IMPLEMENTATION OF A UNIVERSAL PUBLIC Wi-Fi ACCESS

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DECLARATION

I declare that this research project is my original work and has not been previously published or submitted elsewhere for a ward of a degree. I also declare that this Research project contains no material written or published by other people except where due reference is made and author duly acknowledged.

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I do hereby confirm that l have examined the master's Research project of

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Signature_____ Date_____

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ABSTRACT

As demand for Internet grows and its usage keeps evolving, there is need to create an avenue through which users can have access to this facility wherever they are without subjection to ISP providers; this will facilitate economic growth, job creation, and global competitiveness. To address this today depends on incremental solutions that increase and guarantee connectivity without any hassle of having to purchase DTE/DCE (modems).The objective of this study was to implement a universal public wireless Internet access by use of the Wi-Fi enabled feature on laptops and other devices today. This will ensure drive to innovation, deliver seamless connectivity and optimize network use. This study evaluated the effectiveness of the Internet services offered by ISPs (Safaricom, Airtel, Orange and YU). The results from this study revealed that Network coverage was the key reason for subscription to an ISP by a client among others such as cost, equipment (Modem) availability and spread of bandwidth for purchase. Based on the study, a Web based solution was developed from which all transactions pertaining to online purchase of bundles (based on the amount of funds one has in his/her account) and connecting to the Internet everywhere through a Public Wi-Fi would be achieved. This is the uniqueness of the developed solution in this work. Finally, conclusion and recommendations that will help provide better *Universal Public Wi-Fi Access* have been discussed.

Key words: Wi-Fi, Connectivity, Universal, Public and Access

Table of Contents

DEDICATION

To my wife Angeline and the boys (Wayne and Westine)

ACKNOWLEDGMENTS

First, I would like to thank God Almighty for the far He has brought me in this life and especially during the production of this piece of work. Secondly l would wish to thank my Boss Dr. H.K. Were (Masinde Muliro University of Science & Technology) for granting me the opportunity to further my education. Thirdly l would wish to thank my friend Mr. Samuel Barasa and comrade during this course for his tireless encouragement. Last but not least l want to thank my parents for the belief they had in me, KCA University for offering the opportunity to make this possible, my supervisor and other researches whose work cited throughout the thesis, without their openness to share knowledge and expertise, writing on the thesis would have been very difficult if not impossible.

List of Figures

List of Tables

Acronyms and Abbreviation

NGH	- New Generation Hotspots
WBA	- Wireless Broadband Alliance
3G	- **3**rd Generation
AAA	- **A**uthentication, **A**uthorization and **A**ccounting
AP	- **A**ccess **P**oint
GHz	- **G**iga **H**ert**z**
IEEE	- **I**nstitute of **E**lectrical and **E**lectronics **E**ngineers
WLAN	- **W**ireless **L**ocal **A**rea **N**etwork
WISP	- Wireless Internet Service Provider
ISP	- Internet Service Provider
GSM	- Global System Multiplexing
WCDMA	- Wideband Code Division Multiplexing Access
WIODCC	- The Wireless Internet Opportunity for Developing Countries Conference
IIA	- Impact of the Internet on Africa

Terms and Definition

Universal Access - Unlimited access to Internet Services throughout the country

Wi-Fi -Wireless Fidelity

CHAPTER ONE

INTRODUCTION

1.0 Preamble

This section seeks to give an overview of Wi-Fi technology. It will cover the background information, sources of problems, definition of key terms, statement of the problem, purpose of the research, objectives, scope of the study and justification.

1.1 Background

The demand for technology and its use today is on the rise. This has lead to variety of computer hardware on the market to choose from, depending on one's (users) preference. With the ever increasing use of technology has led to the use of Wi-Fi as an alternative to traditional wired cables within buildings. According to WBA (2011), public Wi-Fi networks are going to be a global reality and operators in all regions are shifting to Wi-Fi e.g. rollouts have been carried out in markets such as Romania, Namibia and Qatar.

Wi-Fi has strongly established itself as the widely-used wireless technology ever rolled out as depicted by the volume of data traffic passing through networks using Wi-Fi this is according to Informa Telecoms & Media. In the WBA (2011) report, increase in use of Wi-Fi technology together with the integration of cheap Wi-Fi chipsets into a wide interconnected system made up of millions of devices and the expansion of applications has ensured a large number of users worldwide rely Wi-Fi to access Internet. Vinoth and Fotios (2007) reiterate that Wi-Fi allows connectivity to the Internet from anywhere at minimum speeds of up to 54 Mbps. Wi-Fi-enabled devices use IEEE 802.11 standard to communicate data within the range of an access point.

Access to information is becoming necessary and enhances quick decision making and reduces interconnectivity as they use same platform to share the information and communicate with one another. By having Universal Internet Access barrier in diversity will be breached and thus many will be linked thereby making the world a small village. Koffi Annan says, many in the world today do not feel the impact of this revolution. According to WIODCC (2003) "digital divide" is a threat to the already-wide gap between economies. The stakes are very high. There is need for timely access to news and information that can promote trade, education, employment and health. The beauty of information society is openness which is a crucial component of

democracy and good governance. Information and knowledge form part of the efforts to strengthen tolerance, mutual understanding, and respect for diversity.

Memory (2011) introduction of ICT has improved the quality of life for people in living rural areas. It has also opened various ways in which rural people can overcome problems that have affected their progress in terms of business, communication and, to a great extent, education.

According to Dalberg (2013) the number of internet users has rapidly grown by 4.6 million internet users to its current base of 13.5 million, this reflects 33% by September 2012. Broadband use has also has also gone up by 0.5 million new users in the same period. Kenya's development has been linked to strong national leadership through the establishment of a strong regulator and the making of ICT as a pillar for national growth in the Vision 2030 plan. ICT Strategy in 2006, and ICT Master Plan 2012 followed Vision 2030 that frame ICT as a tool to drive industrial growth by creating jobs and meet the peoples' needs via e-Government. A wide range of ministries and stakeholders formulated the Master Plan. The enactment of Kenya ICT Board, in February 2007 was to help attract ICT investment and implement projects in the sector. They have developed effective regulation of the patchwork of operators and agencies as per the 1998 Communications Act.

1.2 Sources of Problems

In the UK, one of the world's most advanced markets for Wi-Fi, investments are being underpinned by a range of divergent business mode ls: BT, the UK's fixed incumbent, is using Wi-Fi as a means to differentiate and add value to its fixed-broadband offerings.
Telefonica has deployed Wi-Fi to build a location-based services strategy, BSkyB has acquired The Cloud and moved to build a multiscreen content-delivery strategy for its core satellite TV business that relies on its extensive public Wi-Fi assets.

Memory (2011) The availability of these telecommunication networks is expected to improve the way people share ideas and communicate locally and globally, reducing limiting factors like distance through the use of the Internet.The wide spread interest in Wi-Fi is because the number of public Hotspots is set to increase, growing from 0.8 million as at 2010 to 5.8 million by 2015, according to Informa Telecoms & Media (see Fig. 1.1).

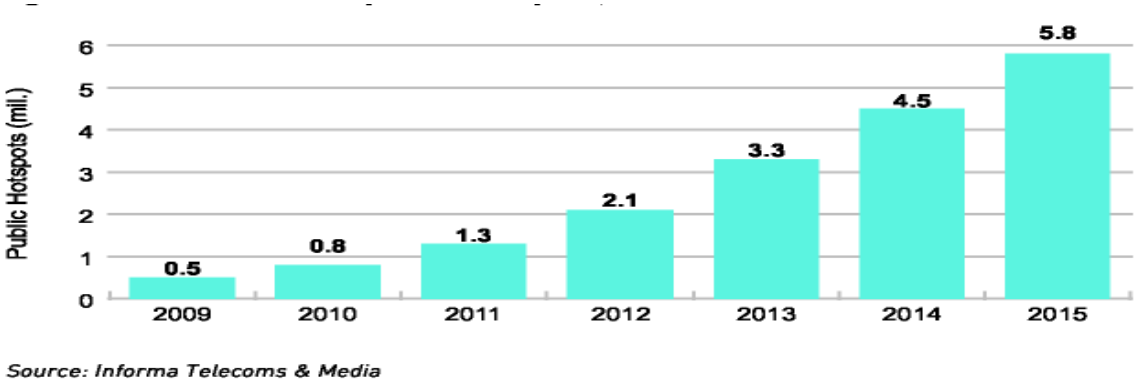

Fig. 1.1 Global Number of Public Hotspots, 2009-2015

1.3 Statement of the problem

Mathew (2005) noted that Wireless networks very flexible and this can translate into quick deployment. According to Chris Bruce, Chair Wireless Broadband Alliance, the future of media and telecoms involves hiding complexity from the user and seamlessly employing the wide spectrum of technologies at our disposal to provide the best possible experience in a world where data demand is insatiable.In Kenya there are quite a number of companies offering Internet services by use of modems which the customer is supposed to purchase and load the same with air time amounting to particular data bundle. The platform used by this companies are independent to them thus if you are in an area where the particular company you have purchased the modem from has weak signals or rather it has no coverage Internet access is impossible.

