

Filling the Digital Divide in Rural Connectivity: Case for Last Mile Mobile Broadband Subscription

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ABSTRACT

Access to Information and Communication Technologies (ICTs) has been found to have a correlation with socio-economic development and gross domestic product. Despite efforts by governments across Africa to revamp the telecommunications sector e.g. the establishment of submarine cables, there is a widening gap between citizens with easy access to ICTs and those without. This study sought to investigate how to promote greater accessibility and higher uptake of broadband services in rural areas. This will minimize the digital divide of the underserved and unserved parts.

A model prototype for last mile mobile broadband subscription for rural Kenya was developed to enable mobile phone users purchase broadband services thus improving access to ICT in rural Kenya. This represents a model last mile connectivity as the closest network where majority of the people live.

In developing this prototype, existing subscription technologies were studied, a conceptual model developed, integration to the existing M-Pesa money transfer technology explored, existing connectivity methods studied, connectivity tokens designed, and linkage through modems using mobile phone achieved.

The prototype was tested by a link to WiMAX network via a local Internet Service Provider (KDN Butterfly). Files of different sizes were uploaded and downloaded. The time taken was measured using a bandwidth manager. The experiment was repeated with a Global System for Mobile Communications (GSM) broadband provided by a different service provider (Safaricom). The study showed that WiMAX broadband was faster than Safaricom GSM.

This research contributes a solution towards alleviating the broadband access gap experienced in rural areas of Africa. The provision of broadband Internet access through wireless technologies as an approach towards solving the digital divide that exist in rural areas has been demonstrated using the prototype developed. This solution would assist governments in planning and developing an appropriate policy on rural broadband access initiatives.

Key words: Last Mile, Mobile Broadband, WiMAX, Digital Divide

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1. INTRODUCTION

According to the United Nations Report (2010), over 77 per cent of the population in developing countries is able to receive a mobile phone signal. The digital divide between developed and developing countries continues to widen for technologies that drive modern information sharing such as broadband Internet connection (Sang et al 2007). On the demand side, the barriers to take-up broadband in developing countries are: affordability of broadband services and computing equipment; unreliable electricity supplies; and the paucity of local content. On the supply side, the limiting factors are: the shortage of and high price of international bandwidth; lack of incentives for operators to invest in rural roll-outs; limitations on access to spectrum; and the lack of a supportive, reliable and regulatory environment. There has been mass-market adoption of broadband in an increasing number of countries in the developed world, while take-up of broadband in many countries in Africa including Kenya, has been negligible, causing the broadband access gap to widen considerably. Wireless broadband technologies, such as HSPA and WiMAX, have a key role in filling the gap of broadband access in developing markets. According to CCK (2010), these technologies depend on the use of spectrum for the roll-out of wireless networks and therefore require regulatory intervention. In order to get connectivity in rural Kenya, cash is used to pay for scratch cards that are fed into slow GSM Networks. There are limited mechanisms of collecting users into a unified single system which could avail unprecedented bargaining power to consumers of broadband services.

The utilization of the National Fiber Optic Cable to facilitate access to ICT services is below the expected level both in rural and urban areas. The low rate of development in rural Kenya has multiple and mutually reinforcing causes which are exacerbated further by the lack of access to ICT. The people living in rural areas lack access to information about income earning opportunities, market prices for the goods they produce, health, their rights and public welfare. They lack access to knowledge, education and skills to improve their livelihood, and a voice in the political and development processes that can shape their lives (CCK, 2010).

The aim of this research was therefore to find out how to promote greater accessibility and higher take-up of broadband services in rural areas using WiMAX technology thus maximizing utilization of National Fiber Optic Networks. In order to achieve this, Kenya was used as a case study.

A model prototype for last mile mobile broadband subscription for rural Kenya has been developed to enable mobile phone users purchase a broadband service thus improving access to ICT in rural areas. The prototype represents a model last mile connectivity which is the closest network where the majority of the people in Africa live. The design of the prototype applies a connectivity layout similar to the one designed by Lu, Wang, and Madhian [2007].

In developing this prototype, existing subscription technologies were studied, a conceptual model developed, integration to the existing M-Pesa money transfer technology explored, existing connectivity methods studied, connectivity tokens designed, and linkage through modems using mobile phone achieved.

The prototype was tested through simulation to ensure the subscriptions and M-Pesa payments are functional and effective, the provision of token allocations via the mobile phone to a user in the rural is possible, and compare the performance of broadband versus the GSM modem.

International Fiber Optic Network is significant in enabling the country's broadband infrastructure to offer investors tremendous opportunities for their business. This will lead to more investment in all facets of the economy. The aim is to improve rural based businesses that provide ICT goods and services to majority of citizens through village kiosks that are run and managed by local entrepreneurs. Some of the services that can be provided are computer education, e-government, health insurance, e-commerce, and microfinance. A standard mobile broadband Internet access to the last mile home connectivity provides a uniform standard way of inter-module communication that is reliable and free from the current propagation delay found with satellite telecommunication.

2. LITERATURE REVIEW

The research reviewed literature on the existing subscription systems and found that dialup connectivity was commonly used for Internet access [Kenya Data Networks, 2009]. Dialup connections result in slow connections, high effects of noise, and congestion in the telephone line, thus making Internet access unreliable. To solve the problem there is need for a common database so that all details of subscribers need to be stored in a single database as suggested by Spool [2005]. Mobile devices are intended to experience displacement while maintaining functionality [Rebolj, 2002]. The growth of mobile phone technology has increased their style, functionality, capacity, application areas, features and usability. Subscription systems based on broadband is more effective than dial up lines or fixed lines [Begh and Kagioglou, 2004]. It is possible to increase the efficiency of registration of new subscribers by involving the centralized database approach [Cheng and Chen, 2002]. Mobile phones can have an influence in rural telecommunication [Flanagan et al, 2001a]. Pervasive computing is made possible by wireless mobile communication between embedded systems, handheld mobile devices, and stationery devices [Flanagan et al, 2001b]. The subscription module is faster than current existing manual subscription where a broadband user must physically look for Internet Service Provider agents to buy scratch cards. Sometimes these agents are scarce in rural areas.

