

Internet Capacity of Higher Education and Research Institutes in Africa: The Need for National Research Education Network

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Abstract Higher Education Institutions especially Universities have for all time been identified as the space for generating knowledge through research. Unfortunately, for many African countries, higher education had witnessed a long period of relative neglect and stagnation. Many higher Education Institutions, especially Universities in Africa, are burdened with a myriad of problems to the extent that they have little time and resources for effective research. Research as connoted in this article refers to independent intellectual enquiry into diverse disciplines and areas, and which leads to the creation of new and significant knowledge. So far, Google Apps for Education is now available to hundreds of thousands of students and university faculty in over 20 African universities, including University of Benin, University of Nigeria, Nsukka, Benson Idahosa University, Covenant University and University of Lagos. By participating in the program, Nigerian universities have access to Google Apps for Education, a free suite of hosted email and collaboration applications exclusively for schools.

Keywords: *research, internet and higher education*

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1. Introduction

The modern world is currently being transformed through research. The growth of nations and indeed, the economics of nations today depend on their commitments to knowledge generation and utilization through research, Adeogun [1]. One of the failures in the African continent is the failure of many nations in Africa to accord research the priority it deserves, AAU [2]. Research is strategically important in Universities, as it is necessary to facilitate good quality undergraduate and graduate training. Gakio [3] agrees that research help universities to motivate and empower its researchers and promote the training of future researchers. According to Jega [4], many African Universities have lost the capacity for doing sustainable research. As early as 1964, at a UNESCO meeting held in Nigeria, African countries, recognizing the importance of research to their national development, committed themselves to spend at least 0.5% of their Gross National products on scientific research, Ojo [5]. Unfortunately, most countries in Africa have not been able to stand up to this challenge.

1.1. Higher Education in Africa

There are over 2300 higher tertiary institutions in Africa, enrolling 6.2 million students. Within the past ten years, Africa has witnessed a high growth in the number

of private and distance learning tertiary institutions. This is partly because the public institutions that had been in existence for many years can no longer cope with the increasing population and high demand for education in the continent. This notwithstanding, Africa tertiary gross enrolment, which is just 5%, is still the least when compared to North America with 70% and Europe with over 24%.

Research in Africa is facing a lot of challenges. It is known that sub-Saharan Africa spends less than 0.3% of its GNP on research and the region has been identified as the region that contributes the least to research funding in the world. Africa's share of global scientific output has fallen from 0.5% in the mid-1980s to 0.3% in the mid-1990s. Apart from this, Africa accounts for the lowest ratio of researchers per million inhabitants in the world. Africa, which accounts for 12% of the world population accounts for less than 1.5% of research publications annually.

Findings indicated that most research in Africa is carried out in the tertiary institutions set-ups. It is also observed that these research institutions are limited by poor infrastructures, ill-motivated staff, incessant and inadequate power and water supply, out-dated equipment, poor funding and poor connectivity to the rest of the world. The last problem of poor connectivity is due to the poor state of telecommunication infrastructure in the continent. The importance of knowledge as a critical element of sustainable development in today's competitive global economy is well known. People and nations therefore

need to be challenged to create access and employ knowledge to be able to meet the challenges of life and survive in our ever-changing world. This challenge cannot be met if the quest for knowledge through research is not attended to.

Wright [6] commented that 'research today is truly global, and scientists, academics and students rely on networks such as the Europe's GEAN to pool resources and to work together effectively, no matter where they are based'. For African tertiary educational institutions to carry out meaningful research in today's world, they need good internet connectivity.

1.2. State of Information Communicational Technology (ICT) Infrastructures in Africa

Gakio [3] has described the state of Internet connectivity in tertiary institutions in Africa as 'too little, too expensive and poorly managed'. According to this report, the average African university has bandwidth capacity equivalent to a broadband residential connection available in Europe, pays 50 times more for their bandwidth than their educational counterparts in the rest of the world and fails to monitor, the existing bandwidth or use it appropriately

for its research and educational purposes.