The cost and speeds vary with the location you are in; some providers have not established themselves in some areas thus if one resides in town and goes to the village, it becomes an inconvenience where as you have the necessary tools to enable you access Internet. Against this backdrop there is need to evaluate the currently used platforms by various ISPs and come up with a high breed solution that will use the available public infrastructure e,g Fiber cable and Wi-Fi feature on modern devices especially laptops. According to Vinoth and Fotios (2007), as Wi-Fi technologies and services continue to expand, it is necessary to come up with new designs merged with appropriate applications. The goal of this systems is to provide increased access to information to everyone; its economic goal is to make information as good along with knowledge products and services.

This will further increase the number of people using the Internet as a resource and will open up to other benefits that come with access e,g trade and there by increase the number of people

using this resource. IIA (2013) state that 7.7 million Internet subscribers in Kenya access Internet through mobile devices. In Fig 1.2 according to WBA 2011Report, Global mobile data traffic is anticipated to reach 16.84 million terabytes by 2014 and this will managed operators through pricing strategies followed by use of Wi-Fi-based offload. Thus there is a need to have better ways to enable people connect to the Internet; use it to improve themselves and thereby drive data traffic and especially Africa to competitive advantage.

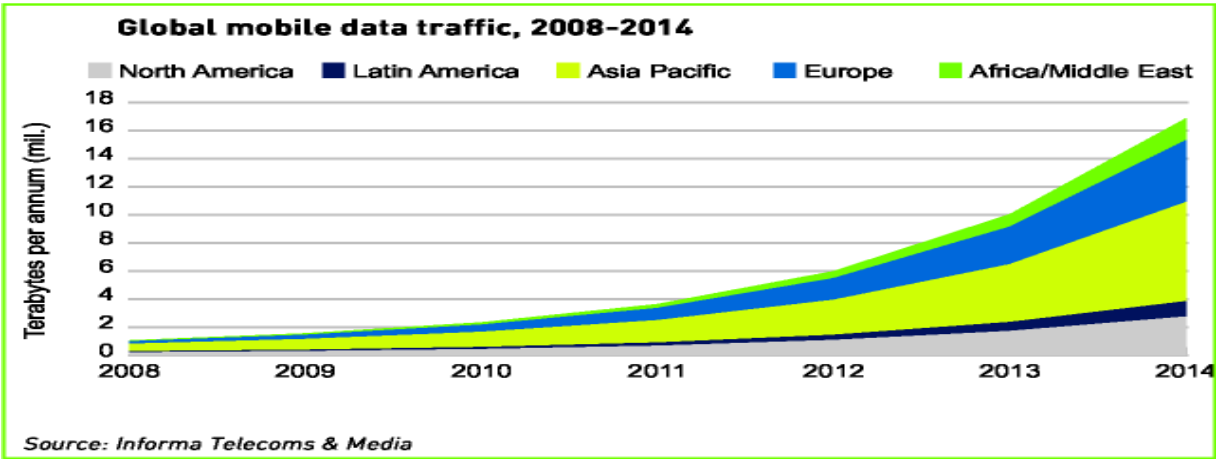

Fig. 1.2 Global Mobile Data Traffic 2008-2014

The platform will aim at providing the Internet service to everybody anywhere; there is no extra cost that the customer will incur in terms of purchasing a modem(s) to suite the coverage of the provider in an area.

1.4 Purpose of the Research

This study will be important in that it will shed some light on the ease of access to the Internet through the use a universal access point via Wi-Fi enabled devices as opposed to the use of modems. According to WBA 2011 Report, The focus today is on simplifying the Wi-Fi user experience and aligning it as closely as possible with the mobile experience in terms of connection management, authentication and sign-on, charging and billing, and – importantly – security and privacy.

The study sought to find out if the current mode of connection to the Internet by Internet service providers especially the mobile companies are adequate enough in terms of reaching out to masses.

The findings will at a large extend contribute to the re-engineering of Internet services through a common platform that will be accessed by everybody regardless of where they are based in the country.

1.4.1 Objectives of the study

The main objective of the study will be to develop a user friendly solution to connect to the Internet.

Specific Objectives

1. To evaluate Internet Connections by ISP's.
2. To design a hybrid solution that enables universal access to Internet
3. To implement a hybrid solution that enables universal access to Internet
4. To test the proposed solution

1.4.3 The scope of the study

It will put more emphasis on the operations or rather how the ISPs (Safaricom, Orange, Airtel and Yu) provide Internet access to their clients by use of modems. According to Dalberg (2013) mobile market in Kenya is very active, with 30 million subscribers, up from 17.5% in 2012. Safaricom leads the park in data usage while Airtel, Orange and Essar command smaller shares. The study focused on coming up with a web based application that will aide in connection, access to Internet at low cost.

1.5 Justification of the study

Universal Wi-Fi access will be a major boost to ensuring the implementation of the vision 2030 which in itself seeks to make ease of access to information key. With the laying of the Fiber cable to almost every part of the country, there is need to take advantage of this potential of high data speeds. Equipment to enable one to get connected to the Internet and enjoy the immense wealth of the power of information at once is expensive and not everybody can afford. In spite of the spread of sponsored Hotspots that offer access for user, users will continue to show willingness to pay for Wi-Fi where no alternative form of connectivity exists or where Wi-Fi is perceived as the best available form of connectivity. The willingness to pay and the amount paid is likely will be proportional to the perceived quality of the network performance on offer, as well as perceptions of usability, security and privacy, and will also be focused on obtaining

access in key venues with high traffic demand, such as airports, hotels and urban Hotzones. WBA (2011) The need to meet these user expectations will be a strong driver towards additional investment into Wi-Fi networks and a move towards Next Generation Hotspot deployments based on common standards.

Today most computers especially laptops, iphones, smartphones and PDA's come when they are Wi-Fi enabled and thus can only be used where you have institutions or business e.g. coffee shops that use it as a way enticing their clients to buy their merchandise and enjoy "Free" Internet access only if you have a portable workstation that is Wi-Fi enabled. In Kenya, the use of the Internet as a resource has gone up and more especially in the towns and higher institutions of learning (to those who can afford modems) thus the need to provide a uniform platform through which people can have access to the Internet at high speeds (Fiber as a backbone), low-cost Internet access to residents throughout the county by use of the Wi-Fi feature on modern computers. According to Thomas Wehmeier of Informa Telecoms & Media, "any network director seeking to efficiently and profitably manage the follow of data traffic across their network should be looking to include Wi-Fi as part of a holistic customer-centric network strategy". Vinoth and Fotios (2007) says that ICT is not a solution for every problem, nor is it an end in itself, it is a step towards reaching out to equate the disparities between communities in the a country. Another challenge he says is the digital divide that can be addressed by putting up ICT infrastructure in rural areas to address the needs of the marginalized (e-eradication). By setting up ICT infrastructure all levels of the economy, the reality of a global citizen can be enriched by providing connectivity to everyone.

In conclusion it is all about the industry as a whole to deliver Internet Access in a compelling and seamless user experience, regardless of the location or delivery mechanism. David P. Blinn et al reiterate that, Mobility: this is an advantage of wireless networking; users are not restricted to a location by structured cabling or an ISP.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter covers State of Art, State of Practice, Technological Advances and Critique of Literature.

2.1 State of Art in Universal Wi-Fi Access

Carlos and Manuela state that hotspots give high-speed wireless Internet access in public places e.g. in airports. People can use either a laptops or PDA that are Wi-Fi 802.11b enabled, customers can browse the Internet or check email. Hotspots should not be confused with wireless LANs as they are WLANs fora public service at a monthly fee .