This research, therefore, sought to design and implement a prototype that can enhance registration of subscribers and contribute to future planning on broadband requirements in rural areas.

To automate payments for broadband services, the research study focused on how to integrate M-Pesa payment to the prototype. This study focused on the factors influencing the mobile payments usage by the micro business operators and applied the theory of Technology Acceptance Model, a theoretical model that explains how users come to accept and use a technology. Adoption of mobile money payment in urban areas in China found that two primary determinants for adopting and using new technology was influence by variables such as security concerns, cost, convenience, and satisfaction [Lu et al, 2003]. M-Pesa integration to the prototype required to be secure. There was need to provide a service that incorporated use of a PIN and secret code financial transactions.

The IEEE 802.16 standard, also known as Worldwide Interoperability for Microwave Access (WiMAX), has emerged as the strongest for broadband wireless technology with the promises to offer guaranteed quality of service to wireless users. The design of WiMAX technology is aimed at providing last mile wireless broadband access at a cheaper cost [Murphy, 2006]. The "last mile" is the final leg of delivering connectivity from the service provider to a user in rural areas. This leg is typically seen as an expensive undertaking because of the considerable costs of wires and cables.

Varshney and Vetter [2002] in their research on prototype testing found that many businesses have

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deployed mobile applications to gain competitive advantage. Such applications developed specifically for small mobile devices include daily news alerts, classified mobile advertising, restaurant and entertainment listings, wireless web portals, and mobile commerce. This research sought to test how the users in rural Kenya can use their mobile phone and gain competitive advantage by applying the prototype to make payment via M-pesa and get allocated a free token from the database.

3. METHODOLOGY

The study explored the last mile mobile broadband subscription and its application to ease the digital divide in rural areas. Analysis and design of the key components required for the broadband subscription system were developed using SSADM tools.

The situational analysis of the existing subscription modes applied in rural Kenya for enhancing ICT access was investigated. The limitations of each mode were identified. The current environment is such that broadband is provided to corporate organizations that pay directly to the service providers by travelling to the Head Office and making payments. Individual users buy scratch cards from mobile broadband agents. Sometimes scratch cards are not available, manual method of purchase not reliable, and the service is expensive as it is charged per bundle purchased. There is lack of economy of scale as the users are individualistic and a mechanism is required to bring them together so that they can enjoy economies of scale. In rural areas there is less impact on development of applications in ICT that can utilize the National Fiber Optic Networks that are found in major towns. More effort is required towards the penetration of National Fiber Optic Network coverage to extend their coverage.

The alternative system used in last mile broadband subscription is the Worldwide Interoperability Microwave Access (WiMAX) network. WiMAX is more reliable and provides for a reliable data transfer compared to connectionless provided by GSM networks. To enhance communication for data transmission the research proposes an integration of WiMAX into rural communication via national backbones, which cover most of the country [CCK, 2010].

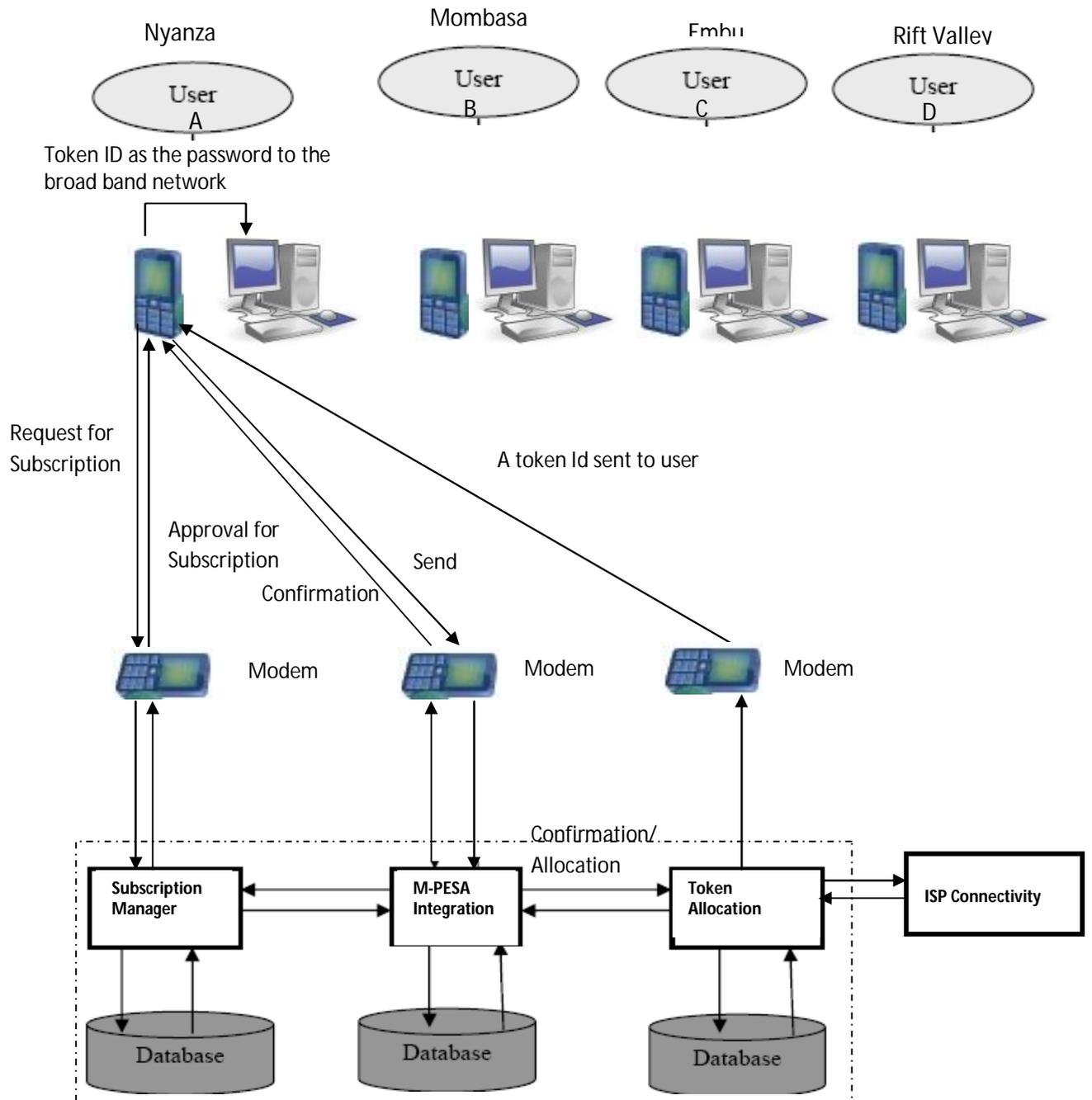
A model database to store details of users was required to support current ICT service demands and for the future. The database can retrieve, process transactions, provide payments for services and enable overall efficiency.