However, initiatives within the continent point the way to a different future. North Africa is the most advanced of all regions in Africa because universities in these countries have just recently become members of the EU MED Connect project, which links them to high-speed undersea fibre networks. The potential for these types of arrangements hold out the possibility to dramatically alter the bandwidth landscape in tertiary institutions in the near future.

These experiences and those around the world argue strongly that there is an imperative to examine the potential to create initiatives to improve bandwidth access for African universities. A range of options is available. At one end relatively simple buying consortia can be created for even small groups of universities, Bemah [7]. On the other end, according to Islam, Anwarul and Panda [8], the potential exists to create a continental not-for-profit telecommunications service provider or organization, which would provide a much broader range of services and ensure that effective network and bandwidth management practices are in place. The need clearly exists for such initiatives to provide cost-effective and well-managed bandwidth services to the research and higher education sectors across Africa.

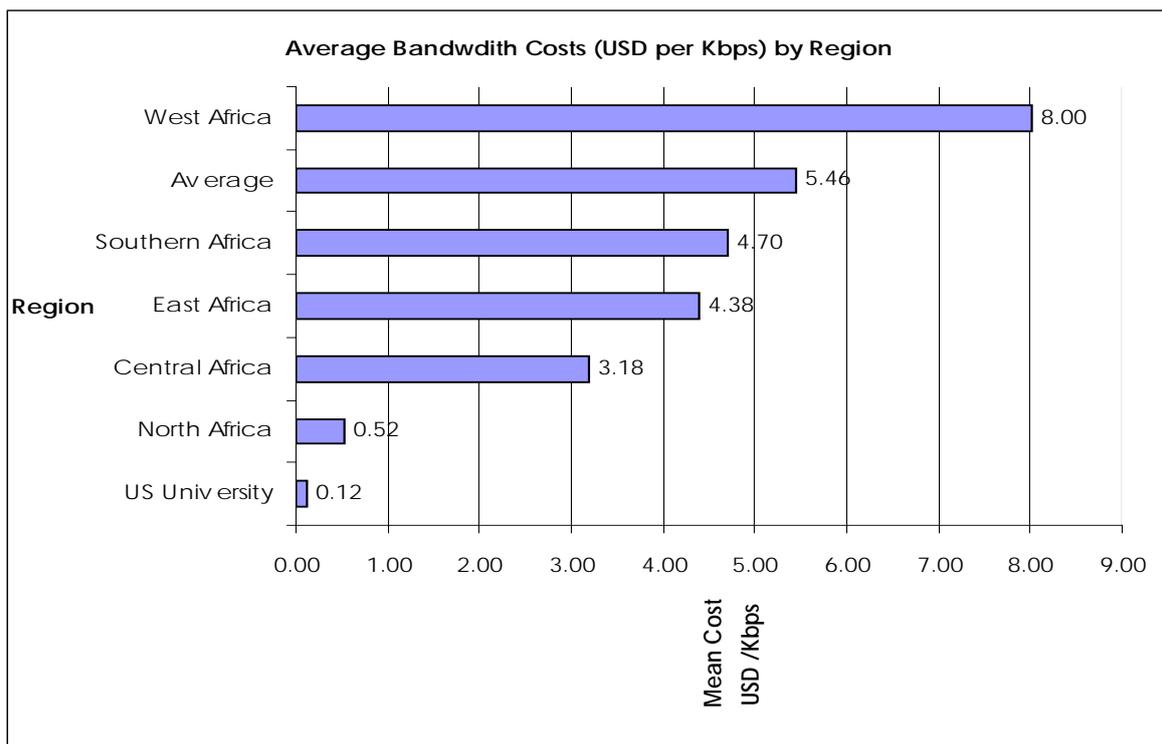


Figure 1. Average Bandwidth Costs/Kbps by Region (Source: ATICS 2005)

1.3. Challenges of Information Technology in Africa

The challenges facing Information Technology has been explained by the Association of African Universities-AAU_s [9] and these include:

(a) The Bandwidth Limitations

Limited bandwidth and its high cost are the major problems that inhibit communication and collaboration

between academic and research institutions in Africa. The absence of connectivity to fibre backbone makes many of the countries to be dependent on low bandwidth and costly satellite links. Fibre optic, which offers better confidentiality and security, high bandwidth, better reliability, high signal quality, longer lifetime and low service cost, is believed to remove some of the challenges of academic connectivity.