According to Carlos J. Costa and Manuela Aparício Wi-Fi Alliance, initially known as the Wireless Ethernet Compatibility Alliance (WECA), was enacted in 1999 to certify interoperability of Wi-Fi™ (IEEE 802.11) solutions and to promote Wi-Fi™ as wireless LAN standard across all market players. www.wi-fi.org state that 802.11b (that evolved from 802.11) standard suports data rates of 11 Mbps in the 2.4 GHz ISM (industrial, scientific, and medical) band. IEEE 802.11b is a specification given by the Institute of Electrical and Electronic Engineers (IEEE) that defines the operation of 2.4 GHz, 11 Mbps, Direct Sequence Spread Spectrum WLANs. Table 2.0 gives a summary of the 802.11 standards and there capabilities.

Wi-Fi standards

802.11	The first WLAN standard; operates between 1 to 2 Mbps.
802.11a	High-speed , works in the 5 GHz band; support 54 Mbps.
802.11b	For 2.4 GHz band; support 11 Mbps.
802.11d	International roaming: automatically configures devices to meet local RF regulations.
802.11e	Addresses quality-of-service requirements for all IEEE

	WLAN radio interfaces.
802.11f	Defines inter-access-point communications to facilitate multiple-vendor-distributed WLAN networks.
802.11g	Establishes an additional modulation technique for the 2.4 GHz band; 54 Mbps speed supported.
802.11h	Is the spectrum management of the 5GHz band.
802.11i	Addresses security weaknesses for both authentication and encryption ; the standard has 802.1X, TKIP, and AES protocols.
802.11n	Has higher throughput improvements; provide speeds up to 500 Mbps.
802.11ac	Is a more scalable and faster version of 802.11n. It couples the capabilities of Gigabit Ethernet(5 GHz-only technology). Clients can work in less crowded 5 GHz band. Certification by Wi-Fi Alliance is in December 2013

Table 2.0 Wi-Fi Standards

Source: Memory Munashe Ranga,2011

Vinoth and Fotios (2007) says that IEEE is in the process of coming up with a new 802.11s standard that will enhance mobility to Wi-Fi access points within very large Wi-Fi networks.
Memory (2011) Advantages of Wi-Fi

- Wi-Fi has a set of standards allowing interoperability between different types of access points and client network interfaces, at a basic level of service. As a result, the deployment Wi-Fi networks are cost effective and easy to deploy;

- The absence of cables means that there are no cabling costs incurred. The infrastructural cost of deployment of wired connectivity is usually high and the outcome from the network, in terms of revenue, is low in addition, wireless has been the best solution since there are no cabling costs. This is mostly the case with connectivity in disadvantaged, rural areas;

Vinoth and Fotios (2007) further states that affordable wireless broadband access has the capability to change emerging economy by increasing investment and innovation in e-commerce, e-education, telecommuting, e-health, agriculture, e-entertainment, e-government, and almost every other economic activity. The most important thing is the fact that Internet is becoming a day-to-day utility, where affordable broadband wireless access will be an extension of everyday life. David et al state that Wi-Fi technologies have a major role to play in our lifes with good speeds and without much investments, Wi-Fi can enable access to knowledge and information e.g. making use of unlicensed radio spectrum to deliver cheap and fast Internet access. Wireless hotspot networks are increasingly becoming popular as a means of providing Internet access in public places.

As described by Vinoth and Fotios (2007), the key areas issues that must be addressed in order to bridge the digital divide are accessibility, availability, and affordability of services and applications. Many solutions are successful, but fail to address these major challenges but Wi-Fi has the capability to address all of them:-

Accessibility: In most developing countries, the in ability to have access to technologically advanced voice and data services is a hindrance to network readiness. In the a few years to come from now access to the next generation of broadband-driven communication technologies, will be fundamental for example Voice-over Internet Protocol (VoIP), video telephony, and Internet protocol television (IPTV). Broadband communication infrastructure accessible to all need to build by developing countries to stay at per with their counter parts in developed nations. The developing countries need to build a broadband communication infrastructure that is accessible to all, in order to encourage social service and e-government applications. Wi-Fi wireless access technology is undoubtedly an attractive option for data, voice (e.g., VoWi-Fi), and video, compared to other traditional communication infrastructures in the developing world.

Availability: 2.4GHz bandwidth in many countries is license-exempt, though in some they might require registration of use. Wi-Fi is the widely used of unlicensed bandwidth for ‘‘hotspot’’ or ‘‘hotzone’’ or ‘‘hotcity’’ type of coverage. This is because of the widespread availability of Wi-Fi radios that comply with IEEE 802.11b and the upcoming 802.11g/a standards. Wi-Fi has 100% global recognition and has become the single networking standard for all developers, equipment manufacturers, service providers, and end users. The main advantage

with Wi-Fi is that large-scale, service-level roaming between different Wi-Fi providers is possible, as Wi-Fi certification has become a de facto standard for IEEE 802.11-based products. **Affordability:** The benefit of using Wi-Fi in the last mile is that the client device is extremely inexpensive due to the large volume of production. Capital investment is also cost-effective, providing greater flexibility than traditional wired communications, which in turn results in lower prices for Wi-Fi broadband services. Standardization and interoperability between different vendor products have lowered Wi-Fi prices and facilitated its rapid penetration from a niche to a mass market worldwide. For the next few years at least, Wi-Fi will proliferate rapidly as a last-mile option and deliver wireless broadband access at prices dramatically lower than WiMAX.

2.2 State of Practice

In terms of usage patterns, we are seeing a greater emphasis on quick-to-consume "snackable" content on the go and this clearly plays to the strengths of next generation Wi-Fi offerings. But the point here is that the general public doesn't care about terminologies such as 3G, 4G or Wi-Fi, as long as they receive the right communications experience. (Chris Bruce, Chair Wireless Broadband Alliance).

David et al reiterates that WLANs have grown as demand for Wi-Fi access increases as 802.11 technology matures. WLANs supporting 802.11 standard can be found in offices, homes and campuses. One popular use is to provide wireless 'hotspots' in public places.

WiMAX

According to Ranga, 2011, this is metropolitan area network (WMAN) technology that interconnects a several LANs employing a high-capacity backbone technology, such as fibre-optical cable, and provides up-link services to WAN and thereby to Internet. Fig. 2.0 shows an example of WiMAX antennae

Fig. 2.0 Wimax Antenna

WiMAX is a technology that is, in most cases, used to establish backhaul connectivity over long distances . It is used in rural areas where setting up the necessary infrastructure on a single connection can be hindered by distance and other natural obstacles, since it does not always require LOS to establish a connection. A WiMAX can cover up to about 50 kms radius with a bandwidth of up to 70Mbps. Despite WiMAX having a long range, the longer the range the weaker the signals become because signal strength decreases as distance increases. Alternatively, trees and buildings also contribute to signal degradation. WiMAX technology has gone through numerous generations since its beginning in 1997. Some of the standards are:

802.16 This was the first version of the WiMAX standard which has a range above 10 GHz and supports line of sight. On this standard, the orthogonal frequency division multiplexing (OFDM) technique was addressed.

802.16a -The 802.16a standard incorporated non-line-of-sight (NLOS) and its spectrum range can go up to 11GHz (Hoskins, 2008). “This version enhanced the medium access control (MAC) layer capabilities. This version was the first to support both time division duplexing (TDD) and frequency division duplexing (FDD)”.

802.16d-This standard is an improvement on previous sessions. Some of the enhancements included support for concatenation of both protocol data units (PDU) and service data units (SDU) which, as a result, reduced the MAC overhead.

Advantages of WiMAX

- WiMAX is a WAN technology that can provide up to 50 km coverage with a throughput of 70 Mbps, making it a possible solution for rural connectivity;
- The deployment of a WiMAX network is easier compared to that of VSAT;
- It is standardized; as a result, it can be easily integrated into other networks;
- It opens up a completely new access alternatives to bring broadband access to the business community in urban areas;
- WiMAX can also be used to access the Internet through the use of hot spots and provides a wireless network extension to cable. There is no need for the tower to achieve long coverage.

Vinoth and Fotios (2007) acknowledge that City-wide Wi-Fi is emerging as a modern, high-tech economic development tool. It is commonly used in developed countries, and can as be used in developing countries. It is viewed that wireless access can be fundamentally good to public communication in the near future.

2.3 Technological Advances

Andrew (2009) Wireless networking offers a bit more freedom, since users are free to move around anywhere as long as they can rely on radio signals to communicate with an *access point,* which itself connects to the Internet by physical cable.

Next Generation Hotspots

(WBA 2011)The vision of NGH is to facilitate a cellular-like seamless, secure and easy to use Wi-Fi experience and interoperability across operators. NGH will offer an improved user experience through;

- Automated selection of approved Hotspots
- Reuse of mobile login credentials
- Protection against loss of critical user data
- Protection against fraud.