After evaluation, the best solution for the problem of data communication in rural areas was a model subscription system. The system should address the shortcoming of lack of centralized database, lack of faster payment for connectivity, an alternative to slow GSM communication, and enhance capacity of broadband available.

The conceptual design model consists of the following five components:

1. Subscription Manager: The module receives details of the user through a mobile phone.
2. M-Pesa Integration: Records payments and assigns a token id into the broadband system.
3. Token Allocation: Allocates the token based on the M-Pesa payments and tracks expiry dates.
4. Modem: Provides the link into the system via message transmission into and through mobile phone.
5. ISP Connectivity: Provides the connectivity for subscription system to the international gateway Internet service.

The components are unified into a single conceptual design as shown in Figure 1.



The mobile phone subscription module consists of a database to store the registration details as follows: Name of user, Identification Number, County, Division, Village and Phone Number. The other component of the mobile phone subscription module is the user mobile phone for sending messages to the database in the above format. A second mobile phone acted as a modem for real time message transmission via the

communication port of the laptop (16 & 17). The system is programmed to accept the information in the format:

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username#id#county#division#village
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Also required is communication protocols, and software for embedded programming to allow packets of data to flow through the ports.

The mobile payment module consists of the M-payment which is connected to the database through the Safaricom M-Pesa system. There are other M-payments such as Zap, Yu Cash, Orange Money available in rural Kenya. According to Safaricom Report [2010], the M-Pesa has been adopted as an ideal approach for E-commerce as majority of the people in rural areas are already registered as M-Pesa account holders (by end of March 2009, there were over 6.175 million registered M-Pesa customers with an average of 11,580 new registrations per day, representing a growth of 198% from the previous year). The report suggests a need for design of innovations that appeal and enhance the utilization of mobile phone to improve their lives. Similar research in Asia [Porteous, 2006], suggested that a mobile phone was a viable technological tool for mobile banking and mobile payment services across the country as there are more people with mobile handsets than with bank accounts. This study applied a similar design approach to Porteous [2006], such that rural people were enabled to automate payments for broadband connectivity through their mobile accounts.

To facilitate payments we have introduced token passing technology. On successful payment of the connectivity fee the mobile user is allocated a token code that is transmitted to the user electronically through their mobile phone number registered in the database. The payments are received in e-float from the user's SIM-card number account upon debit of the account and they are forwarded to the account of service provider. The user is provided with token codes that act as a password for last mile mobile broadband connectivity via the WiMAX. The designed module has a connectivity component that enables processing of token allocated and measures the duration of usage in the Internet by tracking the expiry date for each token.

According to Anurag et al [2009], the mobile phone is quickly becoming ubiquitous deployed technology, even among poor segments of the population. Penetration of mobile is 48% today and it is expected to reach 72% by 2014. This research applied the M-Pesa mode of payment as it is an easier form of cash delivery for payments for broadband and other business transactions. This M-Pesa designed approach was relatively affordable, personal and can be used anywhere and at any time.

The prototype designed used the approach adopted by IEEE 802.16 standard that was linked to WiMAX to provide the real connectivity. The prototype was linked to the KDN Butterfly Server which acted as a proxy to the WiMAX Gateway to enable measurement of the download and upload time for different file sizes using their network bandwidth manager. The future application of the prototype is in WiMAX distribution of Internet access to the people in rural areas who have limited access.

The subscription model acted as proxy to the WiMAX. Payments are made at a monthly rate. The system tracks the M-Pesa payment and computes the expiry date for each token that is issued to a user via a mobile phone. The token identification number is used as the password into the WiMAX broadband network.

The simulation testing showed the mapping of M-Pesa payments to the phone number that made the payment and in return the system allocated a unique token with an identification number and expiry date.

The connectivity tokens are purchased and fed into the database and the expiry date is determined for each user.

4. RESULTS AND DISCUSSION

The last mile mobile broadband subscription was successfully implemented with the use of Java Development Kit (JDK) running on Windows XP with NetBeans Integrated Development Environment (IDE) and MySQL database. M-Pesa setup was done to enable transfer of details of the transaction using Safaricom. The subscription model setup was successful but with limitations of testing via the WiMAX server used for commercial services. The number of connectivity was dependent on token availability purchased with M-Pesa payments.

