

OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE, NIGERIA.

INAUGURAL LECTURE SERIES 304

**JOBS NOWHERE BUT EVERYWHERE:
RESOLVING NIGERIA'S
UNEMPLOYMENT CRISIS THROUGH
INFORMATION TECHNOLOGY**

By

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**An Inaugural Lecture Delivered at Oduduwa Hall,
Obafemi Awolowo University, Ile-Ife, Nigeria
On Tuesday, 4th July, 2017**

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Inaugural Lecture Series 304

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ISSN 0189-7848

Printed by

**Obafemi Awolowo University Press Limited,
Ile-Ife, Nigeria.**

JOBS NOWHERE BUT EVERYWHERE: RESOLVING NIGERIA'S UNEMPLOYMENT CRISIS THROUGH INFORMATION TECHNOLOGY

1.0 Preamble

I thank God Almighty for preserving me and providing the opportunity for me to deliver today's inaugural lecture. The title of the lecture is: **Jobs Nowhere but Everywhere: Resolving Nigeria's Unemployment Crisis through Information Technology**. I chose this topic first, because of the significance of Information Technology in job and wealth creation in this our present economy; secondly, because of the vast benefits of this untapped area, and thirdly, because it encapsulates much of the thrust of my research in Computer Network as well as my administrative and professional activities within and outside the university system. Mr. Vice-Chancellor, Sir, I feel highly honoured and privileged to deliver this inaugural lecture, being the second in the Department of Computer Science and Engineering of this university. The first was given by my mentor, Professor Adebayo Dada Akinde, as the 129th Inaugural Lecture titled 'Computer Processing: Creativity in Solving Scientific Problems' on 8th December, 1998.

The journey of my life that culminated in today's lecture started when I applied to study Computer Science at the Polytechnic, Ibadan, in 1984. Though qualified, I was not admitted. I wept, but I was never discouraged. In 1985, I obtained the Joint Admission and Matriculation Board (JAMB) form to study Chemistry Education, but was admitted to the Faculty of Science to study Chemistry during the 1986/87 session. In 1987, one of my classmates, Mr. Seyi Falae, obtained a Change of Course Form for me to change from Chemistry to Computer Engineering. It was a thing of joy when I got the letter of transfer to the Department of Computer Science and Engineering later that year. This was the beginning of my journey into the interesting world of computing. The field of my research became more interesting when I resumed in Chams PLC in Lagos for the mandatory one-year National

Youth Service in May, 1992. There, I was exposed to both the hard and soft computing. The journey continued when I returned to Great Ife in June, 1993 to commence my Master's degree.

The next port of call after my M.Sc. degree was Kwangju Institute of Science and Technology, South Korea, where I not only continued with hardware design studies but got into the world of Asynchronous Transfer Mode (ATM) Network and Agent Technology. During my one-year stay in South Korea, I was exposed to techniques in Information Technology research methodology. The experience gained during my one-year stay in South Korea gave me the opportunity of completing my Ph.D. programme in record time after I returned to Nigeria, where I researched into the development of an intelligent mobile agent for performance management of computer networks. Mr. Vice-Chancellor Sir, I intend to take this audience through my sojourn in the last twenty-four years, as a researcher in the specialized field of data communication and computer network, highlighting my contributions to the development of Information Technology in Nigeria, especially with respect to wealth and job creation.

2.0 Unemployment Crisis in Nigeria

It is a common knowledge that Nigeria has slipped into recession. The causes are not far-fetched. Our economy has been dependent on oil, our main revenue earner. Not only is oil a non-renewable resource, global oil prices have plummeted to a record level ever and the nation's income has fallen drastically and dramatically. Consequently, there is foreign exchange scarcity and Nigeria appears unable to meet her developmental needs. The emerging scenario is one of loss of purchasing power for the majority of the population, declining activities and performance of businesses, huge investment gaps, increasing challenges in education and health; and rapidly rising unemployment. This situation, no doubt, is quite disturbing. Our dependence on oil is clearly unsustainable. Undoubtedly, there is a need to take a look at the non-oil sector for socio-economic gains and development. Inclusive structural change in the approach to revenue generation and development has

been long overdue. Huge foreign earnings will mean very little if unemployment keeps rising. For us as a nation, a most pressing question is how to create sufficient jobs rapidly, effectively and sustainably.

In its Second Quarter of 2016 Unemployment and Under-Employment Report, released on 31 August 2016, the Nigerian Bureau of Statistics (NBS) stated that 2.6 million Nigerians became unemployed during the first and second quarters of that year. According to the report, there were 26.06 million persons in the Nigerian labour force in Quarter 2 of 2016 that were either unemployed or underemployed compared to 24.5 million in Quarter 1 of 2016 and 22.6 million in Quarter 4 of 2015. Businesses and organisations feeling the effects of the recession are not hiring and have had to close offices and lay off staff. Educational institutions are rolling out thousands of graduates but many are not likely to secure appropriate or any jobs. The nation's growing population does not help matters. It is clear that the job market cannot handle the job-seeking demand. Forced idleness is a serious problem because of the human costs associated with rejection and loss of a sense of belonging. Unemployment robs people of self-worth and the opportunity to contribute and have a say in the development of the nation. Serious threats to security and stability are the reasons why unemployment, in particular youth unemployment, should be high on the nation's development agenda.

Additionally, the unemployment rate is widely regarded as a measure of the level of development. It is also an indicator of how well a nation utilises its human resources. Society as a whole, not just government, must acknowledge the urgency of the challenges being faced. Quite unfortunately, young people constitute the majority in the huge and growing army of the unemployed. Youth unemployment is often described in undesirable terms as a "ticking time bomb". Already idle hands have become tools of crime, terrorism and political violence. Youth strengths should instead be

harnessed and directed towards ushering in Nigeria's renewed growth and sustainable development.

Why Information Technology?

Information Technology (IT) used in this lecture refers to set of tools, processes, and methodologies (such as coding/programming, data communications, data conversion, storage and retrieval, systems analysis and design, systems control) and associated equipment employed to collect, process, and present information. In broad terms, IT also includes office automation, multimedia, and telecommunications.

Traditional approaches are failing to reverse the unemployment trend. Nigeria must turn to IT which is acknowledged as being integral to growth and sustainable development. Computers, the Internet, wireless networks, mobile phones and devices, and the software and applications that utilise those technologies are reshaping the world. IT provides nations, organisations and individuals with a platform to meet their needs in smart and innovative ways. It reduces operational costs, enhances productivity, improves quality, facilitates the creation of new products and services and enables participation in the global digital economy. Strategic IT deployment is essential to diversify the nation's economy and apply innovative practices to effect structural changes that enable inclusive development, open up new growth opportunities and foster job creation.