More and more devices are reaching the market with chip sets that will allow the instant detection and connectivity to local hotspots where they are available.(The Wireless Internet Opportunity for Developing Countries, 2003)

According to Dalberg Report (April 2013), Countries that expect to gain from the Internet's potential both socially and economically must continue to invest in infrastructure and the broader ecosystem for innovation. Pillars that provide the genesis for a well-functioning Internet economy are core infrastructure and conditions for usage. Core infrastructure will incorporate aspects of the enabling environment - both physical infrastructure and characteristics of the business environment, such as mobile and Internet coverage, electricity, availability of skills, education levels, and perceptions of corruption. Conditions for usage on the other hand will include those that influence access, awareness, availability and attractiveness. This encompasses a range of drivers, from the cost of devices and price of packages to factors affecting citizen awareness, such as education levels, usage and relevance of services.

Green Solar Wireless Fidelity

Green Solar Wireless Fidelity (Wi-Fi), in Haiti, is a non-profit organisation which aims to provide Internet connectivity to the people in marginalized areas through the use of a broadband Internet connection, and solar energy. They use Wi-Fi solar access nodes and routers to establish a connection since, in most rural areas, they do not have electricity. The Green Solar Wi-Fi hotspot model has a power control device that controls the power usage on the access nodes as well as on the router. This controller has power control module software running on its Wi-Fi router, which communicates through the Ethernet port (Memory 2011).

2.4 Critique of Literature: Causes of Problems in Universal Wi-Fi Access

It can be observed that there are several solutions or products that can be used together to provide the Universal Wi-Fi Access. From Literature it can be noted that there are different vendors for Wi-Fi products and Wi-Fi Alliance has been tasked with responsibility of ensuring that these vendors manufacture products that be used across the board. There are several Wi-Fi standards each supporting a particular range of data communication at varying speeds. This research will endeavor to use the best standard there is to deliver the proposed solution that will enable clients get access to Internet wherever they are. Evans (2004) In order to support the

socio-economic value of the network then the Sarnoff's law which states that, The value of the network is proportionate to the number of customers it reaches should be adopted.
For purposes of communication between the nodes and the base station the study will adopt the use of Wi-Max technology.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter describes the exiting tools in the problem area, evaluation of the tools and finally the proposed methodology.

3.1 Existing Tools

General Packet Radio Service (GPRS)

This is a cellular access technology; a packet data communication system which is integrated with the GSM cellular telephone system. GPRS is a complex, large system that combines telephone radio transmission technology,cellular, and Internet information delivery protocols. Implementations of GPRS operated initially within the framework of present GSM technology (Mahdi, 2004; Michael, 2006). The use of GPRS has made several devices deployable since it turned out to be compatible with other equipment that was not compatible with traditional GSM networks, due to its limits in speed, message length of the Short Message Service (SMS), dial up time and costs (Mahdi, 2004). In Kenya, GPRS network service providers are Safaricom, Airtel, Orange and YU. These service providers have enhanced their systems to offer other services such as Enhanced Data for GSM Evolution (EDGE), Third Generation (3G) and High-Speed Data Packet Access (HSDPA). Safaricom has the cutting edge technology of 3G everywhere you go internet and have embarked on coming up with the 4G.

There are various efforts by service providers to provide GPRS and related standards so as to provide data at cheaper rates. Below is a table showing the different costs of data for each of the ISPs:

	Safaricom	Airtel	Orange	YU
DATA BUNDLE	**COST PER DATA BUNDLE (KShs.)**			
16 MB	20	20	*	*
20 MB	*	*	20	*
40 MB	50	50	*	*

50 MB	*	*	50	*
80 MB	100	100	*	*
100 MB	*	*	120	250
200 MB	250	*	*	*
250 MB	*	*	*	500
500 MB	500	*	500	*
600 MB	*	500	*	*
750 MB	*	*	*	1,000
1 GB	*	*	750	399
1.5 GB	1,000	*	*	*
1.75 GB	*	1,000	*	*
2 GB	*	*	*	599
3 GB	1,999	1,799	*	2,000
5 GB	*	2,500	2,750	*
8 GB	*	3,499	*	*
10 GB	*	5,000	4,999	*
15 GB	*	*	5,999	*
20 GB	*	7,999	7,999	*

Table 3.1 Bandwidth Predefined by ISPs

Source: Safaricom, Orange, Airtel, & Yu

* Means data bundle not offered by an ISP

From the above table it clearly shows that all the ISP's provide or sell bandwidth that is predefined by each. It further shows that there is no uniformity in pricing of the various bandwidth brackets e.g. for 3GB-Safaricom is charging Kshs.1,999,Airtel is charging Kshs.1,799 Orange is not offering this and while Yu is charging Kshs.2,000. The trend shown is evident with the other categories of bandwidth as well and this leaves the customer feeling cheated in terms of

costing. On the other hand other categories of bandwidth are not sold or offered by others and yet there should be a way of ensuring uniformity amongst all ISP's.

Factors such as cost, Network coverage by ISP, equipment (Modem) availability and spread of bandwidth for purchase determines the choice of subscription to an ISP by a client.

3.2 Evaluation of the current Tools

The ISP's more or less use the same mode of Internet access to provide Internet service to their clients. To access Internet services clients are required to meet the following;

- The customer must purchase a modem with an active pre-paid line.
- Sufficient airtime must be in the main account to subscribe for a particular bundle option.
- A client can only use the provided subscription option. Customer care department can subscribe a user who requests the option provided they have sufficient airtime.
- If a customer buys various volume bundles, these bundles will accumulate but the validity of the accumulated volume bundles will take up the validity of the last purchased volume bundle.

Terms and condition for use include and not limited to;

- To subscribe for the offers, the clients's line will have to be.
- A client will be able to subscribe using credit from pin based and pin less top up e.g. Airtel Money, Orange money, YU Money and Safaricom MPESA.

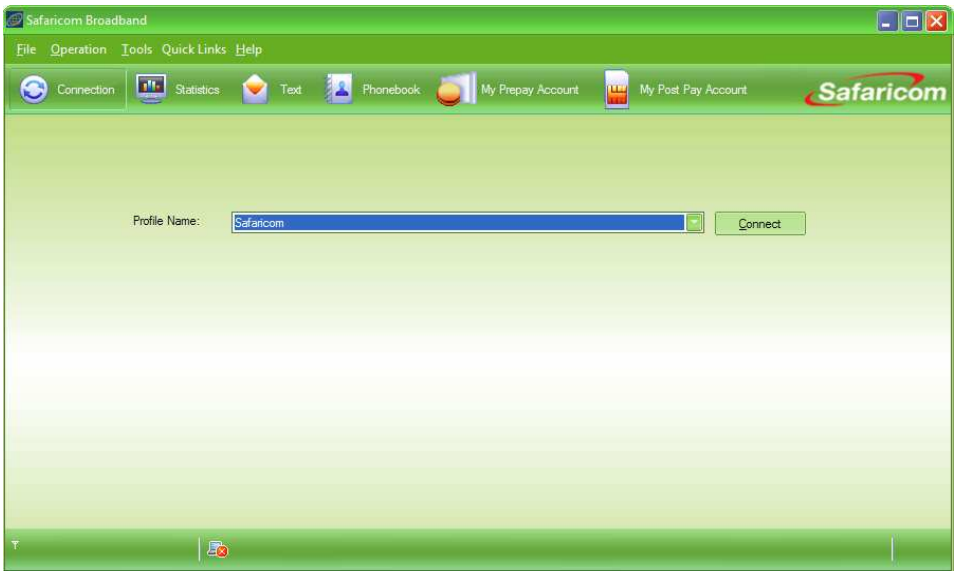

Fig 3.1 Sample of a Log in pop up window (Safaricom)

Fig. 3.1 above shows a sample of the log in pop up window from one of the leading WISP, in fact all the ISP's under study use this mode of connection which is self-installing for first time users when a modem is inserted onto a laptop. A shortcut will be placed on the desktop of the user to enable them log into the system whenever they want to load airtime, convert the loaded airtime to bundles and eventually browse Internet.

Therefore having gone through the above requirements to enable one connect to the Internet regardless of the provider (ISP), the researcher went ahead to draw a distinction between them in terms of their core activity, coverage and degree of service bundling. This was made possible by using modems from the ISPs and test done by connecting each one at time onto a laptop and the observations recorded with regard to parameters to be evaluated as listed below

Connectivity-in this research this basically meant what the users were required to have in order to be able to have Internet connectivity. From what is already there in the market it was evident that all the ISPs use the modem as the sole way of offering Internet Access to their clients across the country.