The last mile mobile broadband subscription model achieved its key functions of Internet access (user subscription, M-Pesa payment, connection management, and effectiveness) through simulation. The objectives of the simulation were to (a) test the functionality and effectiveness of the subscription model, (b) test the functionality and effectiveness of M-Pesa payments integration, (c) test allocation of tokens via the mobile phone, and (d) test the performance of broadband versus the GSM modem.

A remote user makes a request for subscription via a mobile phone. The modem receives the message and stores the details of the user in the database. The user will then make payments via the M-Pesa. The modem will receive the M-Pesa payment confirmation message and store the details in the database. The prototype will then allocate the user a connectivity token. Once the token is allocated, the system sends a message via the same modem to the user. The allocated connectivity token will be used as the password to the WiMAX network. Once in the WiMAX network, the user can download and upload files.

The simulation layout measured the time it took to download files of various sizes from 1KB to 20MB; one set of files from the broadband network using WiMAX, and repeat the same with GSM network. The results were recorded and a graph plotted to show the performance of the two networks. There are two methods of download or upload tests that were used to test the performance.

Download Test:

1. Small binary files are downloaded from the web server to the client to estimate the connection speed.
2. Based on this result, one of several file sizes is selected to use for the real download test.
3. The test is performed with cache prevention via random strings appended to each download.
4. Up to 8 parallel HTTP threads can be used for the test.
5. Throughput samples are received at up to 30 times per second.
6. These samples are then aggregated into 20 slices (each being 5% of the samples).
7. The fastest 10% and slowest 30% of the slices are then discarded.
8. The remaining slices are averaged together to determine the final result.

Upload Test:

1. A small amount of random data is generated in the client and sent to the web server to estimate the connection speed.
2. Based on this result, an appropriately sized set of randomly generated data is selected for upload.
3. The upload test is then performed in configurable chunk sizes (pushed to a server-side script via a POST).
4. The test can be done using up to 8 parallel HTTP threads (configurable).
5. Chunks are sorted by speed, and the fastest half is averaged to eliminate anomalies and determine the result.

The results of the tests are shown in figure 2 and figure 3.

The bandwidth manager was used to monitor the bandwidth utilization of the WiMAX network as shown in figure 2. The figure shows the preliminary stage where the link is under-utilized as the user session is being set up between the user machine and the servers as authentication message for the requested files is made by the operating system. From the figure at time 500 milliseconds, the actual download for each file commences until completion. At this time the WiMAX receives and transmit the data at its highest utilization of 100%.

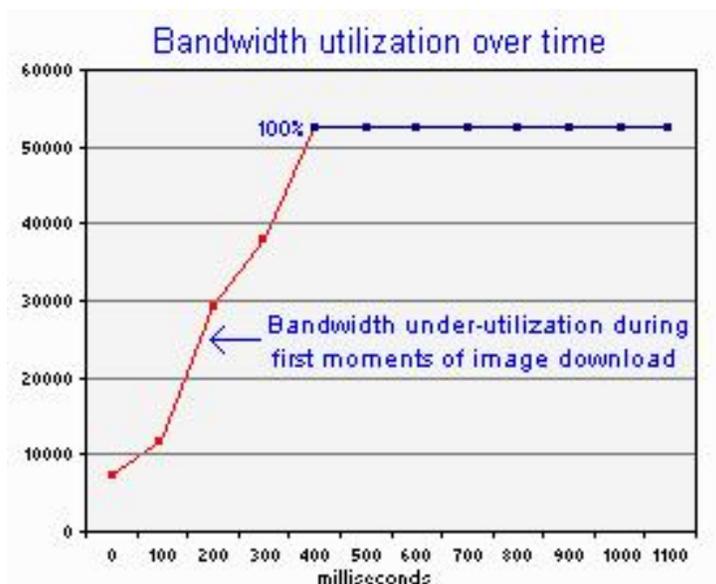


Figure 2: Bandwidth Utilization

The download speed test was done using the bandwidth manager for the various transmission bandwidth links (16KB, 64KB, 256KB, & 512KB) as shown in figure 3. The average round trip time (RTT) for packets was measured for the files downloaded. The data showed the speed of downloads is inverse to the average round trip time (RTT) for the packets of data downloaded. The result showed the higher the capacity of the bandwidth link the higher the speed of download.