The unemployment crisis is not insurmountable provided IT is deployed with purpose and vision. For a start, the amazing growth in technology makes the IT sector itself a major source of jobs in this age. The world simply cannot function without the fast growing field of IT. Taking advantage of massive opportunities in the IT job market (local and global) will assist in improving the employment rate of the country. An indirect impact is in the multiplying effect that IT professionals have on the economy. It is to be noted that one new job in the IT industry creates up to three to four indirect jobs. The new employee will pay for food,

transport, clothes, housing, and so on. Transportation, education, tourism, hospitality, finance, marketing, publicity, entertainment, building and construction, manufacturing and maritime are some of the areas that benefit tremendously from IT deployment.

The digital approach, in addition, ushers more innovation and inclusion into the job market. New forms of work and flexible work methods are already available. A great deal of work can now be done online from anywhere on the planet, facilitated by free or inexpensive online collaboration tools. While based in Nigeria, you could work for people and organisations in Europe. Through IT, Nigerians can tap into virtual and outsourcing jobs within the global digital supply chains.

3.0 My Research Contributions

Mr. Vice-Chancellor Sir, having gone through why IT is germane in resolving unemployment in Nigeria, let me proceed to enunciate my humble contributions to the subject matter in the past 24 years. I have worked with a number of colleagues in the area of ATM Network, Computer Network Management, Web-Enabled System, Computer Network Performance, and policy framework for engineering education in Nigeria.

Asynchronous Transfer Mode (ATM) Network

Through the Government of the Republic of South Korea, I had the opportunity to be in Professor Ahmad's research group at the Kwangju Institute of Science and Technology, South Korea in March, 1998. I found myself in a well-furnished computer communication laboratory. As a young researcher in a strange country and in modern laboratory, I had no other option than to discover myself early. Though I had a very good foundation in the area of data communication, courtesy of my mentor Professor Adebayo Dada Akinde, ATM Network technology was new to me.

Asynchronous Transfer Mode Network has been developed as a high-speed networking solution, capable of supporting many classes of traffic, for private and public networks. Among many components that make up the high-speed ATM network, the ATM

switching systems (or switches) are core components and thus overall network performance is heavily-dependent on the performance of the switching systems in the networks. The ATM Forum defines a number of different Quality of Service (QoS) classes to deal with the diverse requirements of different kinds of traffic, and ATM switches require cell-scheduling methodologies that can provide a suitable QoS to each service class while yet retaining network resource usage. In Aderounmu *et al.*, (1999), it was established that burst input traffic is a major factor in performance degradation of the technology, hence a scheme tagged weighted round robin with absolute increment was developed to completely remove the delays while maintaining bandwidth guarantees for all queues.

Also, in Aderounmu *et al.*, (2000), it was deduced that the development of multi-service traffic on the same network requires greater bandwidth; and to maintain a good performance of the network so as to guarantee the quality requirements of each class of traffic, several control mechanisms have to be put in place. A novel technique was developed for priority buffer management to be used for multi-QoS traffics over ATM switching systems. It was concluded that the developed model can be used for efficient buffer space management and consequently for efficient bandwidth allocation and management aimed at optimising network usage in high speed networks. ATM, which typically runs on fibre optic cables, does not include error control facilities on its payload, while the characteristics of wireless transmission make such an inclusion in wireless ATM necessary. From the results obtained we concluded that a data link protocol best suited for Wireless ATM should have the following characteristics; FEC with 3-bit error correcting capability, selective automatic repeat request scheme and fixed payload size of 16 bytes, Aderounmu *et al.*(2002).

ATM is considered the most suitable transport techniques for the future Broadband Integrated Service Digital Network (B-ISDN). On the other hand, wireless communications have developed to a level where offered services can be extended beyond voice and data (Gibson, 1996). The combination of wireless communications,

together with ATM can provide freedom of mobility with service advantages and QoS. In many enterprises, it is common to find different personal computers (PCs) sharing a single printer, with the printer located several meters from each PC. However, in small enterprises, there may be the need to locate a printer centrally amongst different PCs for sharing purposes without having to necessarily set up a cable network. The printer could even be located in a room different from that of PC. This cannot be done using a serial or parallel cable because for parallel printing, the printer and the PC must not be more than 3.75m apart, while for serial printing a maximum distance of 15.2m must not be exceeded. In 1999, I led a team that designed and implemented a flexible printer controller for mobile terminal or PCs in a wireless ATM local area network. The implemented controller reported in Aderounmu *et al.* (1999) was able to resolve the problem of distance limitation placed on serial and parallel printing. My research team also developed various algorithms to improve the quality of service guarantee in wired and wireless ATM network as reported in Aderounmu *et al.* (2002a), Ogwu and Aderounmu (2003), Aderounmu *et al.* (2003), Aderounmu *et al.* (2003a), Aderounmu *et al.* (2004) and Oluwatope *et al.* (2004),

Computer Network Management

In January 1999, I returned to the Department of Computer Science and Engineering where I continued my research in the area of ATM and Computer Network Management. A computer network is defined as 'a conglomeration of two or more autonomous computers which are separated by physical distances but connected together (Adagunodo, 1993; Tanenbaum, 1981). Computer networks have become veritable means of data transmission. Network management capabilities are needed to configure the system, monitor its status, react to failures and overloads and plan intelligently for future growth.

There are various reasons for proper network management, which include: cost reduction, fault handling, and flexibility. Better control ensures a high level of performance and these performances correspond with high productivity, which in turn

translates into bottom-line financial improvements. Hence, in 1999, I deliberately focused on the development of an intelligent, mobile, object-oriented agent model with specific reference to performance management for small and large networks. An agent can be defined as one that acts or exerts power. Intelligent agent is an agent which has the capability to deal with new and thriving situation. It is a software that uses set of rules to exchange information for automatic problem solving.

There are several dimensions to classify existing software agents (Nwana and Nduumu, 1997). Firstly, agents may be classified by their mobility, that is by their ability to move around some networks. Secondly, they may be classified as either deliberative or reactive. Thirdly, agents may be classified along several attributes that ideally they should exhibit. Fourthly, agents may sometimes be classified by their roles (particularly, if the roles are major ones). However, for the sake of clarity, this space has been collapsed into the following types of agents namely; collaborative, interface, mobile, information/Internet, reactive, proactive, and hybrid.

Collaborative agents emphasise autonomy and cooperation (with other agents) in order to perform tasks for their owners while interface agents emphasize autonomy and learning in order to perform tasks for their owners. A key proponent of this class of agents, points out that the key metaphor underlying agents is that of a personal assistant who is collaborating with user in the same work environment. Mobile agents are computational software capable of roaming wide area networks such as the World Wide Web (WWW), interacting with foreign hosts, gathering information on behalf of its owner and coming back home having performed the duties set by its user. Information agents perform the role of managing, manipulating or collecting information from many distributed sources. Reactive agents represent a special category of agents, which do not possess internal symbolic models of their environments instead they act or respond to the present state of the environment in which they are embedded. Proactive agents, behave accordingly to condition-action rules. A hybrid

agent as the name suggests, is a combination of reactive and proactive agents.

