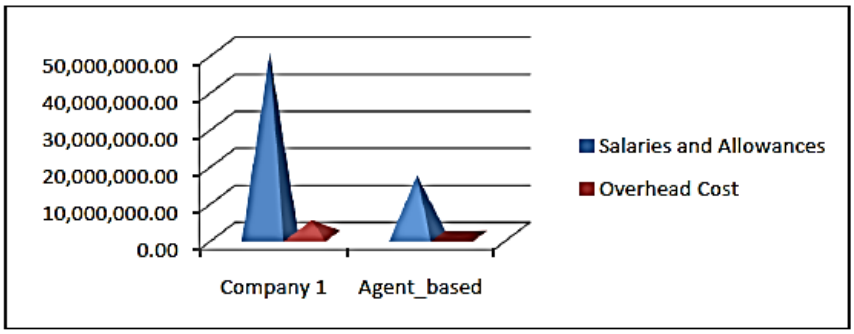

Figure 7: Monthly expenditure difference for Company 1

The graph (Chart) in Figure 7 is plotted from a table of values that summarizes the expenditure of company 1 in terms of salaries, allowances, and overhead cost

spent monthly. The current company's expenditure monthly is compared with the monthly expenditure if the company changes its postpaid billing system mode of operation to our framework. As can be seen clearly from Figure 7, implementing our framework will cost the company less than half of what is spending monthly.

Company 2 and Agent_based Framework compared

Table 1: Company 2 Monthly Savings using Agent_based Framework

Item	Company 2	Agent_based	Difference	Percentage Savings
Salaries and Allowances	13,083,333.33	4,791,666.67	8,291,666.66	63.38
Overhead Cost	1,820,000.00	360,000.00	1,460,000.00	80.22
Total	**14,903,333.33**	**5,151,666.67**	**9,751,666.66**	**65.43**

Table 1 is the summary of the monthly expenditure of company 2, which shows almost 65% of the current amount is going to be saved by implementing the Agent_based framework.

Company 3 and Agent_based Framework Compared

Table 2: Company 3 Monthly Savings using Agent_based Framework

Item	Company 3	Agent_based	Difference	Percentage Savings
Salaries and Allowances	9,083,333.33	3,291,666.67	5,791,666.66	63.76
Overhead Cost	950,000.00	150,000.00	800,000.00	84.21
Total	**10,033,333.33**	**3,441,666.67**	**6,591,666.66**	**65.70**

Similarly, comparing our framework with company 3's mode of operations and cost implications on monthly basis reveals 65% gain using our framework. Only 35% of the current expenditure on bills generation, printing, and distribution is going to be spent by implementing our Agent_based framework.

Company 4 and Agent_based Framework Compared

Table 3: Company 4 Monthly Savings using Agent_based Framework

Item	Company 4	Agent_based	Difference	Percentage Savings
Salaries and Allowances	16,083,333.33	6,041,666.67	10,041,666.66	62.44
Overhead Cost	360,000.00	80,000.00	280,000.00	77.78
Total	**16,443,333.33**	**6,121,666.67**	**10,321,666.66**	**62.77**

In summary, company 4 implementing our framework will minimize its spending by 62.44% salaries and allowances, 77.78% Overhead cost and generally, the company will minimize its monthly expenditure by 62.77%.

Substituting some personnel with software agents

Some billing personnel and customer care centre staff according to our proposed framework are going to be reduced to minimize expenditure, minimize fraud, and maximize revenue for a telecommunication company. The graphs below summarize the implications of reducing the number of billing personnel to 50% and customer care centre staff to 25%.