Network Availability- this was used to refer to availability or attempts by the ISP to make its presence felt by virtue of its coverage in an area by observing the behavior of the network icon for signal strength. From the findings l was able establish that though majority of the ISPs except one that is Yu. Wale (2010) the higher the value of the signal strength, the better the affinity of the STA to want to connect to that AP. The signal strength value can also be used as a sort of tie-breaker when all the other selection factors are equal.

Speed- this refers to the rate at which the modem connects and starts exchanging data with the base station of the ISPs nearest AP. This is further dependent on the kind of technology the Internet Provider has deployed within its infrastructure i.e. GSM or WCDMA. From the test done the results show that only Safaricom deploy the use of both sets of technology and thus the modem is able to switch between the two based on the availability of the based setting within the location of the client. WCDMA supports 3G which is currently has the fastest connection speeds, the rest of ISPs use the GSM which is slow. According to http://www.differencebetween.net Wideband Code Division Multiplexing Access and GSM are two technologies that are used in mobile telecommunications. The difference is that GSM is a 2G technology and WCDMA is a part of the newer 3G group of technologies. WCDMA is the technology that people want and it is slowly being rolled out in a lot of areas that previously used by GSM. In a few years if not

months WCDMA network would equal the coverage of GSM, making the GSM network redundant. From the above it is clear that the GSM network is slowly being replaced with the new and better that is WCDMA. But for now, GSM is still the most widespread technology that is used in the whole world. Surpassing all other 2G and 3G alternatives.

Bulky- this refers the ease with which the Internet access gadget (modem) can be carried from one point to another or can fit among ones luggage with regard to its functionality and use. It was evident that the modems were used by both ISPs as it was a necessity for connection to the Internet.

Installation- this referred to the process of making the Internet access point on the client side executable thus ready for use. It was observed that all the ISPs required users to purchase the modems from their shops and since they are self-installing (plug and play) first time users are required to plug the gadget onto their machines and follow the installation guidelines.

Bandwidth Size- this parameter refers to bandwidth table availed by each ISP to its clients to choose from on the preferred bandwidth to purchase. From Table 3.1 one can deduce that each ISP has its own prescribed bandwidth and cost associated with it thus suppose a client supported by one ISP he or she is forced to choose what is given as there is no variety in terms of client choice to opt for anything outside what is offered.

Connection Type- this was used to refer to the way the users were supposed to be able to connect to the Internet despite having the gadget (modem). All ISPs required their clients to have a prepaid line fixed on the modem to enable them enjoy using the services on their networks. It was further noted that each modem could only work with the pre-paid line of its ISP thus there was no sharing of the Infrastructure among the ISPs.

	Connectivity	**Network Availability**	**Speed**	**Bulky**	**Installation**	**Bandwidth Size**	**Connection Type**
Safaricom	Modem	Yes	First (3G only)	Yes	Yes	Fixed	Pre-paid line

Orange	Modem	Yes	Slow	Yes	Yes	Fixed	Pre-paid line
Airtel	Modem	Yes	Slow	Yes	Yes	Fixed	Pre-paid line
Yu	Modem	No	N/A	Yes	Yes	Fixed	Pre-paid line

Table 3.2 Summary of the evaluation properties

3.3 Proposed Methodology

The proposed solution's main goal will be the deliverance of paid wireless Internet access to visitors/clients whose proximity is close to a public AP. It will do this by means of the 802.11 wireless fidelity protocol in conjunction with the SSID via a captive portal page that can be accessed using any of the Web browsers.

The APs will offer the wireless Internet access to the clients of the hotspots. Wireless users will need to authenticate themselves before they can use the network.

3.4 System Design

The Web Based System was designed based on parameters and information that would make it a more user friendly solution in the market capable of delivering on its functionality at ones comfort. The conceptual model of the system methodology includes the following subsystems: the database component (will handle user data, the transaction and bandwidth details), the model component, the communications component and the user interface component.

Another design goal is usability. One of the most important parts of an infrastructure such as the one being developed now, is that it should be easy to use for the end user, no difficult maneuvers should be needed in order to use it. I used a variety of software which included Drupal version 7.0, Pesapal and Ubercart tools to come up with the proposed solution that would be compatible with any operating system used by the user.

3.5 Characteristics of the proposed Solution

	Connectivity	Network Availability	Speed	Bulky	Installation	Bandwidth Size	Connection Type
Universal Wi-Fi Access	No Modem	Yes	First	No	None	Dynamic	None

Table 3.3 characteristic Properties of the proposed solution

The above table shows a summary of the proposed hybrid solution which will support the provision of a Universal Public Wi-Fi Access to clients. The assumption in this study is that the necessary infrastructure and here am referring to the APs and the base stations are in place throughout the country. First and foremost it will use no modems for Internet connection and rather once a user is logged onto the system he or she is able to surf the Internet. He is able to purchase bandwidth online and thus he is not limited to availability scratch cards from ISPs. Since the solution will be managed online connection and availability will be across the country not dependent on any ISP. The speeds are expected to be high and uniform since the technology to be employed is based on what is current in the market (3G). Users won't purchase any modem to enable them connect to the Internet rather they only need a device that is Wi-Fi enabled e,g. a laptop; no installation is required and since purchase of bandwidth is online clients just need to specify the bandwidth they want to purchase (this is dynamic- no restriction). Lastly the clients won't be required to have a prepaid line since they won't a modem to fix it onto. Vinoth and Fotios (2007) a network infrastructure comprising of pure connectivity alone is not enough to boost the socio-economic class of a community. Therefore, it necessary to have simultaneous development of innovative solutions and new service models. As ubiquitous wireless technologies and services continue to grow, it is mandatory to design new and appropriate applications. The social goal of ubiquitous connectivity is to provide increased access to information for all members; economic goal being to develop information as a commodity along with knowledge products and services. The confluence of these two goals brings together people, information infrastructure, content, and applications

CHAPTER FOUR

CONCEPTUAL MODEL

4.0 Introduction

This chapter discusses the conceptual model of the proposed solution.

4.1 Conceptual Model

It shows relationships among the various variables and how they interact within the system until the final desired out-come is reached. According to http://www.businessdictionary.com, it is a descriptive model of a system based on qualitative assumptions about its elements, their interrelationships, and system boundaries

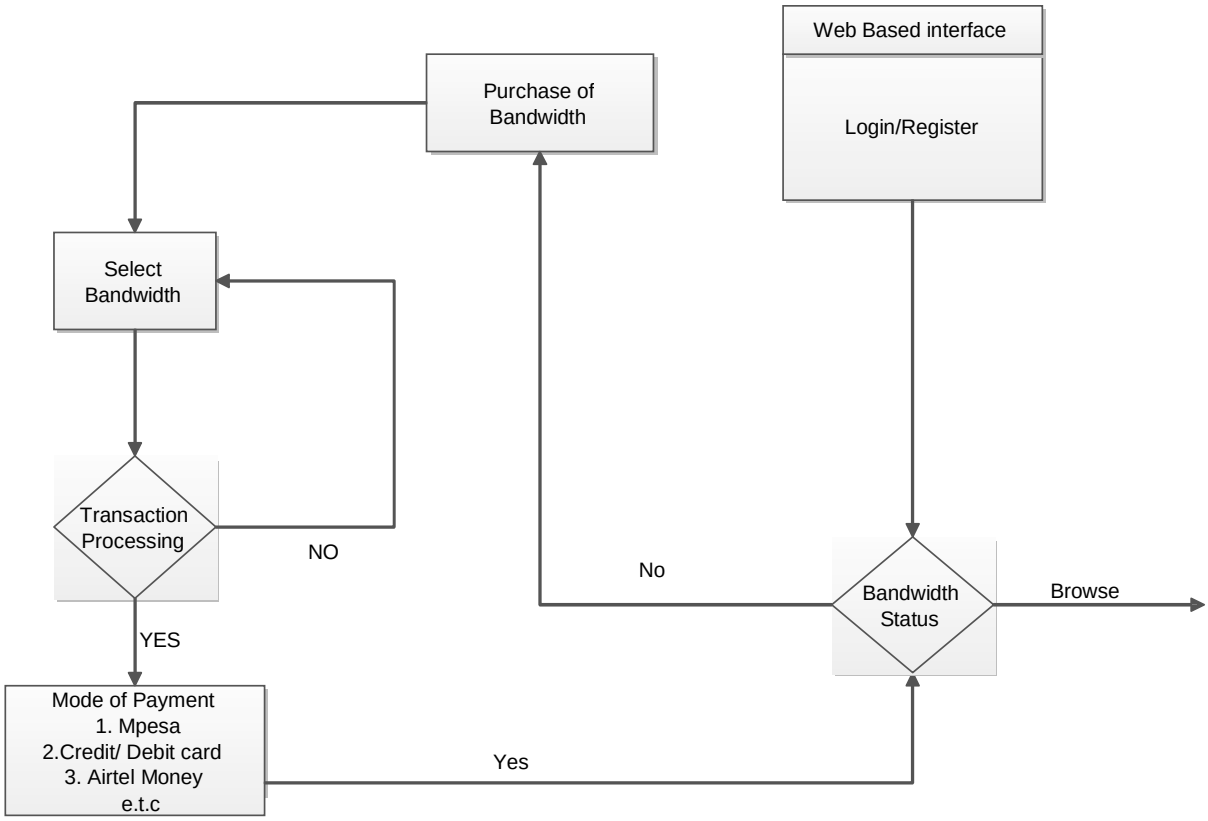

Fig. 3.2 Conceptual Model

(Source: Researcher)