In my Ph.D. thesis defended in 2001, I developed and implemented an intelligent mobile agent for performance management of a computer network (Aderounmu, 2001). Furthermore, in 2001, we reported the use of intelligent hybrid multi-agent computational architecture for resource management in complex systems (Aderounmu *et al.*, 2001). The architecture was based on the concepts of system decomposition and synthetic integration of subsystems. The result thus obtained shows that the criticism converged to zero indicating perfect control mechanism. It also indicated that intelligent hybrid multi-agent systems offer more powerful problem solving strategies than conventional control systems. Further effort was made in 2002 to test the robustness of mobile agent software and we discovered that determining the status of each personal computer in a network is always a big problem as the network administrator needs to move from one machine to another running the diagnostic software and collecting reports for decision making by the management. In addition, time and efforts are spent on this. We employed the concept of mobile agent to tackle these problems (Aderounmu *et al.*, 2002b). In order to minimize the query response time when selecting views in a data warehouse, the concept of agent technology was demonstrated and reported in Aderounmu *et al.* (2003b).

In Aderounmu, (2004), the use of mobile agents in the control and transfer of data in distributed computing environment as against the traditional client-server computing was presented. The conceptual design of the mobile agents was process-based and packet-switching oriented. The monitoring of network resources by the mobile agent starts from the server as shown in Figure 1. The mobility infrastructure was developed to facilitate a Transmission Control Protocol/Internet Protocol (TCP/IP) socket-based connection between source and destination machines using agent transfer. An analytical model was developed and simulated.

Figure 2 describes the dynamic routing model for the mobile agent. The simulated network has a state that is modeled after Bernoulli Random Variable with probability of success $p = 80\%$ and probability of failure $p = 20\%$. It was concluded that the mobile agent based-approach to control and data transfer was found to provide a more superior, efficient, dynamic, autonomous scheme, with a high level of modularity, flexibility, decentralised control, and asynchronism suitable for complex system than remote procedure calling (RPC) technique. The result of the research published in 2004 was cited on ScienceDirect.com by Elsevier publishers as one of the top hottest articles.

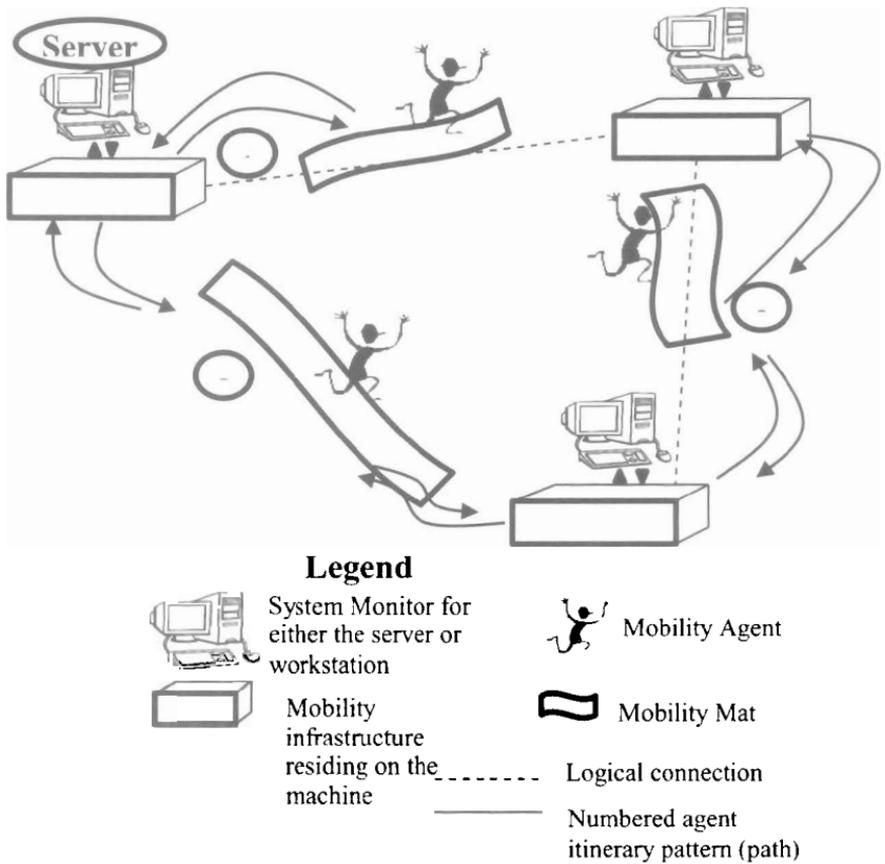


Figure 1: Block diagram showing movement of agent in a distributed computing environment.

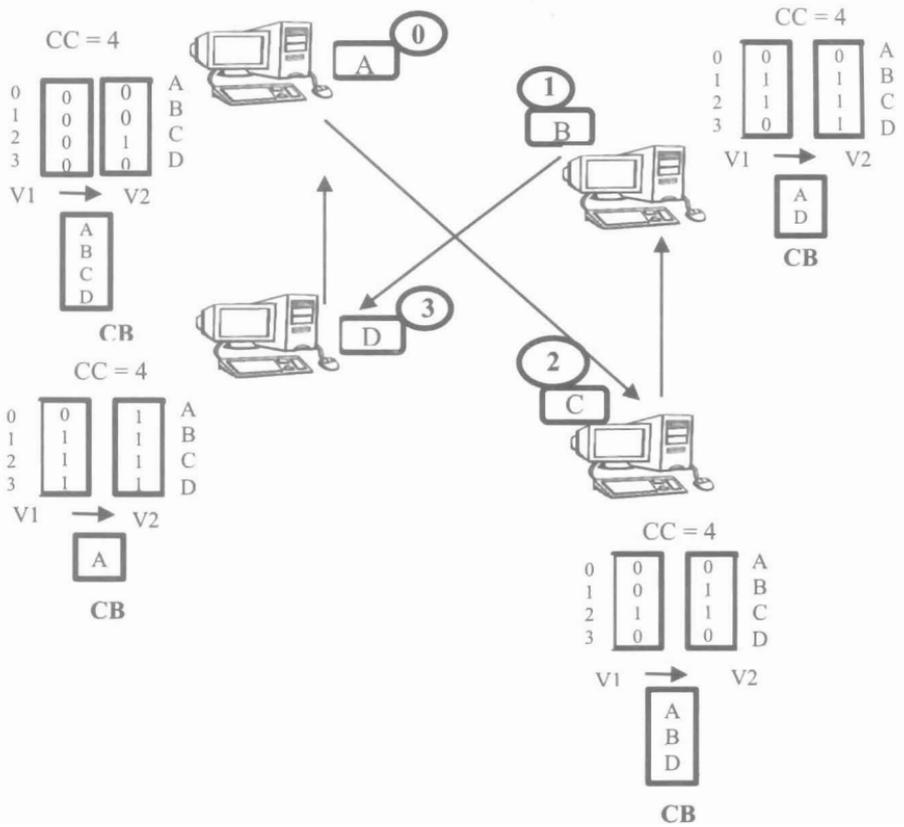


Figure 2. Dynamic Routing Model

Also, Aderounmu *et al.* (2004a) presented a simple analytical model to further measure the performance benefits of using mobile agent technology rather than RPC for detecting computer systems specifications in remote locations on behalf of a user. We evaluated the model by focusing on cost of service, query optimization, and service delay overhead as metrics of interest. Our evaluation of the model shows that mobile agent provides a cost-effective solution, optimizes query time, and generates lower server delay overhead, which results in 95% efficiency.

