

Performance Quality of WIMAX Technology in Nigeria: A Case of Lagos and Abuja.

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ABSTRACT

The introduction of Worldwide interoperability for Microwave Access (WiMAX) as a new technology in Nigeria, and indeed the increasing demand of data services by users has presented a need for evaluating the performance of the technology periodically for meeting a high expectations of its speed for users of the technology in Nigeria. This study examined the performance and usage of WIMAX in Nigeria. A purposive random sampling technique was used for data collection in two cities across Nigeria (Lagos and Abuja). A structured questionnaire was administered to 100 users in each city considered in this study, and descriptive statistics (bar chart, frequency distribution, pie chart etc.) was used to analyze results from the study.

From this study, it was revealed that 38% of the users in Abuja used the technology at least once in a day, while 34.5% of the users used the technology. These results present the intensity of the usage by the users of the WIMAX in the cities considered. The study further revealed that the quality of service experienced by users in Abuja is 41%, which is considerably low; while Lagos is 36.5%. In addition, the respondent views on the extent of quality of services in line with the users expectation revealed that in Abuja 30% of users have higher expectations, while 27% of users in Lagos have higher expectation which is low.

(Keywords: WIMAX, quality of service, data service, Lagos, Abuja, cellular network, user expectations)

INTRODUCTION

Since the inception of the telephone, service providers have staved off competition by relying on the exorbitant capital investment necessary to deploy a telephone network. The cost of deploying copper wires, building switches, and connecting the switches created an insurmountable barrier to entry for other competitors. In most part of the world, the high cost of this infrastructure limited telephone service to the wealthy and the fledging middle class [1].

The Public Switched Telephone Network (PSTN) was the earliest example of traffic engineering to deliver Quality of Service (QoS) guarantees. It consists of three major components: access, switching and transport. Each element has evolved over the hundred years plus history of the PSTN. This network was designed originally to handle voice; later, data was introduced. As data traffic on the PSTN grew, high capacity users found it inadequate, so these subscribers moved their data traffic to data specific networks. Many data users then found themselves limited to an infrastructure that was dependent on wires, either fiber optic cable, coaxial cable or twisted pair copper wire. Using wireless means to bypass wired monopolies is now a practicality for subscribers of both voice and data services. The primary form of bypass is the use of cellular phones [1].

A cellular network is a radio network made up of a number of radio cells (or just cells) each served by a fixed transmitter, known as a cell site or base station. These cells are used to cover

different areas in order to provide radio coverage over a wider area than the area of one cell.

Cellular networks are inherently asymmetric with a set of fixed main transceivers each serving a cell and a set of distributed (generally, but not always, mobile) transceivers which provide services to the network's users. Cellular networks offer a number of advantages over alternative solutions such as increased capacity, reduced power usage, better coverage etc.

The use of multiple cells means that, if the distributed transceivers are mobile and moving from place to place, they also have to change from cell to cell. The mechanism for this differs depending on the type of network and the circumstances of the change. For example, if there is an ongoing continuous communication and we don't want to interrupt it, then great care must be taken to avoid interruption. In this case there must be clear coordination between the base station and the mobile station.

We should understand the concept of broadband wireless and know the evolution of broadband wireless before we step into the WiMAX area. What is Broadband wireless? Broadband wireless is about offering broadband services by wireless solution. The term "broadband wireless" stands for the combination of wireless technology and broadband access. There are two types of Broadband wireless. The first type is called fixed wireless broadband. Instead of using traditional fix-line transmission, it uses wireless transmission media to provide broadband services. The second type is called mobile broadband. It offers additional function with portability, nomadicity and mobility. During the evolution of broadband wireless, it has evolved through four stages that are narrowband wireless local-loop systems, first-generation line-of-sight (LOS) broadband systems, second-generation non-line-of-sight (NLOS) broadband systems and standards-based broadband wireless systems [2].

WiMAX, the Worldwide Interoperability for Microwave Access, is a telecommunications technology aimed at providing wireless data over long distances in a variety of ways, from point-to-point links to full mobile cellular type access. It is based on the IEEE 802.16 standard, which is also called Wireless MAN. The name "WiMAX" was created by the WiMAX Forum, which was formed in June 2001 to promote conformance and interoperability of the standard. The forum

describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL" (and also to HSPA).

WiMAX will change telecommunications, as it is known throughout the world today. As this technology enables a lower barrier to entry, it will allow true market based competition in all of the major telecommunication services: mobile and static voice, video and data [2].