CHAPTER FIVE

IMPLEMENTATION

5.0 Introduction

In this chapter the implementation phase of the thesis project is discussed. The discussion focuses on the choices that were made during implementation, especially in the design of the proposed solution. The Fig 5.1 below captures the implementation model:

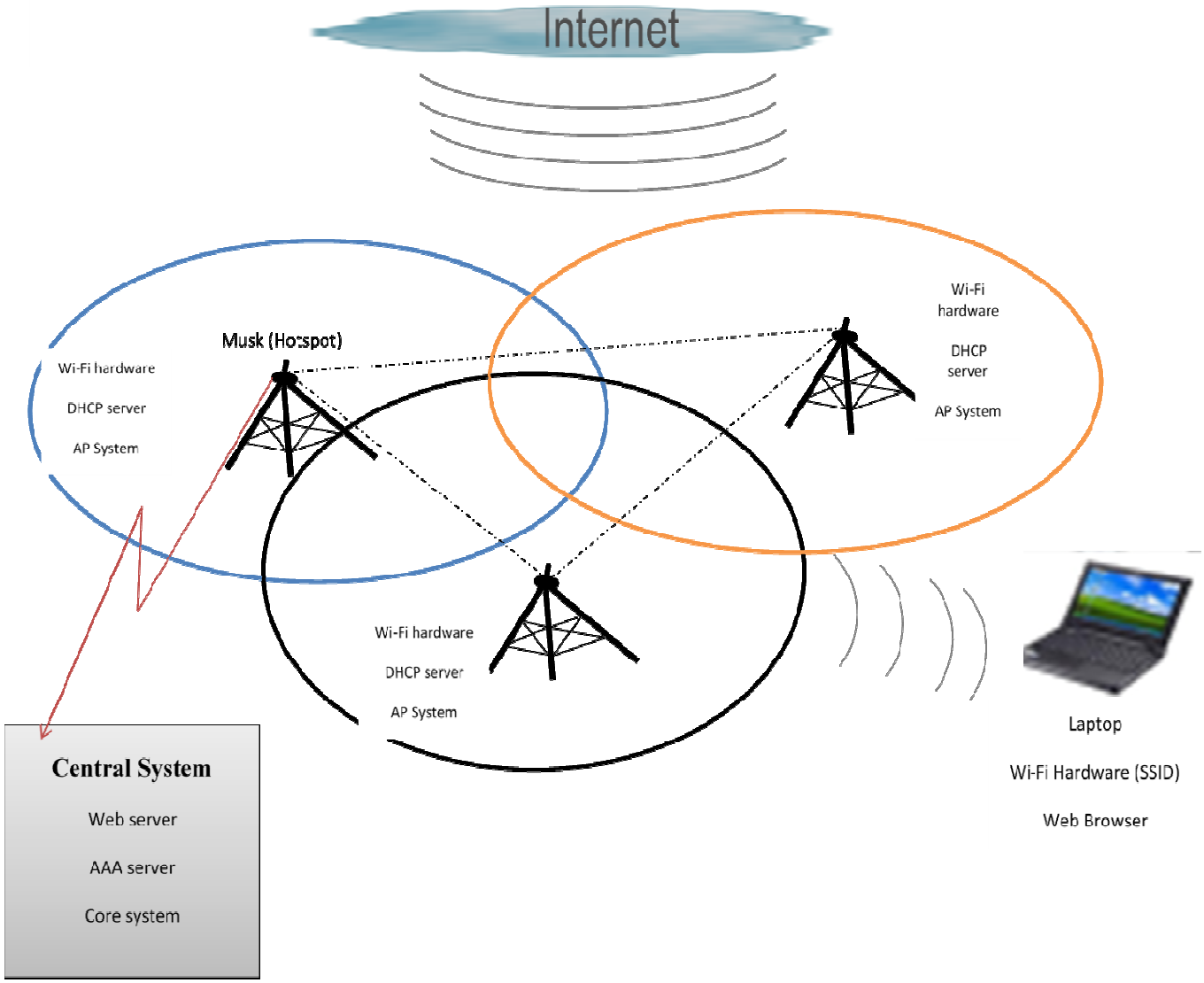

Fig 5.1 Implementation Model

Albert (2002) noted that Roaming is an essential tool to increase the WISP international footprint and service attractiveness – reaching critical mass of hotspots will generate critical mass of users.

5.1 Central System

The core solution will be housed in a central location from where all hardware and system that support it will be installed and secured. The firmware is Linux based, which is available only under a GPL license, it has been chosen to implement as much as possible in the central system. This will make it easy for users to log into the system e.g. proxy web server requests for the Wi-Fi login page to the core solution instead of running a web server on the access point itself eases the load on the CPU of the access points. In addition the core system will store and maintain usage data.

5.2 Access Point

Like in any other Wi-Fi communication you need an access point through which communication between host and guest will be possible. The AP main functionality is to provide wireless access and securing the WLAN or rather the “hotspot”.

The most common method for authentication and user authorization at a public hotspot is the so-called Captive Portal Page (CPP) solution. A captive portal is a web page to which every unauthenticated user is redirected when trying to access the Internet through a browser. The CPP provides a form for entering the credentials, giving the option to use the credit card account and gives links to the roaming partner’s login pages.

The Fig 5.2 below shows the interface through which users get to interact with the system (log in. Register and browse).

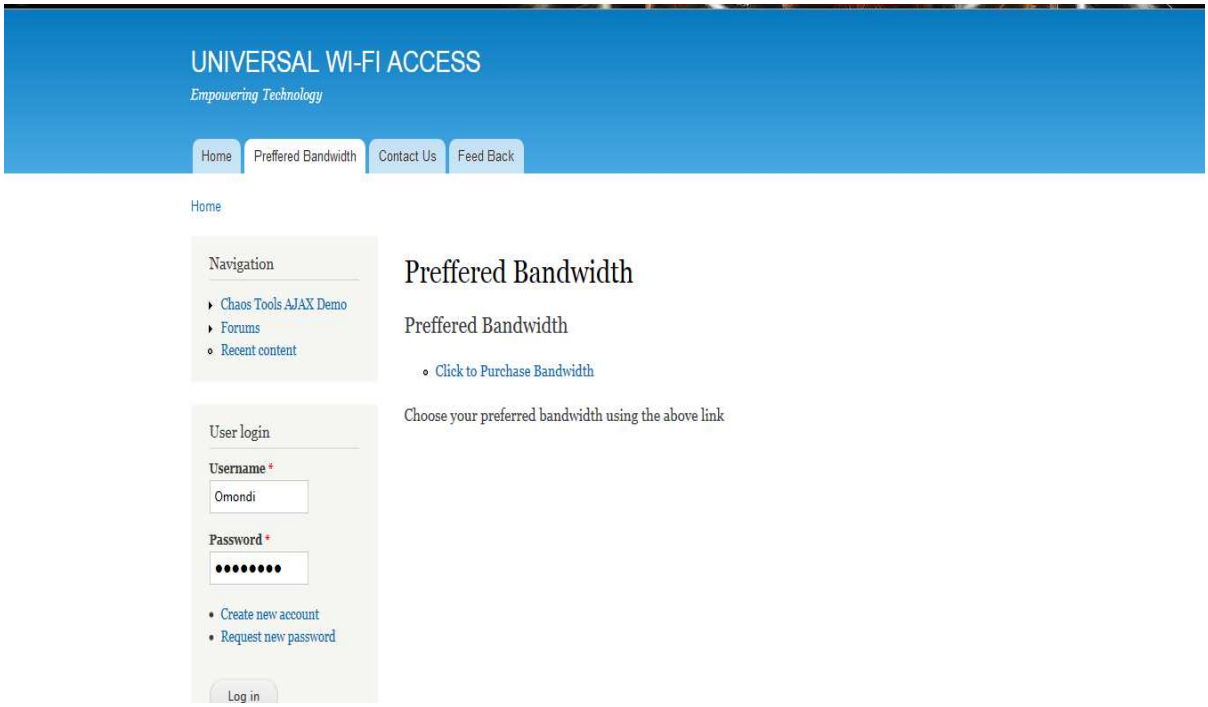

Figure 5.2 Captive Web portal page

The captive portal page can only be displayed if the customer first connects to the access point of the provider, using the Service Set Identifier (SSID) on their mobile gadgets.