Furthermore, Aderounmu *et al.* (2006) presented a comparative analysis of Remote Method Invocation (RMI) and Mobile Agent

(MA) used to implement the information storage and retrieval system in a distributed computing environment. The results of the simulation shows that mobile agent paradigm offers fast computational speed; procure lower invocation cost and reduced network bandwidth.

The traditional approaches to results processing in our academic environments are inappropriate in a dynamically changing, heterogeneous environment. Academic staff usually waste a lot of time in running around for results. The length of time it takes results to move from one department to another has contributed greatly to the delay in result processing. To eliminate the aforementioned problems, we developed a novel technique for collecting students' results using the mobile agent technology concept (Olajubu *et al.* 2004). My research team further exploited other application areas of Mobile Agent Technology such as property valuation, stock market, and supervisor finders in an academic environment as reported by Ajayi *et al.* (2004), Oluwatope *et al.* (2004a) and Iyilade *et al.* (2005) respectively.

With the awareness that the world is fast becoming a global village to increased application of the Internet especially in the area of e-commerce and m-commerce and due to the fact that mobile agent technology is now one of the tools used for information storage and retrieval, information security is an issue that cannot be overemphasized. In Oluwatope *et al.* (2006), we implemented a memory optimized public-key crypto algorithm using modified modular exponentiation to protect the mobile agent from being intercepted.

Web-Enabled Technology

Over the years, computers and computer communication had gained so much attention and had grown tremendously (Buchanan and Wilson, 2001). Technology has reduced the big and expensive computers of those days to portable and affordable devices. Most people nowadays can now easily afford computers systems at home. With the mass availability of personal computers, statistics

have shown that people spend more time on computers than they do with friends and family members because most of the activities that are needed to be done are either locally-available on the computer or can be found on the Internet or over a network. Since much time is spent on the computer systems, it is therefore becoming a necessity for home appliances to be controlled via the computer system. This includes switching home appliances like electric fans, pumping machines, electronic bulbs, television sets, microwave ovens, security lamps, and so on, from the computer system. This, primarily, will ensure full concentration on whatever activity is being performed on the system. In the same trend, the Internet has proven to be a good tool, by which several activities, which could have cost large resources and manpower to be invested in, can now be carried out easily and in a short time. The trend for some years now has been e-commerce, e-education, and so on. The idea is to achieve on the Internet, what one would have done locally. I was part of the research team that implemented a web-enabled automation system for controlling home appliances over the World Wide Web (WWW). The system consists of three main modules, namely: the electronic device unit that handles the actual control of the devices, web based Graphical User Interface (GUI), and Apache web server. The electronic unit was implemented using FT 245BM microchip which is capable of controlling up to eight (8) devices via the USB port. The second module focused on the design of a web-based GUI using java programming language. Details of the implementation was reported in Oluwaranti *et al.* (2006).

The concept of Referral System dates back to 1960s and evidence of wide variations in the rates at which general practitioners refer patients to specialists began to emerge in the 1970s. On the average, general practitioners make about five outpatients referrals per 100 consultations per year (Wilkin, 1992). The reasons for referring patients could be for investigations, advice on treatment, request by patients or relatives, fear of litigation, diagnosis, among others. Advent of IT gave birth to Telemedicine, which has led to electronic-based consultations such as electronic referral system in

hospitals. In Nigeria, all the state hospitals are having problem in referring patients from one hospital to another. Most of the time before a patient could be referred from one hospital to another; the patient would have given up the ghost. To solve this problem, in Idowu *et al.* (2006), we embarked on the design of a system that handles referral of patients from one hospital to another electronically using Osun State as a case study. It was concluded that the implemented system has the ability to guarantee the security of patients' case notes, examination data and effective referral of patients, which in turn make patients treatment timely, efficient and cost-effective.

Computer Network Performance

Computer network performance is the analysis and review of collective network statistics, to define the quality of services offered by the underlying computer network. It is a qualitative and quantitative process that measures and defines the performance level of a given network. It guides a network administrator in the review, measurement and improvement of network services. Computer network performance is primarily measured from an end-user perspective (that is quality of network services delivered to the user). Broadly, network performance is measured by reviewing the statistics and metrics from the following network components:

- Bandwidth: the maximum rate that information can be transferred (bits/s).
- Throughput: the actual rate that information is transferred.
- Latency: the delay between the sender and the receiver decoding it.
- Jitter: variation in packet delay at the receiver of the information.
- Error rate: the number of corrupted bits expressed as a percentage of the total sent.

The growth of the Internet has caused a significant increase in the type and volume of network traffic and it has also provided the biggest change to the way human beings communicate with e-commerce adding a new dimension by allowing consumers and businesses to interact via the Internet to carry out commercial

transactions. These interactions have given rise to workload patterns as well as challenges to people involved in the performance management and the capacity planning of the Information Technology infrastructures that support e-commerce activities. In general Quality of Service in the context of e-commerce is the ability of an e-commerce server to provide different service level to different users' sessions over various technologies. While there are several proposals to improve the quality of service in an e-commerce environment in place and many QoS enabled networks in operation, the acceptable level of quality as perceived by users still need to be improved, most especially in environment where obsolete infrastructure such as limited network resources (bandwidth, unreliable computing devices, and so on) are used.

The goal of any QoS mechanism is to maintain a good level of user-perceived QoS even when the network conditions are constantly and unpredictably changing. User-perceived QoS of online transactions is usually expressed by performance characteristics such as response time, throughput, predictability, and consistent perceptual quality. Hence, customers seeking quality online services have choice, they may either take their business elsewhere when response time exceeds acceptable threshold or reject such a technology. QoS provisioning in the Internet has been a topic of active research in the last few years. Most proposed solutions are not commonly employed in practice due to financial and technical reasons (Grossman, 2002; Romano *et al*, 2004). More so, proposed QoS approaches focused on controlling only web server response time of individual URL (Universal Resource Locator) requests. They do not take into consideration the limited bandwidth between end user and Internet Service Provider (ISP), and the characteristics of the client's device (processor speed, processor load, screen resolution, colour depth, available memory and so on) in ensuring that a customer has a fruitful and eventful session while conducting business online.