In the past two decades, the telecommunication industry have been developing fast both in technology area and business area. Wireless mobile services grew from 11 million subscribers worldwide in 1990 to more than 2 billion in 2000 [1]. At the same time, the Internet has spread all over the world. The requirement for high speed internet drives the broadband Internet access development. To replace the traditional wireline-access technology, telecommunication companies search for wireless solution for providing the broadband service. Many companies developed wireless access systems. Those systems varied in protocol, frequency spectrum, application supported, performance capabilities and some other parameters. But the broadband wireless has not been developing enormously because of lacking a common standard. WiMAX is developed to change the situation [2].

Worldwide Interoperability for Microwave Access (WiMAX) is a standard-based interoperable solution for wireless broadband. A WiMAX forum has been established to certify broadband wireless products for interoperability and compliance with a standard. WiMAX is based on wireless metropolitan area networking (WMAN) standards developed by the IEEE 802.16 group and adopted by both IEEE and the ETSI HIPERMAN group [2].

WIMAX TECHNOLOGY

The IEEE 802.16 group was established in 1998 to develop an air-interface standard for wireless broadband. The original 802.16 was finished in December 2001 which was based on a single-carrier physical (PHY) layer with a burst time division multiplexed (TDM) MAC layer. Many of the concepts related to the MAC were adapted for wireless from the cable modem DOCSIS (Data over Cable Service Interface Specification).

After this, an amendment has been made to include NLOS (Non-Line-of-Sight) application in the 2GHz-11GHz band by using orthogonal frequency division multiplexing (OFDM) based physical layer. For the MAC layer, orthogonal frequency division multiple access (OFDMA) was added in this revision. In 2004, the IEEE802.16 group produced a new standard which is called IEEE 802.16-2004. It replaced all the previous versions and created the first WiMAX solution.

Those WiMAX solutions based on IEEE 802.16-2004 targeted fixed applications and they were called as fixed WiMAX. In 2005, the group made an amendment to IEEE 802.16-2004 standard.

This amendment added the mobility support in the standard. This revision is called IEEE 802.16e-2005. It offers the basis of the solution for nomadic and mobile application. Therefore, this revision is called as mobile WiMAX. Table 1 shows the basic data for above-mentioned standards [3].

After standards were completed, the WiMAX forum designed the certification profiles for fixed WiMAX and mobile WiMAX. Those profiles specified the frequency band, channel bandwidth and duplexing mode [3].

Table 1: Basic Data on IEEE 802.16 Standards.

Status	802.16	802.16 – 2004	802.16e - 2005
		Completed December 2001	Completed June 2004
Frequency Band	10GHz -66GHz	2GHz-11GHz	2GHz-11GHz for Fixed 10GHz -66GHz for mobile applications.
Application	Fixed LOS	Fixed NLOS	Fixed and mobile NLOS
MAC-Architecture	Point-to-multipoint, mesh.	Point-to-multipoint, mesh.	Point-to-multipoint, mesh.
Transmission Scheme	Single carrier only	Single carrier, 256 OFDM, 2048 OFDM	Single Carrier, 256 OFDM or scalable OFDM with 128, 512, 1,024, or 2,048 subcarriers
Modulation	QPSK, 16 QAM, 64 QAM	QPSK, 16 QAM, 64 QAM	QPSK, 16 QAM, 64 QAM
Gross data rate	32Mbps-134.4Mbps	1Mbps-75Mbps	1Mbps-75Mbps
Multiplexing	Burst TDM/TDMA	Burst TDM/TDMA/OFDMA	Burst TDM/TDMA/OFDMA
Duplexing	TDD and FDD	TDD and FDD	TDD and FDD
Channel bandwidth	20MHz, 25MHz, 28MHz	1.75MHz, 3.5MHz, 7MHz, 14MHz, 1.25MHz, 5MHz, 10MHz, 15MHz, 8.75MHz	1.75MHz, 3.5MHz, 7MHz, 14MHz, 1.25MHz, 5MHz, 10MHz, 15MHz, 8.75MHz
Air-interface designation	Wireless MAN-SC	Wireless MAN-SCa Wireless MAN-OFDM Wireless MAN-OFDMA Wireless HUMANa	Wireless MAN-SCa Wireless MAN-OFDM Wireless MAN-OFDMA Wireless HUMANa
Wimax Implementation	None	256 - OFDM as Fixed WiMAX	Scalable OFDMA as Mobile WiMAX
a. Wireless HUMAN (wireless high-speed unlicensed MAN) is similar to OFDM-PHY (physical layer) but mandates dynamic frequency selection for license-exempt bands.			