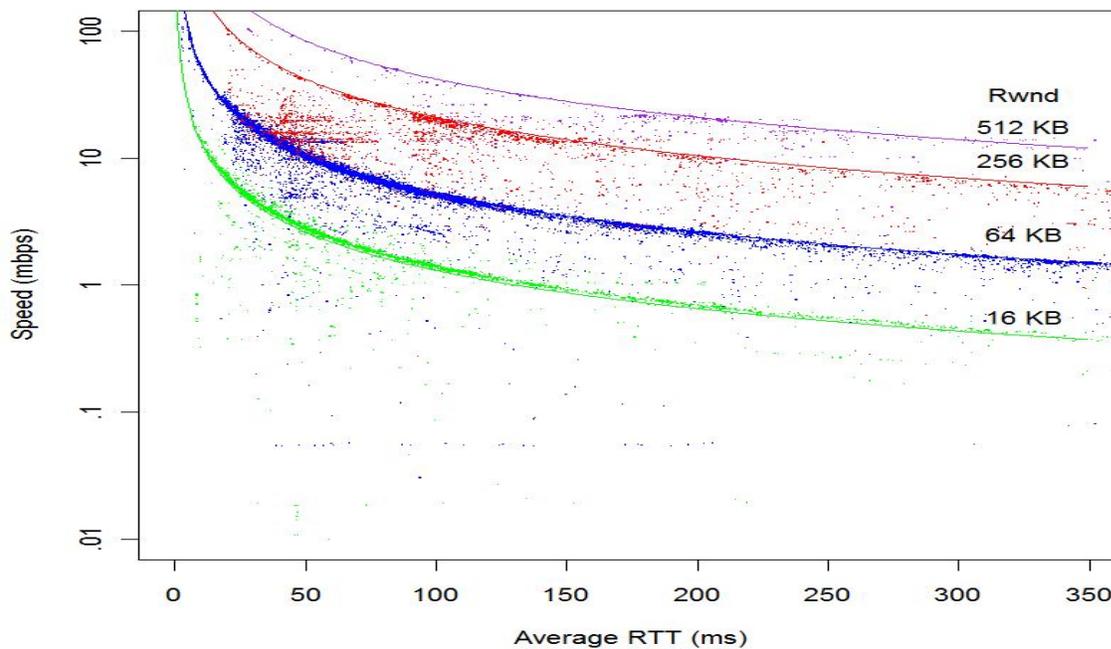


Figure 3: Download Speed Test

The performance of the prototype is shown in tables 1, 2, and 3; and graphs in Figures 4, 5, and 6.

Figure 4 shows that the file size determines the time of download, meaning that the bigger the file size the more time taken to download the file. The speed of the network determines the performance.

Table 1: Network Data Transfer Rate

File Size in Mb	Rate of Transfer in mbps	Time in Sec
5	1.66	3.01
10	1.66	6.024
15	1.66	9.036
20	1.66	12.04

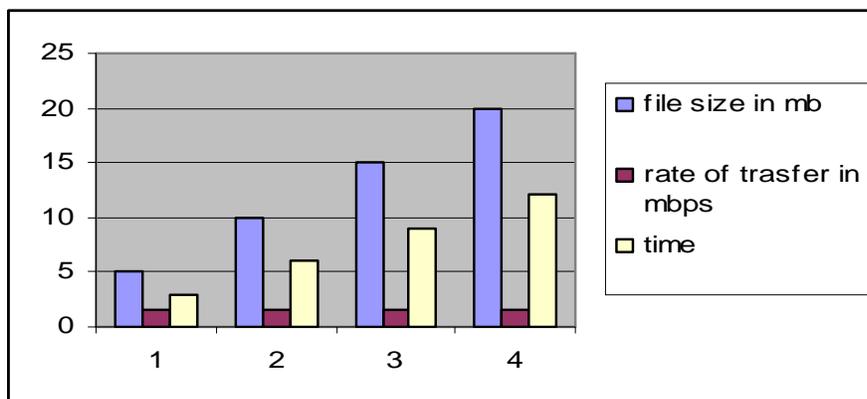


Figure 4: Rate of Data Transfer

Table 2: Last Mile WiMAX Performance

Download speed (Kbps)	upload speed (Kbps)	latency (ms)	jitter (ms)
2636	2829	178	226
11443	2830	173	226
16806	2852	19	3
1690	2907	36	41
16745	2870	17	2
16825	2837	19	6
Sum: 83114	22729	778	1056
Average : 10389.25	2841.13	97.25	132

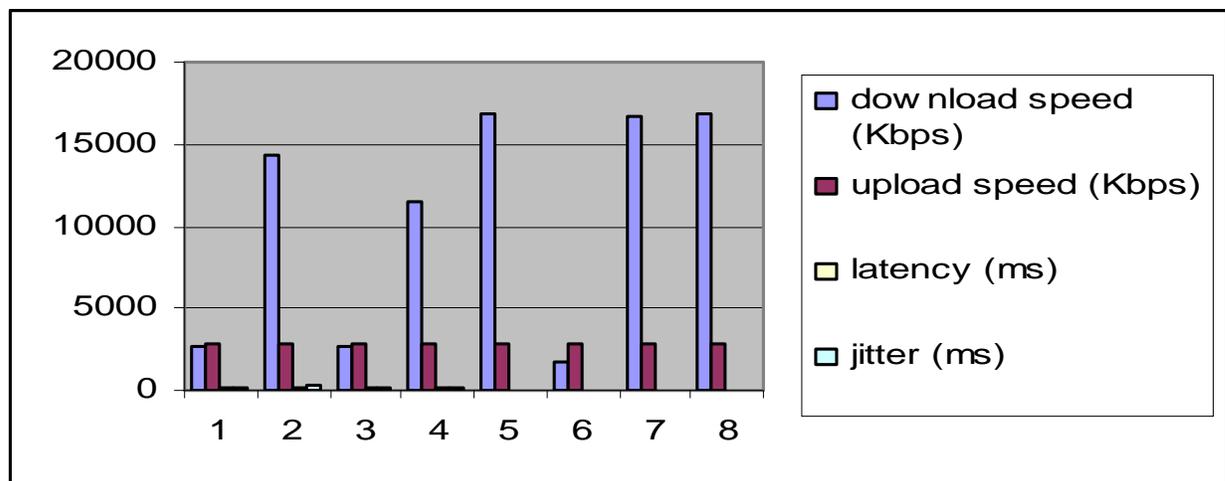
Figure 5: Performance of the Last Mile Mobile Broadband Connectivity

Table 2 shows that the performance of the WiMAX network is faster than the GSM network, which makes it more efficient and provides better performance to the network users. The test successfully shows that the performance of the last mile broadband connectivity for rural Kenya can be supported by the model. Figure 5 shows that the download speed is faster than the upload speed; the latency and the jitter are minimal showing that the network is reliable for commercial purposes. This information shows the network is linked to the fiber optic cable that supports very high data transmission rates.