In 2008, we developed a fuzzy logic based QoS brokering model to dynamically manage networking and other limited resources so as to reduce traffic load as well as improve user perceived QoS of e-commerce (Ajayi *et al.*, 2010). We were able to address two important QoS application parameters that directly impact user's quality of experience, namely: the response time and throughput. Furthermore, an adaptive fuzzy information retrieval model to improve response time perceived by e-commerce clients was also implemented (Ajayi, *et al* 2010a). Our approach drastically reduced the response time, which is experienced by users, especially when they are performing search operations on e-commerce servers.

Engineering Education

Today, more than ever before, the ability of any nation (Nigeria inclusive) to realise its potential and sustain any form of national growth depends almost entirely on its ability to build and develop high-quality local human resources. Increased competition in the global market-place adds to the need and urgency to get the right people, with the right skills, in the right place, at the right time. To keep these people motivated, they must also be adequately remunerated. Considering the fact that the main thrust of current global competition is technologically driven, a well-articulated and coordinated nation-wide strategy for the development and training of engineering personnel becomes a critical success factor (Mbonu 2000). The training of engineers in Nigeria is based on the traditional model of theory and practice in the university followed by 4 years' pupilage through attachment in an industry to acquire necessary engineering experience. According to Salawu (2000), the theoretical aspect includes: Analysis, Design and synthesis, Testing and, Implementation methods. The practical experience which should provide the candidate with the opportunities to become aware of the practical limitations of real systems should include components such as: visits to existing engineering works, with opportunities to see equipment and systems in both operational and maintenance circumstances; application of equipment as part of the larger systems, including , for example,

the merits of reliability of the role of computer software, and understanding the end product or engineering work in relationship to the equipment; opportunities to experience and understand the limitations of practical engineering and related human systems in achieving desired goals, including for example, limitations of production methods, manufacturing tolerance, performance minimum, maintenance philosophies, and so on; opportunities to experience the significance of time in the engineering process, including difficulties of workflow, scheduling, equipment wear out and replacement scheduling among others.

Mr. Vice-Chancellor Sir, in 2002, we raised the debate on engineering education and practice in order to examine the issues facing developing and poor countries in managing and improving the quality of engineering education. We also gave a brief overview of the key challenges the country will be facing in the next few years, in its efforts to give meaningful practical training to its engineering personnel. We reported poor funding, inadequate equipment, students' population explosion (without commensurate facilities), lack of high-quality manpower (in terms of trainers or teachers), inadequate industrial training and poor attitude of employers as the dominant problems faced by engineering education in Nigeria. In addition to finding solutions to the above problems, we recommended better remuneration for practicing engineers, appropriate government policy and disposition and intervention of professional and international bodies (through provision of financial and material assistance) for assisting in the training and practice of engineering in Nigeria and in order that the country may achieve meaningful development comparable with foreign countries (Akintola *et al*, 2002).

4.0 My Contributions to Capacity Building in IT Development and Job Creation in Nigeria

New technological trends such as the ubiquity of mobile devices, alternative power sources, improved battery design with longer hours, enhanced intra-country fiber penetration by telecommunication providers have assisted in improving

communication access. Coupled with the abundance of human resources, Nigeria is well positioned to be a virile ground for a thriving IT industry that will be a major economic mainstay, successfully rivaling the Oil & Gas industry both in terms of revenue generation and employment. The spectacular growth of the IT industry, in particular, software industry in some developed and developing economies has aroused both interest and concern from all sectors, researchers, entrepreneurs and even governments. Of particular interest are countries such as India, United States, Russia, Ireland and China. India, often seen as Nigeria's contemporary, is regarded as the premier destination for global IT and ITeS outsourcing, accounting for almost 55% of the global sourcing market in 2010, according to Vijayasri (2013). The Indian IT sector is estimated to have aggregated revenues of USD 88.1 billion in 2010–2011, with the IT software and services sector (excluding hardware) accounting for USD 76.2 billion of revenues. During this period, direct employment reached nearly 2.5 million, while indirect job creation was estimated at 8.3 million.

In the United States of America, the federal and state governments have played many important roles such as relaxing regulation on the use of pension funds for venture capital, reforming/updating law on intellectual property rights on telecommunication, setting requirements and standards, and, provision of matching grants to assist start-up businesses as well as grow existing developers. In the United States, software industry is considered today the third-largest U.S. manufacturing business, after automobile and electronics.

Over the past thirty years, Ireland has built an international reputation as a centre of excellence in software. The industry has two complementary elements: a strong cadre of international companies that are global market leaders, and a larger number of indigenous companies who have achieved significant success in world markets. There are over 500 indigenous software companies employing over 10,000 people with combined income valued at \$2.2 billion, the vast majority of which is exported. The software

sector in Ireland has been driven by the availability of young, highly-skilled and well-educated workforce, increased investment in research and development, development of sectoral expertise, and multinational presence.

The software industry in China is the third largest in the world and is a major income-earner of China's economy. The software sector has been driven by the following initiatives: foreign investment in software, enforcement of regulations and standards, committed government, stakeholders, National Science and Technology Program, development of incentive policies through software parks, indigenous innovation catalogue, promoting China's indigenous innovation through R& D and so on. Today, there are more than 11 million IT companies, and mature IT professional education system. Domestic companies have been able to control the market through government support, deep understanding of local needs and business practices, localized services, and more competitive pricing.

Nigeria's local IT (software) industry needs to grow and be involved to make the required impact since software is required for the effective use of IT devices such as personal computers, handhelds, mobile phones, the Internet, network devices, telecom equipment and cloud (Aderounmu, 2013). It is noted that 90% of software currently used in Nigeria are imported. Literature revealed that there are several local software providers doing well but as a whole the software industry needs to move faster than it is doing at present. According to Evans (2012), lack of scalability, lack of proper documentation, lack of proper research before development and inability of the developed software to meet the standard are some of the problems facing the industry in Nigeria.