The Bandwidth challenge is currently being met by the various Academic and Research Networks which are evolving in Africa. The National Regional Research and

Educational Network Initiatives are forming regional consortia to foster cooperation, mobilize resources and work around regulatory and policy challenges. One of these is the UbuntuNet Alliance, founded in 2005, which vision is to ensure that Africa participate effectively in the global research community. In 2008, a high speed network link connecting the UbuntuNet Alliance hub in London to the international research community via the European GEANT2 network was completed.

(b) Bandwidth Management

Apart from the limited bandwidth, the improper use of existing connectivity is a major challenge. Ineffective utilization of existing bandwidth, due to absence of bandwidth management strategies promotes bandwidth wastage on unwanted traffic (viruses, music and movie download, etc). Institutions therefore need to put in place necessary policies for optimizing the available bandwidth in academic and research institutions.

(c) Human Resources

Lack of skilled human capacity in many countries is a limitation to the use of IT connectivity for research. Human resources are needed to evolve the necessary vision and policy frameworks for ICT.

(d) Policy and Regulatory Challenge

There are many regulatory policies affecting IT connectivity for research in some countries. These include:

- Restrictive telecommunication s sector policy and regulations that constrain academic institutions from owning and operating satellite or fibre networks;
- Lack of clear policy and regulations on the status of academic and research networks;
- Lack of open access to fibre networks and lack of competition

1.4. Connectivity Study in Africa

The Association of African Universities (AAU) Connectivity survey was conducted during June 2008, from a total of 51 Higher Education Institutions (HEIs) in the nine West African countries of Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Liberia, Mali, Mauritania, Nigeria and Senegal. The 2.2 million staff and students in the region have on average on 0.37 Kbps per head (which is reduced to 0.10 Kbps of raw bandwidth once the exaggerating effect of broadband services is removed). Under current procurement arrangements, HEIs will fall further behind their own estimated bandwidth requirements

of about 3Gbps by 2013. Half of the universities are covered by satellite although fiber is currently available to over 95% of the universities, AAU_a [2].

The study found out that the universities pay around US\$2300 per Mbps/month and currently pay around US\$30 million for connectivity. The expense is estimated to be over US\$100 million if the current pricing for connectivity holds. There are two options for the research and academic institutions to increase their bandwidth to a more desirable level: either increase the budget in order to buy more bandwidth, or find ways of negotiating better price to buy more bandwidth with the same budget.

The study argued that it is extremely unlikely that west and central African universities will be able to afford to increase their budget to some US\$100 million over the next five years in order to meet the estimated cumulative demand. Even within a bandwidth buying consortium negotiating bulk discounts on satellite bandwidth, they would still fall considerably short of the bandwidth they require. For this reason, the option of negotiating price reduction is preferable.

The projected bandwidth in the demand study will not be sufficient for academic institutions. African academic and research institutions should strive to obtain bandwidth comparable to their peers in America, Asia and Europe. Universities should aim for bandwidth between .3 to .5 Gbps in the long run, AAU_b [9]. There are many formulae available for common-cost sharing.

The report on the supply of fiber connectivity in West Africa noted that National Research and Education Networking is about peering with other research and higher education institutions via links to regional and global networks. With few exceptions, African universities lack access to the same resources for research and education as their peers on other continents, simply because they are not connected to the global research and higher education infrastructure consisting of high capacity regional networks such as GÉANT in Europe, providing transit to TEIN in Asia, Red CLARA in South America as well as to INTERNET2 and CANARIE in North America, Tusubira [10].