Table 3: GSM Network Performance

Download speed (Kbps)	Upload/ speed (Kbps)	latency (ms)	Jitter(ms)
0.61	0	0	0
1.12	1	0.04	0.014
1.45	1.2	0.051	0.002
1.5	1.45	0.456	0.12
6.5	1.2	0.31	0.002
4.5	1.4	0.21	0.003
Sum: 15.68	6.25	1.067	0.141
Average: 2.61	1.04	0.178	0.018

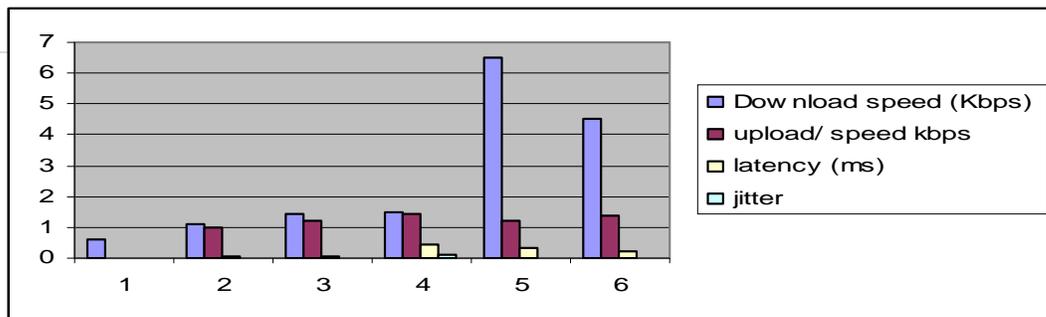


Figure 6: GSM Data Transmission Rates

Table 3 shows that the network had a download average of 2.61Kbps which is quite low and an upload of 1.03Kbps which was consistent with the standards rate provided by the International Telecommunication Union (ITU). The performance data is within the normal transmission rate through a GSM network as per the specifications of the ITU [ITU 1999, 2004]. This shows that the network performance is lower than WiMAX which is because of the Time Division Multiplexing (TDM) applied in GSM where the available links are shared among the users. The system allocates time slots for each user to download and upload data. This sharing results in delays that make the network slow and sometimes busy and connections become difficult resulting in delays as demonstrated in figure 6.

The WiMAX provide superior services because the infrastructure used in WIMAX are such that the links in WIMAX (16, 64, 256, 512) in figure 3 are leased to specific users thus more reliable as there is less sharing, less noisy, and are only used to service the specific organizations such that they are always available on demand. The research demonstrates how this service can be duplicated to the rural areas as an option towards increasing access to Internet connectivity that is more reliable.

The results from simulations done with the subscription model, M-Pesa payments and connectivity tokens lead to the following main findings and observations.

The subscription module (Figure 7) successfully achieved the registration of new users, their identification numbers, their county, division, and villages, by use of mobile phone which acted as the front-end processor. The details are stored into a MySQL database in the server in ascending order of identification number. The prototype was able to keep records of subscribers regardless of their location. The prototype demonstrates an alternative solution towards filling the gap of digital divide problem of low rural broadband connectivity as identified by Waema, Adeya, and Ndung'u [2010]. The research finding agrees to similar conclusions by Begh and Kagioglou [2004] who argued that subscription modules contribute towards alleviating the broadband access gap problem. This is therefore an applicable solution towards problems in rural Africa.

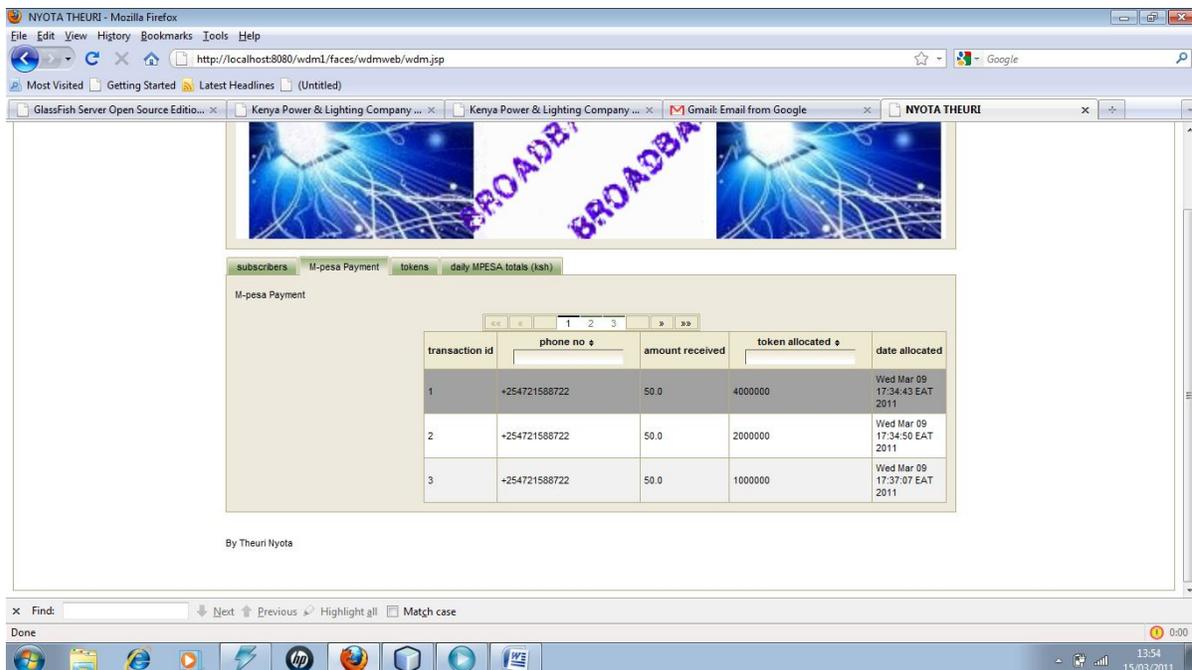


Figure 7: Subscription System Interface

The integration with M-Pesa enables the user to send payments for broadband and the user is allocated a unique token identification number. The message is sent to the user via the mobile phone. The system's interface records a message from M-Pesa confirming the amount of money send and the balance in the user's M-Pesa account. The prototype computes the expiry date for each mobile phone number upon receipt of payment and relays the expiry date to the user. The findings agrees with similar designed prototype by Khodawandi, Pousttchi and Wiedmann, [2003] who concluded that mobile phone was utilitarian and can be advantageous in automating payments compared to direct purchases from Internet Services Provider agents, which is the case in most areas. The prototype reduces the costs inherent in scratch cards or other electronic option available and twists expenses into benefits to all parties in the value chain as concluded by Lu, Yu, Liu and Yao [2003].