Approach to Resolving Unemployment Crisis

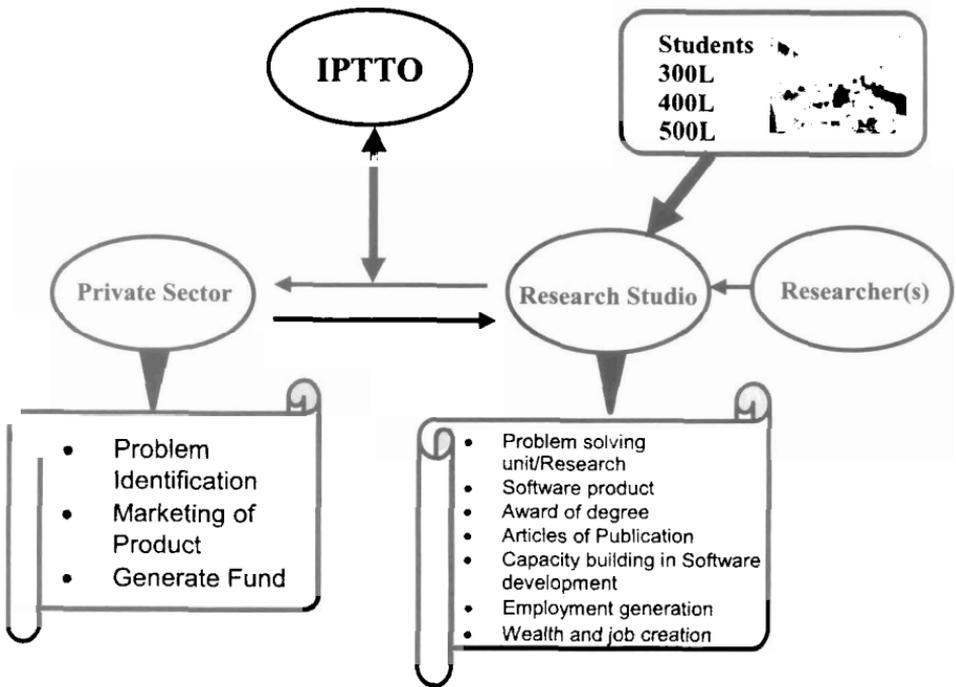
The unemployment problem in Nigeria is just not due to lack of jobs. There is also a dimension of lack of capability of our graduates to fit in to the available ones especially in the IT sector. Indeed, and sadly too, one is becoming used to the phrase 'Nigeria graduates are unemployable' such that even those who produce the

graduates also join in re-echoing same. Attempts to review curriculum has been most difficult, almost becoming impossible. In spite of several and repeated calls for University-Industrial linkage by stakeholders, such calls are yet to translate to concrete actions. A recent World Bank appraisal concludes that weak university-industry linkage in Nigeria is the greatest impediment to the development of a knowledge-based economy and consequently unemployment. Traditional approach to University-Industrial linkage has been through Public Private Partnership (PPP). In this regards, there are few models of this viz Build-Operate-Transfer (BOT), Buy-Build-Operate (BBO), Build-Own-Operate (BOO), Build-Own-Operate and Transfer (BOOT), and Design-Build-Finance-Operate (DBFO). A major defect in these models is the overarching influence of the investor and lack of capability of the University to maintain infrastructure/service after transfer. In addition, this model suffers from lack of sustainability strategy that ensures continuity.

A modified approach as shown in figure 3 was proposed. This approach: Build-Transfer-Operate-Jointly (BTOJ) is more participatory in design. This avoids the pitfall of poor problem identification typical of other models of PPP as the industry is involved in the problem identification and research design. In addition, there is continuous communication and feedback mechanism between the actors typical of an agile model form. The identified actors namely the industry, the knowledge institution comprising of the facility, faculty and students all interact in mutually beneficial relationship. Thus, the students build further skill, researchers generate articles for publication, the industry generate funds and the society benefits from solution provisioned. Figure 4 shows mode of engagement between private sector and knowledge institution.

In employing this modified approach and realising the potential benefits of IT in the area of job and wealth creation, I approached one of the leading IT companies in Nigeria, Chams PLC, in August, 2006 to discuss the possibility of research collaboration

between the company and Obafemi Awolowo University. In November 2006, Chams PLC and Obafemi Awolowo University agreed through Memorandum of Understanding (MoU) to collaborate and jointly solve IT problems that will lead to job and wealth creation; and capacity building. It was agreed in the MoU that Chams PLC has the responsibility to identify IT problems, work with students and researchers; market the final products and generate fund from the products, while Obafemi Awolowo University will provide problem-solving environment, pool of researchers and software products. Using this approach, the capacity of our students and staff have improved substantially, employment generated and sustainability funds provided. The strategy also takes into consideration the issue of intellectual property right which has been lacking in most partnerships of this nature.



IPTTO – Intellectual Property and Technology

Figure 3: Proposed approach to resolving unemployment crisis through IT



Private Sector

**Knowledge
institution**

Figure 4: Mode of engagement between private sector and knowledge institution

Mr. Vice-Chancellor Sir, let me now discuss capacity building and wealth creation projects I handled through the above model which led to employment generation.

Project I: Airtime Switch Application

The GSM market in Nigeria is a large market with over 200 million GSM lines. On the average; each subscriber carries 3 lines from 3 different GSM providers. This is because of the unreliability of the networks and/or the geographic coverage limitations. To that extent, there is often a need to move money (airtime credits) from one provider to another in time of need. Transfer of credit has also become a very popular means of transferring money among subscribers in Nigeria where recipient will exchange the airtime credit for cash at pay phone centres at discounted rates. Between August 2006 and July 2008, a novel airtime switch application was developed to enable the transfer of airtime credit among the available GSM networks in Nigeria. The

research was carried out with our partner, Chams PLC and supported by the British Council under the African Knowledge Transfer Partnership Project. With this project we were able to train 3 postgraduate students. They are all entrepreneurs now.

Project II: Achieving Accelerated Learning with Foundation Courses in Computer Engineering

Obafemi Awolowo University (OAU) is one of the first-generation universities in Nigeria. It began as a regional university and later became a federal university. OAU was the first university in Nigeria and West Africa to establish a B.Sc.(Hons) Computer Engineering programme in the early 1980s thus making the program a highly sought one in Nigeria and West Africa. The programme has produced over 70% of the IT human resource driving the IT industry in Nigeria today. Enrollment grew steadily from less than 20 students in the 1980s and less than 30 students in the 1990s to about 100 students in 2008. Conversely, the number of laboratory experiment modules has remained at about 10. Furthermore, the ratio of students to teaching assistants has grown exponentially which have continued to worsen the learning rate and increase the attrition rate of our valued students. The lecturers are challenged by the share size of the class. Hence, as a result of the current situation of poor learning rate, the program leadership is being challenged. To address this, in September 2009, we identified key lecturers in the computer engineering programme who are interested in building capacity in the use of Hewlett Packard (HP) Tablet PC and technology to innovate new approaches in teaching of undergraduate foundation courses of computer engineering. A software tagged 'Akowe' Version 1 was developed and used by the lecturers, with HP Technologies, to (1) sketch circuits, diagrams and the writing of science notations as against the use of marker board and or chalkboards, (2) electronically grade submitted student work and return same to them with all of the notations plainly visible. The students, also through this software, worked as a group and used HP Technologies to take lecturer's notes, annotate on presentations, and electronically submitted class work and home work to the

course lecturer. The research was supported by HP under the HP Innovation in Education Intervention (IEI). Plate 1 shows the laboratory setup with the grant.