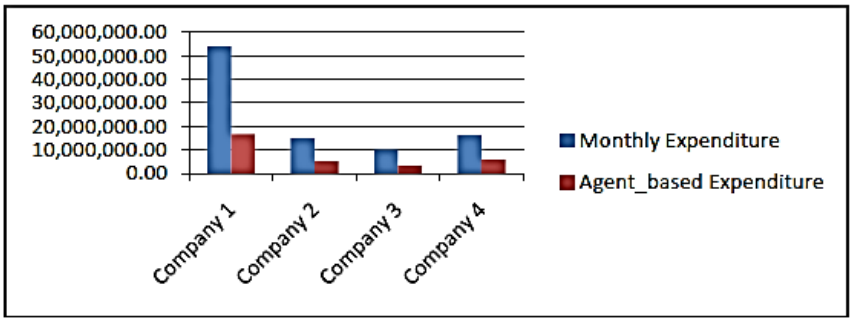

Figure 8: Monthly Expenditure for the four Companies

Minimizing fraud by implementing the Agent_based Framework

Fraud as one of the elements causing revenue leakages that may result a loss of between 5% and 15% of Telecommunication Company's revenue annually, according to Mills (2002), will be minimized by implementing our proposed framework. According to Mills (2002), the likely areas exposed to fraud are:

i. CDR handling / processing by human personnel
ii. Payment in banks
iii. Billing personnel
iv. Customer care centre

If $Fraud_1$ is a function of these four areas then,

Let x be the number of personnel handling CDR

Let y be the number of banks involved

Let b be the number of billing personnel

Let c be the number of customer care centre personnel

Then, $Fraud_1 \propto (x + y + b + c)$

where K is constant

$$Fraud_1 = K(x + y + b + c)$$

Assuming K = 1, then

The total fraud on the system now is

$$Fraud_1 = x + y + b + c \quad (1)$$

Equation (1) is the Fraud in the currently executing environment for the four companies we are dealing with.

For our proposed framework, CDR is handled purely by software agents, payments are done purely by customers using recharge vouchers or ATM card, and we have the following:

$x := 0, y := 0,$

$b := \frac{b}{2}$,

and $c := \frac{c}{4}$

Therefore,

$$Fraud_2 = \frac{b}{2} + \frac{c}{4}$$

$$= \frac{2b+c}{4} \quad (2)$$

Assuming 10% of billing staff handle CDR

Assuming the twenty five banks are involved in bill settlements.

From the above simple computations we can say if our framework is carefully implemented, fraud as one of the causes of revenue leakages is going to be minimized by about 70%.

Tackling the fear of unemployment

From the results we have seen so far that, the downsizing of the billing and customer care centre personnel by 50% and 75% respectively, and replacing the downsized billing personnel with collaborative software agents should not generate fears of unemployment, as the framework will help a telecommunication company to minimize expenditure on salaries and materials for bills printing and distribution by 65%. Also, the framework if well implemented may minimize fraud by 70%.

According to Kumar (2012), it has been found that telecommunication companies lose 5% of their revenues as a result of faulty and fraudulent billing systems.

Going by our findings since these fraudulent activities are carried out by human personnel, this 5% is going to be minimized by 70%.

From the point of view of company 2, which is earning between 50 and 52 billion naira monthly, going by Kumar's finding, between 2.5 and 2.6 billion naira is likely lost monthly in that company. Implementing our framework, this amount is going to be minimized by 70%.

Thus, monthly amount to be minimized is going to be: = 2, 500, 000, 000.00 * 70/100

= 250, 000, 000.00 * 7

= 1, 750, 000, 000.00

Therefore, implementing our framework by company 2 that realizes between 50 and 52 billion naira monthly will minimize the revenue leakages by 1, 750, 000, 000.00.

Assuming one hundred million naira is spent to build one Base Transceiver Station (BTS) then company 2 can build up to 17 new BTS in different communities every month. So, in one year, company 2 may reach up to 204 different communities. The implications to this development are:

i. For each 10 BTS there is going to be at least one electrical engineer employed

ii. For each 10 BTS there is going to be at least one mechanical engineer employed

iii. For each community there is going to be:

1. At least one recharge card seller
2. At least one phone charging shop
3. At least one technician repairing phones
4. At least two security guards

Therefore, the total new job opportunities per year are going to be:

20 + 20 + (5 * 204) = 40 + 1020 = 1060 new job opportunities per year.

CONCLUSION

In conclusion, it can be seen that the new framework proposed and developed, that is, application of software agent technology in building a postpaid billing system in telecommunications, if properly implemented will result in minimizing fraud, minimizing expenditure and also minimizing inefficiency. By minimizing these three factors, profit and revenue are going to be maximized; while fraud is minimized by at least 70%; and a total of 1060 new job opportunities are going to be created per year.

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