When the payments are received and confirmed the token access code is allocated to the user in the token allocation table. The prototype relays the identification number of the token and its expiry date via the mobile phone to the user. The unused token are given '0' status while the used are given '1' showing the tokens have been allocated hence prevention of double allocation making the model reliable and successful. The user then keys in the received token identification number into the Butterfly Network. This is similar to buying a scratch card and entering the reference number so as to get connectivity. On confirmation, the user's computer immediately gets broadband Internet access for one month.

The prototype was implemented using purely open source products. All the main modules were implemented and tested to make sure they are working within the expected time limit. The integration of WiMAX to the fiber backbone makes it efficient than the GSM that is expensive and sometimes unreliable. At the experimental stage, the prototype was linked to the KDN server by setting the public Internet Protocol and enabled the prototype to act as a proxy for WiMAX where the token identification numbers are defined in the server and WiMAX gateway at KDN provided the actual connectivity. The bandwidth manager was used to measure the speed of download and upload when access through the token identification number was made. Different file sizes were used and measurement of time, latency and jitter

done. The experiment was repeated for the Safaricom GSM modem. This research also comes up with an interesting finding that WiMAX can provide faster access to broadband despite earlier view. The results agree with the findings by Spool [2005] on centralized database approach for subscription systems. The tests made concurred with those obtained by Varshney and Vetter [2002]. It is possible in mobile e-commerce to extend electronic businesses to mobile devices. In this case, a user in rural Kenya is able to buy connectivity token where scratch cards are not readily available.

This study is closely related to the upcoming cloud computing platforms and pervasive computing that enables the computer users to have unlimited access to information in whatever form and at whichever speed. Using M-Pesa, consumers can quickly purchase token for Internet access without having to travel to an agent thus provides even stronger application of M-Pesa adoption and usability in rural areas.

The research results illustrate the following key practical implications apply:

- 1 Boost connectivity: The prototype for connection in rural areas is unreliable, lacking and difficult to achieve. In this research, connectivity was easily developed using M-Pesa payment platform.
- 2 Adoption of M-Pesa: The advantage electronic payments would boost the users' ability to use M-Pesa service for payment of services.
- 3 Penetration of broadband Internet access: The penetration of broadband Internet access and its distribution to as many users as possible hence boost of socio-economic status.
- 4 National Fiber Optic Network utilization: The ability of the model to connect to WiMAX implies it is possible to utilize the national fiber optic cable network by providing rural connectivity resulting in triple play. The model can act as a basis for transmission of voice, data and video to the rural areas of Africa resulting in a last mile broadband connectivity Internet for socio-economic development.

5. CONCLUSION

A last mile mobile broadband subscription prototype solution with the following features has been developed: subscription, M-Pesa integration, and connectivity tokens that provide Internet access through broadband network using WiMAX. This research contributes a solution towards alleviating the broadband access gap experienced in rural Africa. This solution would assist governments and Internet Service Providers in planning and developing an appropriate policy on rural broadband access initiatives. Acquisition of infrastructure, such as routers, gateways and powerful servers, will ensure that, instead of using the public telecommunications network, one can set up a complete broadband Internet access network that would be more reliable. Further work requires broadband benchmarking in order to determine the quality of application systems that can be developed to enable economical use of the broadband Internet access in rural areas that can support business process outsourcing. Also further work is required in integration to Global Positioning Systems (GPS) and integration to a spatial database, such that the location coordinates of each user is stored.

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APPENDICES

Appendix A: Sample worker.java file

```
package wdm;
import java.util.ArrayList;
import java.util.List;
import java.util.logging.Level;
import java.util.logging.Logger;
import org.smslib.ATGateway;
import org.smslib.ICallNotification;
import org.smslib.IGatewayStatusNotification;
import org.smslib.IInboundMessageNotification;
import org.smslib.IOrphanedMessageNotification;
import org.smslib.InboundMessage;
import org.smslib.Library;
import org.smslib.Service;
import org.smslib.ATGateway.GatewayStatuses;
import org.smslib.ATGateway.Protocols;
import org.smslib.InboundMessage.MessageClasses;
import org.smslib.Message.MessageTypes;
import org.smslib.modem.SerialModemGateway;
import org.smslib.OutboundMessage;

public class WDMClient {

    Service srv;

    public void doIt(String cport) throws Exception {
        // Define a list which will hold the read messages.
        List<InboundMessage> msgList;

        // Create the notification callback method for inbound & status report
        // messages.
        InboundNotification inboundNotification = new InboundNotification();

        // Create the notification callback method for inbound voice calls.
        CallNotification callNotification = new CallNotification();

        //Create the notification callback method for gateway statuses.
        GatewayStatusNotification statusNotification = new GatewayStatusNotification();

        OrphanedMessageNotification orphanedMessageNotification = new OrphanedMessageNotification();

    try {
        System.out.println("Example: Read messages from a serial gsm modem.");
        System.out.println(Library.getLibraryDescription());
        System.out.println("Version: " + Library.getLibraryVersion());

        // Create new Service object - the parent of all and the main interface
        // to you.
```

```

this.srv = new Service();

// Create the Gateway representing the serial GSM modem.
//SerialModemGateway gateway = new SerialModemGateway("modem.com1", cport, 57600,
"Generic", "");
SerialModemGateway gateway = new SerialModemGateway("modem.com1", cport, 9600,
"Generic", "");
//SerialModemGateway gateway = new SerialModemGateway("modem.com1", "COM1", 9600,
"Generic", "");

// Set the modem protocol to PDU (alternative is TEXT). PDU is the default, anyway...
gateway.setProtocol(Protocols.PDU);

// Do we want the Gateway to be used for Inbound messages?
gateway.setInbound(true);

// Do we want the Gateway to be used for Outbound messages?
gateway.setOutbound(true);

// Let SMSLib know which is the SIM PIN.
//gateway.setSimPin("0000");
//gateway.setSmscNumber("");
// Set up the notification methods.
this.srv.setInboundMessageNotification(inboundNotification);
this.srv.setCallNotification(callNotification);
this.srv.setGatewayStatusNotification(statusNotification);
this.srv.setOrphanedMessageNotification(orphanedMessageNotification);

// Add the Gateway to the Service object.
this.srv.addGateway(gateway);

// Similarly, you may define as many Gateway objects, representing
// various GSM modems, add them in the Service object and control all of them.

// Start! (i.e. connect to all defined Gateways)