The study showed that there is a substantial amount of fiber that is available to academic institutions in West and Central Africa and more fiber is currently being planned and rolled out. However the policy and regulatory frameworks of the communications market is not adapted to facilitate the development of NRENs. The market is still a high price-low volume one and there is limited competition for supply of Internet and telecommunication services.

Table 1. Estimated Total Bandwidth Requirements for Selected Public Universities in Southwestern Nigeria

University	User Size	Total No. of Networked computers	Total Mbps Available	Mbps Required	Bandwidth Difference
OAU	30,950	1,200	14.00	22.22	8.22
FUTA	3,00	750	5.00	15.00	10.00
UNAAB	800	650	1.40	2.60	1.20
LAUTECH	700	900	1.00	12.0	11.00
LASU	60,120	6,500	3.00	40.00	37.00
OOU	20,000	320	1.07	15.26	13.56

Source: [5].

A study carried out in Southwest Nigeria by Ojo [5], reveals in Table 1 that the bandwidth capacity of the universities surveyed. OAU seems to have the highest bandwidth with 14.00 Mbps, 30,950 users, while LAUTECH has the lowest of 1.00 Mbps with 700 users.

LASU has the highest estimated user size of 60,120. In all universities bandwidth the availabilities are inadequate as shown in the column for bandwidth difference.

2. Literature Review

Kumar and Kaur [11] state that the current information revolution and increasing impact of information and communication technologies has modernized the process, learning and research in most universities. Several studies provide details about ICT adoption. Ramzan [12] observes that expert systems, wireless networks, virtual collections, interactive web interfaces, virtual reference services, and personal web portals have brought changes since the start of the new millennium. Ramzan [12] in his study observed that librarians in Pakistan were not prepared to embrace the changes brought by information and communication technologies. Most of them were not even sure about ICT applications in their libraries. They were also uncertain about the benefits of these new technologies for their organizations since they have little knowledge of ICT. Islam [13] stated that the application of web-based information retrieval trends of researchers is ever increasing and the electronic material will eventually replace the traditional library and users need not go there to find and collect information they need. Al-Ansari [14] focused on the Internet use by the faculty including purpose of use, impact on teaching and research, Internet resources that they use and the problem faced while using the Internet. It was discovered that majority of them have been using the computer and Internet for more than five years. That is, almost all of them want to improve their Internet use skill through formal training.

Research and Education Network (REN) is an association of institutions that is focused on conducting research and educational instructions, with the aim of institutional collaboration for the purpose of maximizing scarce resources, proffering solutions and improving infrastructure for the realization of their organization objectives. It may be geographically related or otherwise.

An Example of a non-contiguous geographic REN is the Partnership for Higher Education in Africa (PHEA). A National Research and Education Network (NREN) is a specialised internet service provider dedicated to supporting the needs of the research and education communities within a country. It is usually distinguished by support for a high-speed backbone network, often offering dedicated channels for individual research projects, Wikipedia [15]. The ultimate goal of a National Research and Education Network is to establish a robust academic research and education network that facilitates the sharing of content among its members. This implies the need for establishing a strong driving link between the university research and teaching strategies and the NREN strategy, building the capacities of members in optimizing network resources for sharing learning resources, UbuntuNet [16].

2.1. National Research Network Contribution to Research and Teaching in Higher Education

Osuzuwa [17] identified the following as the effects of the ICT AND NREN on quality of research. He noted that medical school in Dakar, Senegal is collaborating with medical experts in Toulouse, Strasbourg and ULB Bruxelles to strengthen the quality of teaching, learning research by using Distance Learning And Telementoring in Surgery programmes to upgrade critical surgery skills. (Toure) and that the University of Ibadan has been able reduce the withdrawal rate of undergraduate students from 14% to 2.6% as a result of introducing ICT based admission process and Post-UME test. The Distance Learning Institute have increased enrolment of students from 1,000 in 2005 to 17,000 in 2011, through the deployment of ICT-driven open distance learning (ODL) mode of delivery at significantly reduced cost when compared to the traditional classroom model.