Project III: Research in Software Engineering

Science and Technology (S&T) sector has been largely responsible for the scientific and technological breakthroughs of many developed countries of the world. Science and Technology-based post-basic education is one of the key factors to these breakthroughs. Presently, there is a paucity of educational software that utilise teaching aids such as simulations, animations and graphics in the teaching and learning of S&T post-basic courses, resulting in the problem of inadequately-prepared post-basic teachers to cope with the 21st century S&T challenges.



Plate 1: HP Laboratory Setup

A corollary of the poor preparation of teachers of S&T is their inability to offer practical training to students thus making the teaching and learning of S&T theoretical and uninteresting to students. The direct impact of this is low interest in S&T courses

for some and incomplete metamorphosis in the pupil's learning experience for most, yielding weak S&T foundation in the majority of students matriculating into tertiary institutions in the country. This is particularly so among females who shy away from S&T courses. To address these problems, my research team, through a World Bank project created an enabling environment for imparting knowledge in S&T using ICT-driven, participatory and student-centered teaching and learning approaches. Consequently, OAU is now designated as Centre of Excellence in Software Engineering. I am glad to inform you that at its sitting of December 8, 2015, the Centre received the approval of the University Council as a full-fledged Unit in the University with its own establishment quota. We are building national capacities (through postgraduate training, short-term training, conferences and workshops) in software engineering, particularly in the areas of educational software development and application, networking, development of Internet and web applications, simulation, graphics, remote experimentation, hardware design, implementation, and maintenance. This research also developed strategies to equip subject teachers and students in S&T with skills to develop, deploy and evaluate teaching and learning using modern ICT facilities.

The Centre, in just about 2 years of operation, has churned out 4 world-class software: **Keedu**, **Akowe Version 2**, **National Qualification Register (NQR)**, and **Visitor Management System** and in the process created direct and indirect jobs. In partnership with Chams PLC, some of the products of the Centre had been adopted by a few organisations in Nigeria. While the World Bank grant was used to purchase research equipment, the Skye Bank PLC, under the BTOJ strategy provided the ICT Centre (Building) that housed all the equipment. This research was supported by World Bank and Skye Bank from 2010-2013. The centre currently boasts of robust cloud computing facility (Plate 2), 2 telepresence facilities for online conferences, collaborative meetings, and multisite teaching (Plate 3). The centre is presently leveraging on the national and international partners shown in Table 1 with

whom the University has working relationships in the identified areas to further boost the capacity of staff and students.



Plate 2: Cloud Computing



Plate 3: ICT-Driven Research, Teaching and Learning Environment with Telepresence Facility

Table 1: Obafemi Awolowo University Partners in the area of Information Technology.

S/N	Name of Organization	Country	Type of Support	Year
	Abdulsalam International Centre for Theoretical Physics (ICTP)	Italy	Research and Development in Computer Network	1995 –date
	Massachusetts Institute of Technology (MIT),	United States of America	S&T training and research on Internet and remote experimentation	2000–Date
	Hewlett Packard (HP)	United States of America	Innovating modern methods of teaching S&T courses with HP digital technologies;	2009-2012
4.	Centre for Mobile e-Services, University of Zululand	Republic of South Africa	Software Development	2004–Date
5.	British Council	United Kingdom	Software Development	2004-2008
6.	Chams PLC	Nigeria	Software Development	2000–Date
6	Omatek Computers PLC	Nigeria	Hardware Design and Implementation	2007–Date
7.	CISCO Academy	United States of America	Capacity Building in Networking	2006–Date
8.	ORACLE Academy	United States of America	Capacity Building in Database Management	2004–Date
9	SKYE Bank Plc,	Nigeria	Appropriate physical structure	2010–Date
10	Main One Cable Company	Nigeria	Bandwidth and support for Research and Education Network (REN).	2013–Date
11	International Business Machines (IBM)	United States of America	Research and Development in Cybersecurity, Cloud Computing and Mobile Computing	2014–Date
12	Cape Peninsula University of Technology	Republic of South Africa	Research and Development in Enterprise Resource Planning	2013–Date
13	Sidmach Technologies	Nigeria	Research and Development in Cyber Security	2014–Date
14.	George Mason University	United States of America	Research and Development in Cyber Security	2015-Date

Mr. Vice-Chancellor sir, it is a pride to this University that the first set of six students that participated under this model are all gainfully employed in a foremost e-commerce provider company in Nigeria. In addition, one of them, Richard Akinboyewa, went ahead to create a platform *sanwo me* – a real time offline payment system which has been bank rolled to the tune of N50m by an investor and widely used now in Lagos for transaction settlement. Also, Moyin Adeyemi, one of the second set of intakes to the scheme went ahead to create the first Yoruba Watch Faces which is a collection of watch faces that deliver time in local Nigerian dialects.

Project IV: SAP Enterprise Resource Planning (SAP ERP)

Unemployment in Nigeria is alarming. It requires urgent and concerted solution. We are all witnesses to the ugly incident of the Immigration Service recruiting exercise in 2013 where, sadly, lives of able men and women were snuffed out prematurely. This unfortunate but preventable incident is one of the many ugly faces of Nigeria's unemployment situation. Indeed, recruitment business is now an industry on its own and a lucrative one for that matter.

The SAP ERP project is within the erp4school/erp Foundation self-organized, future-oriented learning aimed at integrating the SAP software as part of business curriculum for students to learn process-oriented skills and thereby increase their chances in the job market. Discussion with respect to the SAP ERP project in OAU began in September 2012 coordinated by my humble self. Subsequently, OAU was granted an operative license to deploy SAP ERP software in OAU with a larger view of OAU becoming the hub for West Africa. In 2014, the University received equipment donation worth ₦5 million from Cape Peninsula University of Technology, Republic of South Africa under the SAP ERP project. The Laboratory for this purpose is already setup (Plate 4) and many staff and students have benefited from the trainings conducted using the facility.



Plate 4: SAP Enterprise Resource Planning Laboratory

Project V: Cyber-Security

There is a strong desire and push to develop a viable e-Government capability in Nigeria. In today's information age, business-critical information has become a crucial differentiating factor whereby businesses can gain competitive advantage. Many of our critical national infrastructure, such as power grids, telecommunication systems, health records, and financial systems will increasingly depend on critical information networks for their operability, ranging from control data in Supervisory Control and Data Acquisition (SCADA) systems to operational data in Automated Teller Machines (ATMs) and Point of Sales systems (PoS). As we increasingly rely on these infrastructure for the normal daily activities of the society, it is possible for hackers and terrorist groups, to cause untold damage to citizens, businesses, and potentially bring the nation and the running of government to its knees by attacking critical national information and

infrastructure through the cyberspace. The ease of mounting attacks has also increased significantly. This is because we live in a highly-interconnected global village where it is becoming frighteningly easy to attack a nation and its infrastructure, carry out industrial espionage and steal sensitive intellectual property, trade secrets, and national security intelligence while operating from any corner of the world with a limited hope of attribution.