```

Appendix B: Sample Client.java File

```

package wdm;
import java.util.ArrayList;
import java.util.List;
import java.util.logging.Level;
import java.util.logging.Logger;
import org.smslib.ATGateway;
import org.smslib.ICallNotification;
import org.smslib.IGatewayStatusNotification;
import org.smslib.IInboundMessageNotification;
import org.smslib.IOrphanedMessageNotification;
import org.smslib.InboundMessage;
import org.smslib.Library;
import org.smslib.Service;
import org.smslib.ATGateway.GatewayStatuses;
import org.smslib.ATGateway.Protocols;
import org.smslib.InboundMessage.MessageClasses;
import org.smslib.Message.MessageTypes;
import org.smslib.modem.SerialModemGateway;

```

```

import org.smslib.OutboundMessage;
public class WDMClient {
    Service srv;
    public void doIt(String cport) throws Exception {
        // Define a list which will hold the read messages.
        List<InboundMessage> msgList;
        // Create the notification callback method for inbound & status report
        // messages.
        InboundNotification inboundNotification = new InboundNotification();
        // Create the notification callback method for inbound voice calls.
        CallNotification callNotification = new CallNotification();
        //Create the notification callback method for gateway statuses.
        GatewayStatusNotification statusNotification = new GatewayStatusNotification();
        OrphanedMessageNotification orphanedMessageNotification = new OrphanedMessageNotification();
        try {
            System.out.println("Example: Read messages from a serial gsm modem.");
            System.out.println(Library.getLibraryDescription());
            System.out.println("Version: " + Library.getLibraryVersion());
            // Create new Service object - the parent of all and the main interface
            // to you.
            this.srv = new Service();
            // Create the Gateway representing the serial GSM modem.
            //SerialModemGateway gateway = new SerialModemGateway("modem.com1", cport, 57600,
"Generic", "");
            SerialModemGateway gateway = new SerialModemGateway("modem.com1", cport, 9600,
"Generic", "");
            //SerialModemGateway gateway = new SerialModemGateway("modem.com1", "COM1", 9600,
"Generic", "");
            // Set the modem protocol to PDU (alternative is TEXT). PDU is the default, anyway...
            gateway.setProtocol(Protocols.PDU);
            // Do we want the Gateway to be used for Inbound messages?
            gateway.setInbound(true);
            // Do we want the Gateway to be used for Outbound messages?
            gateway.setOutbound(true);
            // Let SMSLib know which is the SIM PIN.
            //gateway.setSimPin("0000");
            //gateway.setSmscNumber("");

```

Appendix C: Sample Code for the user interfaces using Rich faces for Java

```

allocated">
        <f:facet name="header">
            <h:outputText value="token allocated" />
        </f:facet>
        <h:outputText value="#{Enrol.token}"></h:outputText>
    </rich:column>
    <rich:column>
        <f:facet name="header">
            <h:outputText value=" date" />
        </f:facet>
        <h:outputText value="#{Enrol.date}"></h:outputText>
    </rich:column>
</rich:dataTable>
</div>

```

```

</rich:tab>
<rich:tab label="tokens">
  <rich:spacer width="1" height="5"/>
  <br />
  <a4j:outputPanel ajaxRendered="true">
    <h:outputText value="tokens 0-available "></h:outputText>
    <br />
    <h:outputText value="tokens 1-used "></h:outputText>
    <hr>
  </a4j:outputPanel>
  <br />
  <rich:spacer width="1" height="15" />
  <div align="right">
    <rich:datascroller maxPages="200" id="pinlesscroller" for="pinless"/>
    <rich:dataTable
      onRowMouseOver="this.style.backgroundColor=#F1F1F1"
      onRowMouseOut="this.style.backgroundColor=#A1A1A1"
      cellpadding="0" cellspacing="0"
      width="600" rows="3" border="0" var="Pinless" value="#{wdmbean.tok1}"
      id="pinless" >
      <rich:column rendered="false" colspan="4">
        <f:facet name="header">
          <h:outputText value="PINLESS" />
        </f:facet>
      </rich:column>
      <rich:column breakBefore="true" >
        <f:facet name="header">
          <h:outputText value="token allocation code" />
        </f:facet>
        <h:outputText value="#{Pinless.token}"></h:outputText>
      </rich:column>
      <rich:column>
        <f:facet name="header">
          <h:outputText value="duration (days)" />
        </f:facet>
        <h:outputText value="#{Pinless.datatime}"></h:outputText>
      </rich:column>
    </rich:dataTable>
  </div>

```