- SANReN ('South African National Research Network) is a new National Research and Education Network in South Africa. However, unlike most other NRENs, SANReN provides its clients with both connectivity to the world's research networks as well as commodity Internet access, Wikipedia [15]. The first nine universities in the January 2011 webometric ranking of Africa Universities are based in South Africa. It justifies the heavy investment of the South Africa government and institutions on ICT and e-infrastructure.
- TENET (Tertiary Education and Research Network of South Africa) is actively engaged in the construction of Access Networks connected to the SANReN network. provides Internet and information technology services, involving, inter-alia high-speed Internet access, inter-campus connectivity, ancillary operational functions in support of service delivery, and the provision of other value-added services as may be needed from time to time in support of higher education and research in South Africa.
- National LambdaRail (NLR) the innovation network for research and education operates her 12,000 mile, nationwide, advanced optical network infrastructure supports many of the world's most demanding scientific and network research projects. With no restrictions on usage or bandwidth, NLR is the platform of choice enabling cutting-edge exploration and discovery in the biomedical, engineering, network research, physics and many other disciplines at over 280 leading research institutions and federal agencies. And NLR offers users the choice of Ethernet-, IP- or Lambda-based connectivity and transport services, as well as highly customized technical support. With virtually unlimited capacity, speeds of up to 40 Gbps, an existing footprint throughout the U.S.

GARNET, The Ghanaian Academic and Research is assisting to fulfill a very crucial need for research and education within Ghana by providing services aimed at

fostering collaboration among research and educational institutions in the region as well as between them and peer institutions worldwide, Dakubu [18].

2.2. Telecommunication Companies and Internet Capacity of Higher Education in Nigeria

Internet giant, Google is partnering with Nigerian universities to remove Internet access barriers and to equip them with free communication tools. Through the Google Apps Supporting Programmes (GASP), a Google initiative aimed at increasing Internet usage in universities across Africa, through the provision of Internet bandwidth, infrastructure grants, technical consulting and Google Apps for Education deployment support and training, the company supports African universities to use technology more effectively for research and collaboration.

So far, Google Apps for Education is now available to hundreds of thousands of students and university faculty in over 20 African universities, including University of Benin, University of Nigeria, Nsukka, Benson Idahosa University, Covenant University and University of Lagos. By participating in the program, Nigerian universities have access to Google Apps for Education, a free suite of hosted email and collaboration applications exclusively for schools.

The University of Benin formally launched its partnership with Google in September this year. In addition to Google Apps for Education, it received about 25 Mbps of Internet bandwidth from Google. The Google Apps Supporting Programs is firmly committed to making technology a core part of Nigerian university life.

So far, among Nigerian Universities, American University of Nigeria (AUN) has emerged as a model university in both Google apps and technology usage. Students at the University use Google Apps for communication and collaboration for their student groups, independent projects and extracurricular activities. In addition, at the school, each student has a laptop, each faculty and staff member has a tablet, and the administration's goal is to transition entirely to eBooks in the coming years.

Mwangi [19] stated that "Stable power and networking infrastructure, combined with a strong commitment to advancing technology usage on campus, has resulted in a consistently good Internet experience. This has allowed AUN students and faculty to expand their learning opportunities with the Internet and Google Apps. The AUN model represents the frontier of connectivity and technology usage in African education."

Google also provides capacity building assistance through technical workshops and trainings for university Information Technology (IT) staff. The most recent Google sponsored workshop was a campus network design workshop at Obafemi Awolowo University, Ile Ife where network engineers from about 18 universities across Nigeria attended. This is in line with Google's goal to make the Internet a part.