Opportunities of WiMAX Technology are Highlighted Below:

- The market has an urgent need for a flat-rate voice and Internet access service. This can be delivered to customers in business and rural areas using WiMAX.
- For the first time there has been a huge step forward with a technology to address last-mile broadband connectivity.
- It has the potential to make Internet connectivity a reality in rural areas.
- WiMAX will also be useful in cities for applications including traffic control and emergency services, and for high-speed Internet access for tourists with a laptop.
- WiMAX the potential to be the first wireless technology to replace wired infrastructure.
- WiMAX can take voice, data and broadcast services into areas with no fixed network.
- Broadband wireless networks could prove invaluable in emerging markets where many areas are not served by traditional networks.
- WiMAX could open up new geographic areas for areas for telecommunications organizations by filling the gaps in fixed-line network.
- Voice-over-WiMAX offers the possibility of offering telecommunications services other than data, enabling more competition and thus better pricing for consumers.
- Investment opportunities in wireless broadband solution (WiMAX and CDMA), fiber optic cable infrastructure, electricity transmission and distribution lines, railways and oil and gas pipelines. This present ideal model to address the backhaul and terrestrial challenge to wider availability of broadband in Nigeria.
- Expanding access across terrestrial broadband segment could also be achieved through joint infrastructural investment in co-location and Tower sharing. However, for better collaboration for the development of backhaul broadband systems, there is need for regulating agencies framework.
- Multi-country rolls outs of terrestrial broadband infrastructure such as stations and sub-stations, concentrated nodal points for further distribution and transmission of data.
- Short term investment in wholesale backhaul services both to offer complementary coverage and targeting of growth in currently uncovered areas.
- Broadband infrastructural investment opportunities involving backward integration with data center (i.e., creating wholesale clusters)
- Securing long-term contracts from single off takers (e.g., governments or large corporations) in currently under-served or land locked areas as a basis for a primary cable investment into the specified region. However, understanding the market terrain and demand-supply dynamics is required.
- Broadband infrastructural investment in partnership and Alliances. Such alliances and partnership could be in form of Public-private partnership (PPP).
- Partnership and alliances with Mobile Network Operators (MNO) because of their firm grip on the consumer mass market. This could involve ISPs, large corporates, and other wholesale users incorporating into broader long term partnership that goes beyond sales and purchase agreements.
- Partnership with sub-sea cable operators that go beyond purchase of bandwidth for transmission.
- Partnering with Governments and various government agencies due to public benefits of the infrastructure, public sector capacity to stimulate demand, the extensive licensing and Right-of-Way requirements for various elements of the business.
- Infrastructural broadband investment in Public Passive Infrastructure. In this case, governments build an infrastructural broadband platform without becoming a network owner but found the installation of passive infrastructure (poles, conduit, etc.) which can be used by various operators.

- Rural strategy: based on universal service targets for broadband access, investment in high speed backbone networks to rural communities (schools, hospitals and other public institutions as anchor points for high speed connection in the community) may be more efficient than projects that pay for last-mile connection to homes. If government provides this, then the business opportunities for private ISPs might be to interconnect at these points and distribute access directly to users on their own facilities and services.

- Out-sourcing business opportunities: existing large scale operators outsource the less profitable parts of their operation, small local companies take in the edge of market coverage areas and get a reasonable interconnect with the large-scale operators [4].

Challenges of WiMAX Technology are Stated Below:

- Computer literacy is still very low in Africa.
- It is difficult to build a decent business case for implementing WiMAX networks with a low-income population base.
- High levels of poverty mean that ant telecommunication services are out of the reach of most Africans, even if WiMAX is cheaper.
- Security of infrastructure.
- Theft of copper wire has been a major problem associated with the roll-out of traditional telecommunications delivery. There is no reason to think that new technology roll-outs would be immune.
- Wireless phone networks are evolving quickly and have relative ubiquity of coverage when compared to WiMAX.
- Wireless data technology called EV-DO, already in use on wireless phone networks, is predicted to have future speeds as fast as 15 to 20 megabits per second.