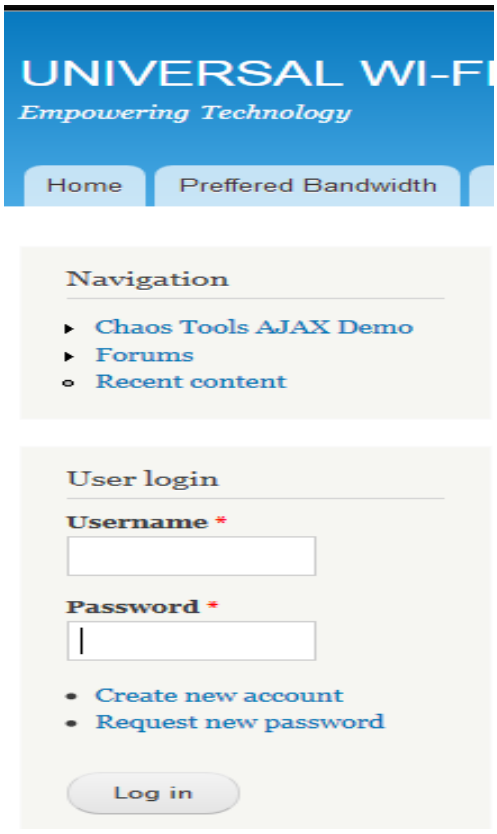

Fig 5.3 Log In page

The captive portal page is authenticated using a standard HTTPS connection based on a server certificate. HTTPS encrypts the login data sent by the user there by protecting the connection against eavesdropping for the duration the user will be online.

Users will be required to input their credential thus the username and password to be able to use the system. In case you have a new user they will be required to register by clicking on the create new account on the log in page (See Fig 5.3 above) and he/she will be taken to that section as shown in Fig 5.4

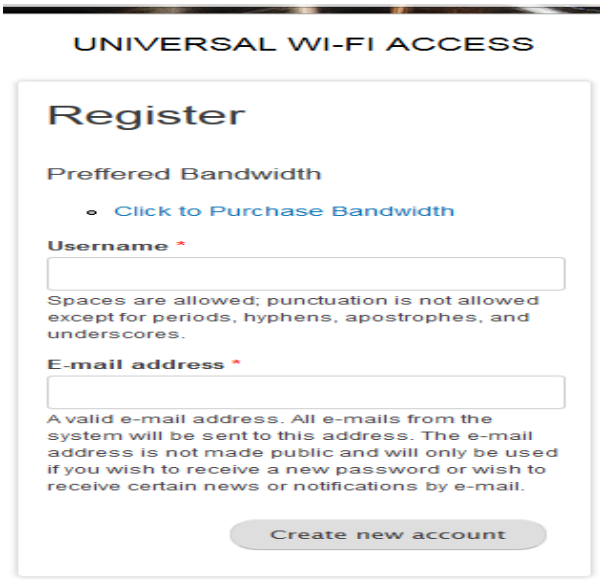

Fig 5.4 Registration Page

For users who have registered onto the system they won't be required to register again but rather they will have to navigate to the click to purchase bandwidth (See Fig 5.4) to proceed to check their bandwidth status.

To purchase bandwidth the client/user navigates to the link click to purchase bandwidth or from the main menu to the tab Preferred bandwidth. Once a user clicks on it he/she will be directed to the bandwidth portal where one will choose their preferred choice depending on the amount of money they have.

Once the bandwidth selection has been done the user will be required to add it onto the shopping cart to start the purchase process. See Fig 5.5

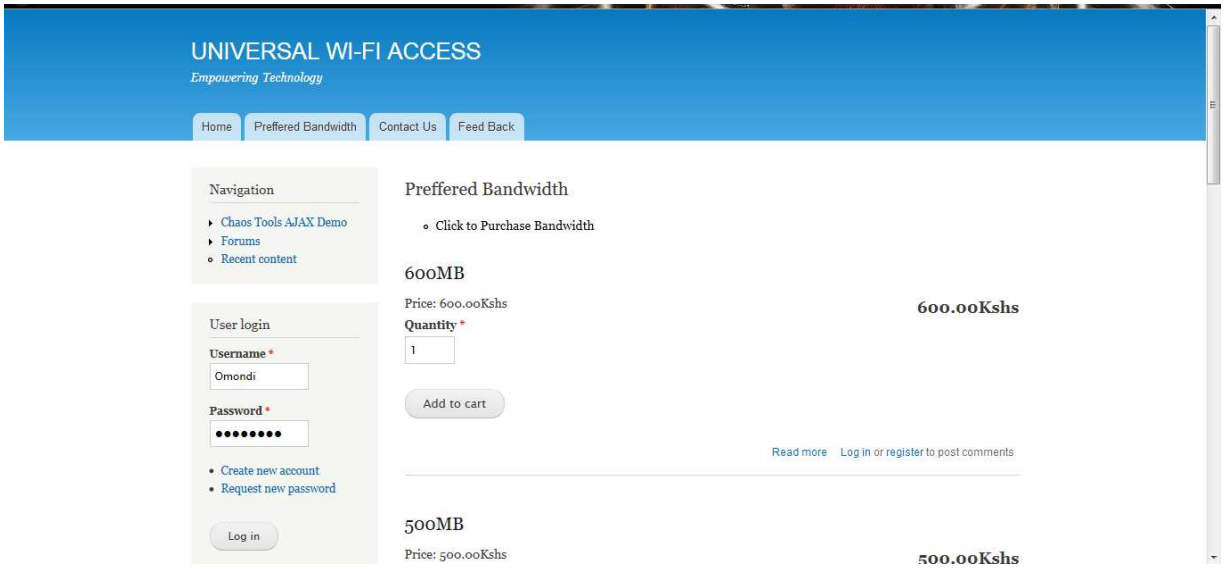

Fig. 5.5 Bandwidth Purchase Page

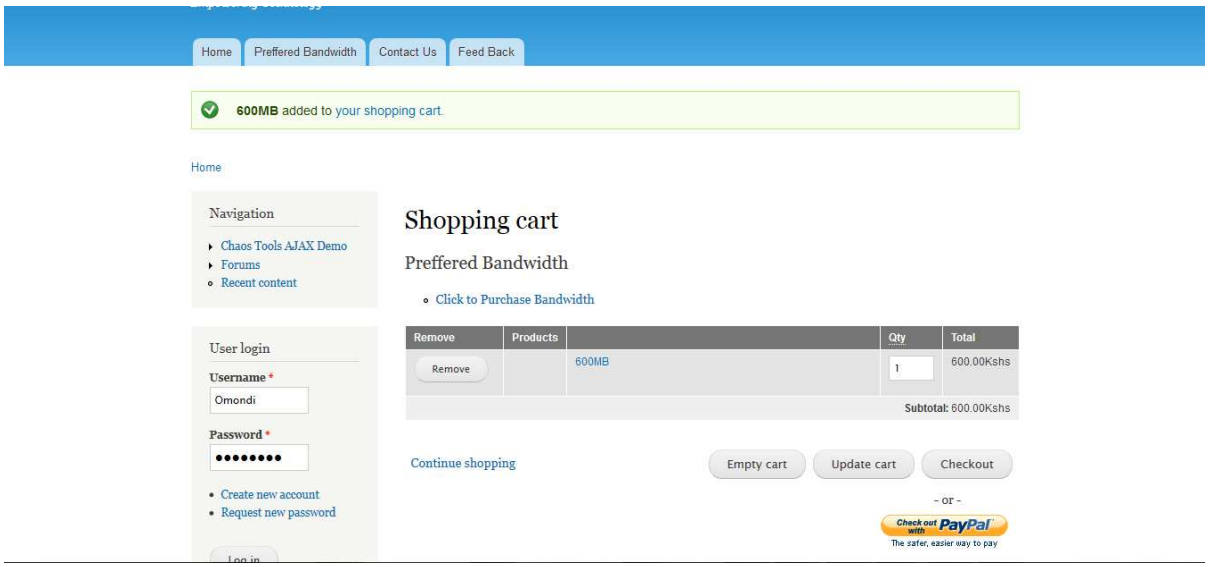

Fig 5.6 Shopping Cart Contents

The above figure (Fig. 5.6) shows the resulting outcome of adding the chosen bandwidth onto the shopping cart. It gives a clear picture of item and price of the product. From this the user can either proceed to check out thus be taken to the payment portal or he can amend the cart contends before authorizing the payment.