The **GLO-1** (Globacom-1) submarine communications cable is a cable system along the west coast of Africa between Nigeria and the UK, owned by Nigerian telecoms operator Globacom. The submarine cable system is

9,800 km long, and became operational in 2011 with a minimum capacity of 640 Gbit/s. A project of Globacom, Nigeria's 2nd largest telecoms provider, total capacity of the system is now advertised as 2.5 Tbit/s. The cable's link To Ghana was turned up in April; 2011. The GLO-1 (Globacom-1) submarine communications cable is a cable system along the west coast of Africa between Nigeria and the UK. The submarine cable system is 9,800 km long, and became operational in 2010 with a minimum capacity of 640 Gbit/s. It originates from Brud in the UK and it is laid from this origin to Alpha Beach in Lagos, where it will have its Landing Station.

The main cable landing points are:

- * Lagos, Nigeria.
- * Accra, Ghana
- * Dakar, Senegal
- * Nouakchott, Mauritania
- * Casablanca, Morocco
- * Sesimbra, Portugal
- * Vigo, Spain
- * Bude, UK

The service is expected to drastically reduce cost of internet connection and other telecommunication services.

Such services will include:

- * Teleconferencing
- * Distance learning
- * Disaster recovery
- * Telemedicine
- * Internet connection

3. Conclusion

Africa has very high capacity strengthening needs. Strategic approach to harmonizing the existing and future research capacity strengthening programmes is required. ICT and good management are indispensable keys to enhance the capacity African higher education to provide quality training, conduct high caliber research and produced skilled graduates for the labour market.

Research and Education Network (REN) help to foster information exchange among researchers, facilitate the interactions and collaboration of researchers to produce high quality research and world class institutions. NRENS and deployment of ICT driven collaboration in teaching and research is developing the next generation networking and applications in research and higher education. Solving the Next Generation problem require highly trained academics, administrators, students and graduates working within functional tertiary institution and collaborating through local and international networks. Improved and affordable regional and international connectivity will enable African researchers and higher education institutions to generate a proportionate amount of intellectual property goods to achieve parity with the rest of the world, with higher return on investment. Research and Educational Network is a platform of synergy, growth and development for increased collaboration, cost effective application of resources, improved infrastructure and capacity building.

The development of sustainable NREN and RREN in West and Central Africa requires considerable investment

in awareness creation. The following actions need to be taken forward to facilitate awareness creation. There is need to organize a meeting of university leaders in all countries in West and Central Africa. A high level of support from university leaders is important for sustainable NREN. University leaders are the owners of NRENs, while the ICT departments become customers. All meeting of the university leaders should be accompanied by a half day tutorial discussing demand, infrastructure, policy, regulation, financing based on international best practices.

Building sustainable and successful NRENs in the West and Central African region needs to take the unique circumstances of the countries in the region. This includes improved availability of experts that speak French and provide coaching on NREN development. Availability of experts that provide on site and off-site support to NRENs is critical to take NRENs off the ground.

It is also important to select a dozen of countries where NREN activities are ripe enough and use these as a showcase to other nations.

- All academic and research institutions in Central and West Africa need to be encouraged to put all the building blocks of NRENs in place. These include:
- Getting political endorsement from policy makers
- Building skilled human resources
- Securing Autonomous Network Numbers (AS numbers) and address space
- Securing affordable access dedicated to NRENs is another prerequisite for successful deployment of NRENs.

The development of Regional Research and Education Network requires further resources for promoting policy and regulatory harmonization through CEMAC, ECOWAS, WATRA, UEMOA and other relevant bodies. A formal creation of WCAREN and dialogue with regional and international fiber network providers on securing cheap connectivity to NRENs is also important. The Association of African University needs to continue regional coordination and leadership until such time a fully functional WCAREN is established.

The deployment of NREN and RREN is at early stages in West and Central Africa. This implies that resources for their establishment and operation should be available externally at the beginning. The Association of African Universities needs to ensure that the initial resources for formation NRENs and RRENs become available from international development partners.

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