Some of the Solutions to the Challenges of WiMAX Technology in Nigeria:

Hesitancy: Companies are very hesitant of setting up WiMAX base stations today since it has not yet reached widespread use. Intel has made their Centrino laptop processors WiMAX enabled. All laptops are expected to have WiMAX by 2008.

Exclusion of Start-Up Companies: Even though cost provides a low barrier to entry, none of the startup companies are projected to be major players in the development of WiMAX. Intel and Cisco seem to have an obvious advantage today, and by the time it reaches widespread use, large operators will find WiMAX to be a very attractive new way of raising revenues.

Research and Development: For WiMAX to succeed, new products must be researched and developed to incorporate WiMAX. Without the help of major companies investing in this R&D, WiMAX could be gravely underutilized [5].

METHODOLOGY

For the above objectives to be met, interviews and literature studies is used as the research methods. With the help of literature (electronic and printed) a framework is created for understanding and analyzing issues arising in the coming interviews. Also it is important to get a certain level of knowledge especially in technology issues beforehand. Available literature has almost totally targeted WiMAX operators, applications developers, service providers and content providers. From the point of an end user, subscribers in this case; it is difficult to find any literature or research related to the benefits of using WiMAX technologies in e-transactions. This is one of the reasons for carrying out this research work.

DATA COLLECTION

The raw information also known as data was collected using purposive random sampling techniques. Purposive sampling technique is a type of non-probability sampling where the researcher consciously selects particular elements or subjects for addition in a study so as to make sure that the elements will have certain

characteristics pertinent to the study. It normally targets a particular group of people.

DATA ANALYSIS

Descriptive statistics (bar chart, frequency distribution, pie chart etc.) was used to analyze the data in this work.

RESULTS AND DISCUSSION

Survey: Lagos study area: Result on the usage of WiMAX technology in the study areas: In presenting the result it is necessary to present the number of users to different network provider in achieving the objective of the study.

Some respondents indicated they had more than one WiMAX modem, so they were asked to identify their principal provider. This table shows that the sample sizes for some providers are small, so any comparison between providers should be treated with caution.

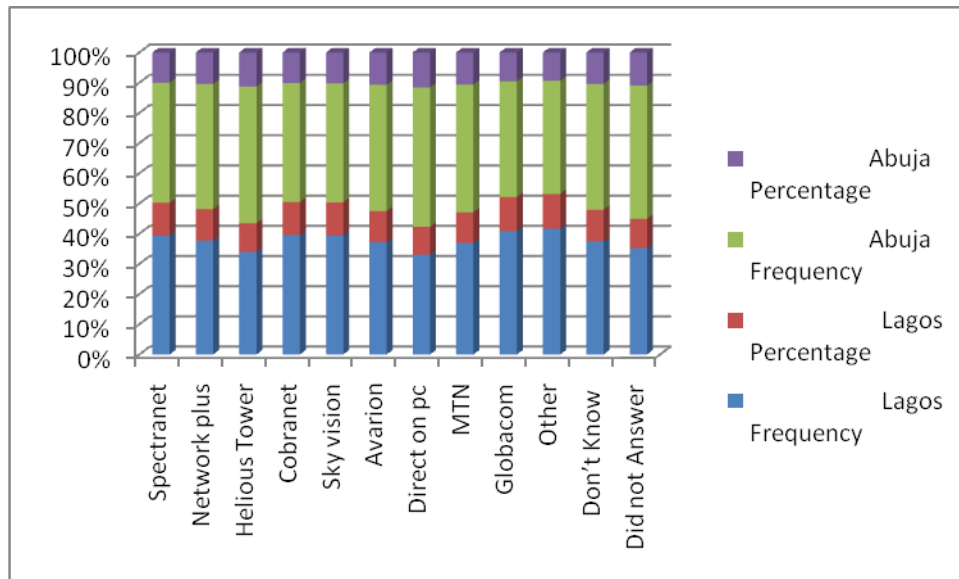
Table 2: Proportion of WiMAX Users Subscribing to Providers (%).

Network Providers	Whole sample	
	Lagos	Abuja
Spectranet	25	25
Network plus	10	10
Helious Tower	5	5
Cobranet	3	2
Sky vision	2	2
Avarion	3	4
Direct on pc	7	8
MTN	30	35
Globacom	10	9
Other	20	20
Total	110	120

Table 3: Principal Provider used by WiMAX Modem Users (%).