Satisfied with what is in the cart the user then checkout to start the payment process, he/ she will be required to enter the billing information as shown below on Fig. 5.7 before they choose the payment option (see Fig 5.8)

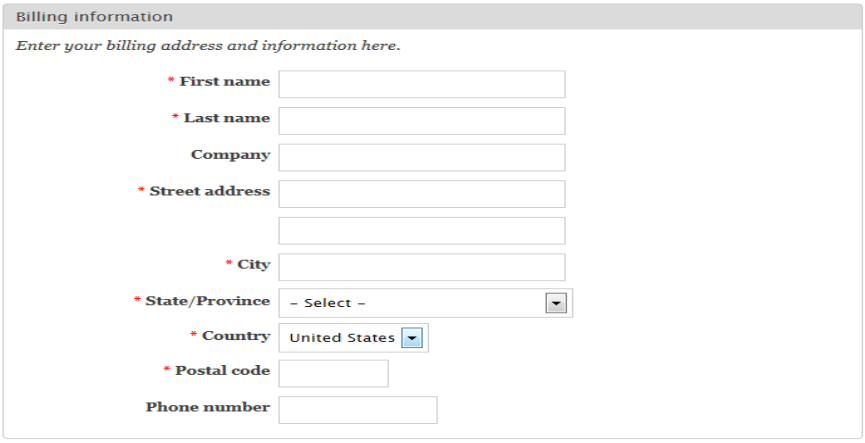

Fig. 5.7 Customers Billing Information

In the billing information section the names marked with asterisks must be entered to proceed with the payment.

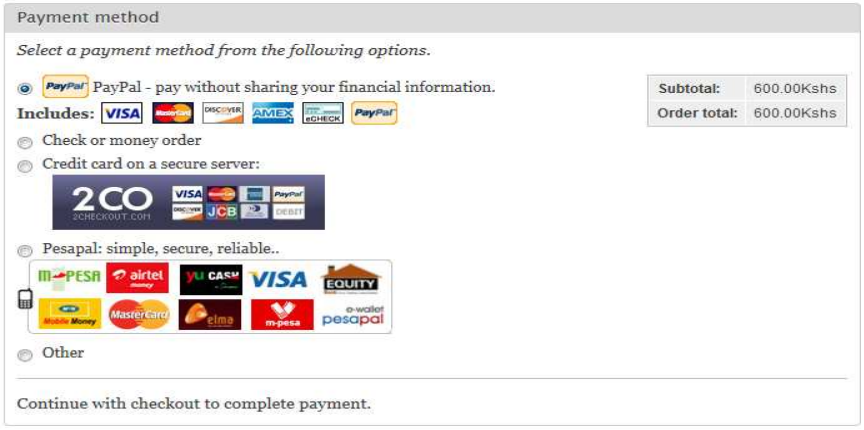

Fig. 5.8 Payment Modes

The solution offers a wide number of payment methods ranging from credit card to local payment methods e.g. Mpesa, Airtel, Yu cash e.t.c as shown in Fig. 5.8 above.

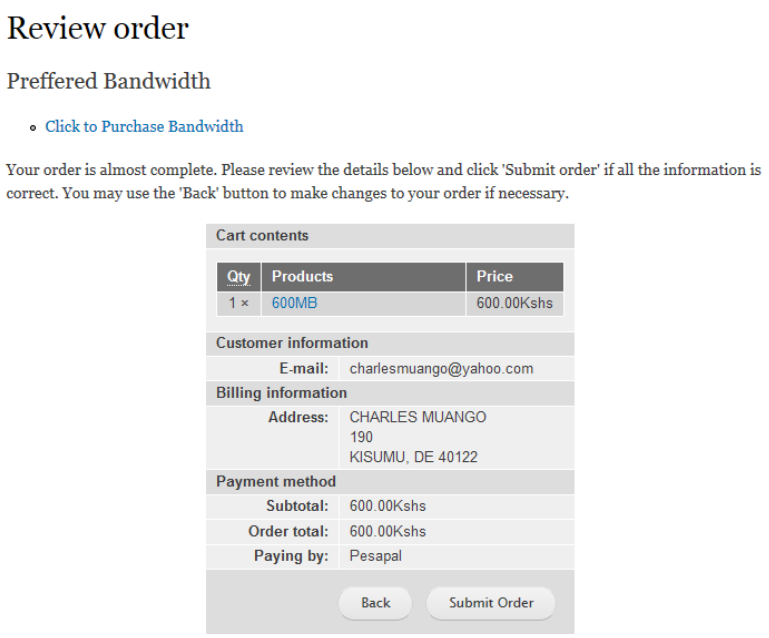

Fig. 5.9 Review Order page

From Fig. 5.9 the summary of Cart contends is shown including the customer information or rather what the user keyed in earlier (see Fig. 5.7)

The user then submits the order for processing and subsequent debiting his/her source of funds depending on the mode of payment chosen (see Fig. 5.8) and thereby completing the process hence is authorized to browse the Internet.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.0 Introduction

This chapter contains conclusions and recommendation from the study under taken that is '*The Implementation a Universal Public Wi-Fi Access*'. The chapter starts with a discussion containing conclusions about how the entire research was perceived.

6.1 Conclusions

Wireless services are increasingly ubiquitous and essential components in the global communications infrastructure. The mobility, flexibility, and re-configurability of wireless offer compelling complements, or at times, substitutes for wired infrastructure. They enable many new services and expand the usability of old services, extending the ability to stay connected anywhere and anytime we desire.

In this project a Web based Wi-Fi Access was designed and built which is used to provide the user with a wireless connection to the Internet different from what the ISPs under study use. The problem that was perceived is the fact ISPs do not have a wide network coverage for instance a user might be able to log in using their equipment in one location and fail in another. This is perhaps driven by the number of clients the ISPs target in an area, the dominance and financial power to offer Internet Service to certain areas than others. The equipment to enable one access Internet (Modem) are too expensive for low budget clientele in rural areas; it is quite bulky and cumbersome carry around everywhere one goes.

Since the solution is aimed to be low budget, thus there will no extra burden to the users to purchase modems but rather one only needs to purchase a device with Wi-Fi enabled feature. The only cost that will be transferred to the user will be for the purchase of bandwidth.

Another quality of the solution will be the ability for users to roam, thus they need not to worry about carrying with them different modems to suite their preferred destination. Through this solution they will be able to connect anywhere to surf and purchase bandwidth of their choice, pay for them using their preferred payment mode. This limits the use of pre-paid scratch cards to load onto the modem before one is able to purchase bandwidth for use.

Not all functionality of the solution was implemented, although the key area was. Things that have been designed but not implemented include the Central System that houses the various servers, the masks, setups with multiple cooperating access points and VPN security on the WLAN. This are features that can be included in the implementation to complete the solution to a production ready system.

The solution created in this project was walked through completely from inception to completion, applying previously gained knowledge and researching needed new knowledge. This project was perceived as very useful and contributing a lot to personal growth and in the field of work of ICT.

6.2 Recommendations

Wi-Fi should be made a public utility service just like any other service such as health care, roads e.t.c so as to be available instantly to everybody everywhere at affordable cost.

The government should increase their funding in the ISPs they have stake in so as to boost them and make them vibrant institutions capable of competing with privately owned ISPs. This will make them vibrant and together with their cutting edge technology they will be able to lower the cost of Internet and thereby increase Internet access.

The Government should invest in having Public ‘hotspots’ throughout the country to realize the dream of a Universal Wi-Fi Access.

6.3 Further Work

There is need to look into the security of this solution with reference to making the transaction processing water tight.

Wi-Fi speed need to be improved by using new technology that is available i.e.802.11n

Exploits can ventured into to see if the ISP’s can integrate into using this uniform platform without being irrelevant in the market while providing their services

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