Network Provider	Lagos		Abuja	
	Frequency	Percentage	Frequency	Percentage
Spectranet	75	20.8	76	19
Network plus	30	8.3	33	8.3
Helious Tower	15	4.2	20	5
Cobranet	9	2.5	9	2.3
Sky vision	5	1.4	5	1.3
Avarion	8	2.2	9	2.3
Direct on pc	20	5.6	28	7
MTN	100	27.8	115	28.8
Globacom	32	8.9	30	7.5
Other	50	13.9	45	11.3
Don't Know	18	5	20	5
Did not Answer	8	2.2	10	2.5
Total	360	100	400	100

Figure 1: Principal Provider used by WiMAX Modem Users (%).



From the above table, it is seen that most people still use WiMAX modem produced by MTN followed by the Spectranet and the rest.

Table 4: Intensity of WiMAX Usage (%).

Intensity of Usage	Whole Sample	
	Lagos	Abuja
Once A Week	11.8	13
1 or more times A Week	27.7	26
1 or more times A Day	34.5	38
Did not Answer	26	23
Total	100	100

Table 4 shows that there is a sizable minority of WiMAX users that uses their modem infrequently (less than once a week).

Table 5: Views on Quality of Services Provided (%).

View of Quality of Service	Whole sample	
	Lagos	Abuja
Very poor	8.9	8
Poor	12.1	14
No opinion	10.2	11
Good	36.5	41
Very Good	20.3	15
Did not answer	12	11
Total	100	100

Views on the quality of services specifically to fixed line networks in Lagos closely matches this – 48% felt the quality was good or very good, compared with 21% who felt it was poor or very poor (Table 5).

The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the quality was good or very good while in Abuja Views on the quality of services specifically to fixed line networks closely matches this 56% felt the quality was good or very good, compared with 22% who felt it was poor or very poor (Table 5). The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the quality was good or very good.

In Lagos, 42% felt that the accuracy of charging of data rates was good or very good, compared with 30% who felt it was poor or very poor (Table 6). Similarly, the proportion of respondents that felt the alignment of charges with advertised rates was good or very good (33%) was higher than the proportion who felt it was poor or very poor (22%) (Table 6). While in Abuja 44% felt that the accuracy of charging of data rates was good or very good, compared with 35% who felt it was poor or very poor (Table 6). Similarly, the proportion of respondents that felt the alignment of charges with advertised rates was good or very good (35%) was higher than the proportion who felt it was poor or very poor (25%) (Table 6).

Table 6: Rating of WiMAX Modem Charges (%).

Rating of Modem Charges	Lagos		Abuja	
	Correct charging Of data rates(Downloads)	Agreement of Charges with rates Advertised	Correct charging Of data rates(Downloads)	Agreement of Charges with rates Advertised
Very poor	8.2	5.5	8	7
Poor	21.8	17	27	18
No opinion	5.2	12.1	6	12
Good	31.5	22.2	34	23
Very good	10	11	10	12
Did not answer	3	2.9	3	4
Don't know	20.3	29.3	12	24
Total	100	100	100	100

Table 7: Overall Quality of Services – Fixed WiMAX Modem

Quality of Service	Lagos		Abuja	
	On fixed WiMAX networks	On mobile WiMAX networks	On fixed WiMAX networks	On mobile WiMAX networks
Very poor	4.2	6.5	6	8
Poor	17	11	18	9
No opinion	10.1	7.2	10	7
Good	37.1	34	33	35
Very good	11.2	11.3	14	12
Don't know	1.5	1.2	3	1
Did not know	18.9	29.8	16	28
Total	100	100	100	100

Views on the quality of services specifically to fixed WiMAX networks closely matches this – 48% felt the quality was good or very good, compared with 21% who felt it was poor or very poor (Table 7). The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the quality was good or very good. But for mobile WiMAX networks closely matches this – 45% felt the quality was good or very good, compared with 17% who felt it was poor or very poor (Table 7).

The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the

quality was good or very good. While in Abuja, Views on the quality of services specifically to fixed WiMAX networks closely matches this – 47% felt the quality was good or very good, compared with 24% who felt it was poor or very poor (Table 7). The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the quality was good or very good. But for mobile WiMAX networks closely matches this 47% felt the quality was good or very good, compared with 17% who felt it was poor or very poor (Table 7) The response rate to the question on quality of services to the networks was lower, but among those who did answer, a higher proportion felt the quality was good or very good.

Table 8: "To what extent is the quality of services in line with your expectations?" (%)

Quality of Service in Line with Expectations	Whole sample	
	Lagos	Abuja
Much lower	6.8	6
Lower	24	21
In line	7	9
Higher	27	30
Much higher	9	11
Don't know	5	3
Did not answer	21.2	20
Total	100	100

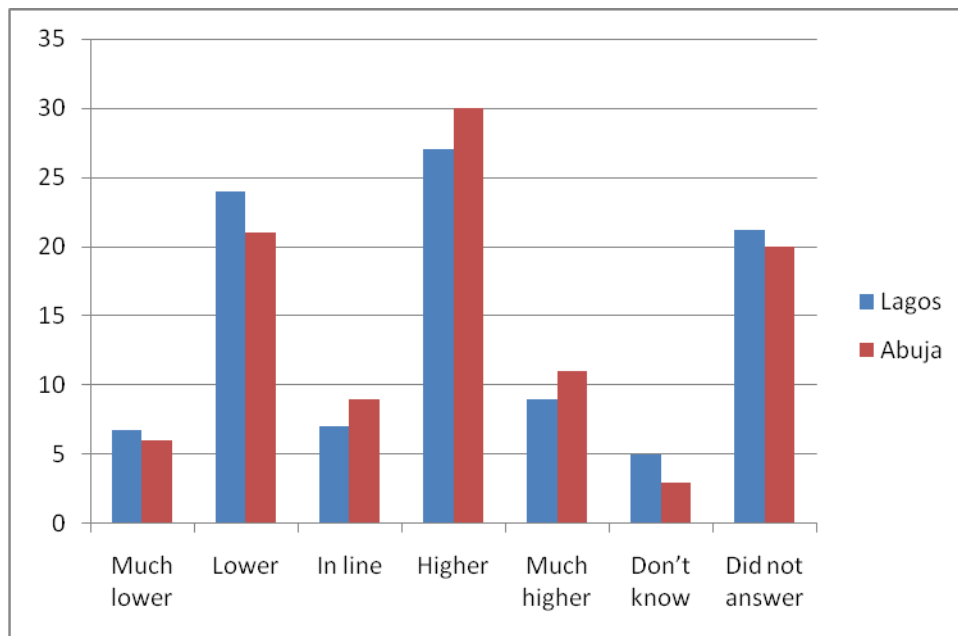


Figure 2: Expectations of Quality of Service.

CONCLUSION

From the results so far, it is deduced that quality of WiMAX technology is very high in Abuja compare to that of Lagos. No country can develop in modern civilization without Internet powered communications. The basis for enjoying the new world economic order and enhancing the wellbeing of citizens is participation in world trade via e-commerce. E-commerce implementation is hinged on the availability of Internet connection to the super highway.

Apart from the existing Information Technology Infrastructural hiccups, the most debilitating factor against Internet diffusion in Nigeria is low speed and expensive bandwidth.

This has dwarfed the expectations of the WIMAX technology. The absence of indigenous satellite capability calls for political will on the part of governments in Nigeria to put efforts together to design and launch functional communications satellites, work on local breed raw band width via broadband revolution and the deployment of terrestrial and broadband Internet infrastructure to create adequate opportunity for her citizens to join the new world information society and economic order. No nation can effectively develop nor compete in the global market place without seriously embracing information technology as an economic enabler. In conclusion, government needs to revamp our IT infrastructure, improve the literate level of among the citizens, fixing of power sector to give adequate electricity and all other hiccups that prevent the usage of WiMAX technology by individuals in Nigeria.

RECOMMENDATIONS

Governments need to budget fund for realistic research in the WiMAX technologies, lay the right information technology infrastructure such as the construction of fiber optics ring to be linked to Nigeria 1, provision of good and regular electricity power, launching of a sustainable communications satellite, sponsor mass I.T. education from the school system to the civil society as well as provision for the retraining of lecturers in the new IT paradigm, development of infrastructure and superstructure for increment of local content of locally assembled PCs and work towards component fabrication, foundries for microlithography/ Very Large Scale Integration. Thus, Nigeria's internet diffusion will get a

quantum leap if computers are cheap, tariff for telephone and internet access low, emergence of functional and sustainable energy supply, continuing investment via public-private participation for provision of additional ICT Infrastructure nationwide. Other tactical strategies include collaboration with African Universities for proper coordination of ICT budgets; establishment of a detailed plan, costing for setting up a hub in Europe or North America to provide bandwidth at low tariff to tertiary institutions in Africa. That is the way forward for Nigeria and other African nations.

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