The nature of information warfare today calls for a more advanced methodology for tackling the issues that traditional security techniques cannot deal with in their current form. For example, traditional information security mechanisms and protocols such as access control, encryption, watermarking and message authentication codes have provided us with the basic building blocks for the assurance of information at rest or in motion. However, these individual controls lack the breadth and the depth of expressiveness to capture end-to-end assurance requirements that can reason about and cope with the physical, technological, and social aspects of information in use.

There is nothing that prevents an actor that obtains legitimate or accidental access to sensitive information from abusing it. One might cite research in homomorphic encryption, which has currently developed techniques that allow limited computation with encrypted data as a promising approach to access control for critical information. However, in the near term, we will not have viable means to successfully compute with encrypted information without first decrypting it, so information must still be decrypted before use. But, once the information is decrypted, abuse is inevitable. Technology alone will not be sufficient to deal with all the possible ways that threat actors can seek to circumvent our defences and attack critical information and systems. Therefore, an end-to-end protective monitoring capability that is underpinned by a sound cyber-physical understanding of security that cuts across both the cyberspace (information technology), physical space (geo-spatial environments) and social space (people, society and processes) will be needed. It is thus highly imperative to develop a

national cyber security strategy to understand the risks and to protect the nation, its citizens and businesses from cyber attacks from within or outside the borders of the nation.

In 2014, we applied for a research grant from TETFund to develop a rigorous scientific approach to modeling and reasoning about the security of critical information in cyberspace and a way to assess the risks posed by threat agents with various capabilities, and a scientifically verifiable methodology of measuring the effectiveness of controls and risk mitigation strategies that may be tested in cyber game-theoretic experiments that will benefit Nigerian businesses, operators of critical infrastructures and various arms of government involved in national security. The proposed innovation provided an enhanced threat modelling and reasoning capability to capture the space, motion, linkages and interdependencies of critical information and information-bearing assets across the physical, logical, and social layers comprising the Nigerian Critical Infrastructure as shown in Figure 5.

Two of my students (Akinkunle Bimbo and Victor Jekoyemi) used the facilities in this laboratory to complete their M.Sc. programmes while Mr. Bayo Johnson is rounding up his M.Sc. programme using this environment. Furthermore, Dr. B.O. Akinyemi who bagged her Doctoral Degree recently also benefited from the use of the facilities in the Cyber Security Laboratory in addition to the grant she received from the University Research Committee (URC). We also developed a prototype (HoneySpot) software with potential of company spin off from the product. Our partner in this project Sidmach Technologies is now ready to invest in the development of the product. The laboratory has provided an enabling environment to develop expertise in the area of cyber security up to doctoral level (Plate 5). As a result of this environment one of the world's leading IT company, International Business Machines (IBM) trained 150 students and 10 staff in the area of Cyber security.

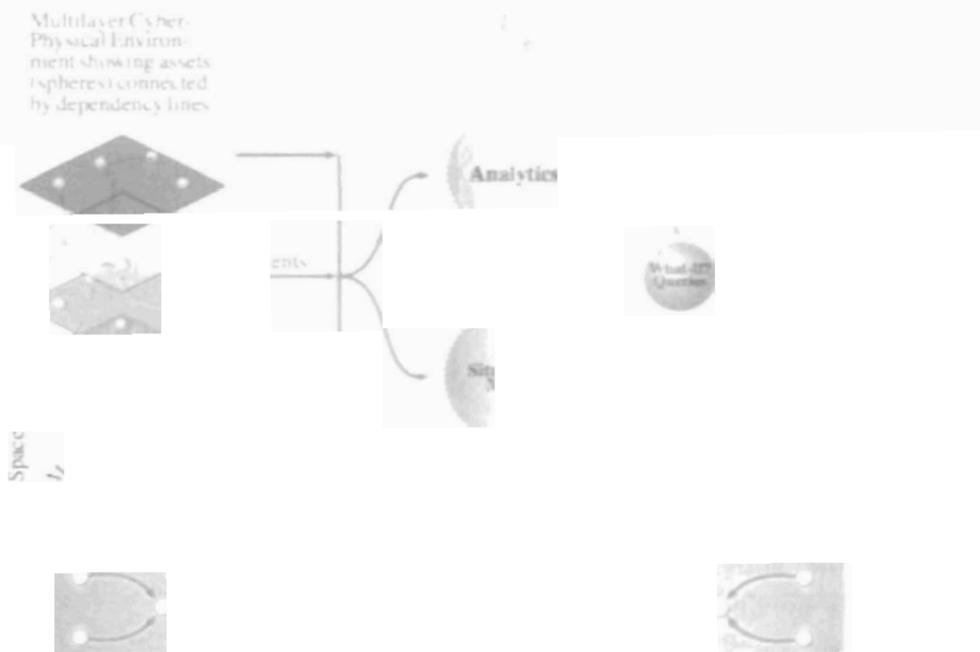


Figure 5: A schematic of the Cyber-Physical Situational Modeling and Analytical Platform



Plate 5: Enabling Environment to train Cyber Security Experts

IBM now engages some of these staff as cyber security instructors while some of the students that scored above 80% during the certification examination were employed by IBM. Recently, the laboratory, leveraging on one of the project research partner, signed a Memorandum of Understanding with Volgenau School of Engineering and School of Business, both of George Mason University, Fairfax, Virginia, USA. The MOU allows for staff exchange and student internship. Two of my students have already being ear marked to travel to USA as part of the exchange program. Plate 6 shows the training participants during capacity building in the area of cyber security organized by IBM at no cost to the participants.

Project VI: Video Streaming Application

Budgeting and funding Internet bandwidth provisioning is a huge challenge to higher education institutions, HEIs, in Nigeria. It is also acclaimed to be eating deep into the finances of individual citizens while the quality of service, QoS, perceived by the end-users is next to nothing. Secondly, students' enrollment in HEIs is on the increase rendering face-to-face mode of teaching fast becoming irrelevant and interestingly the demand for technology-enabled teaching and learning approaches is also on the increase. And thirdly, the level of user derived utility from Internet connectivity is very low in comparison to resources invested.

Nigerian HEIs are significantly dependent upon subvention from government – States or Federal; with exception of privately-run HEIs which have come as a recent development. As result of dwindling national economy and autonomy policy, funding to HEIs has continued to reduce making HEIs administrators to find it difficult to provide state-of-the-art equipment and infrastructure to support quality teaching and research activities. One unique example is the funding of sufficient Internet bandwidth. The unit cost of Internet bandwidth hovers around \$3125 Mbits per second (Mbps) per month on a VSAT link. So in order to provide 10Mbps for one year, a sum of ₦60,000,000 is required to be invested.

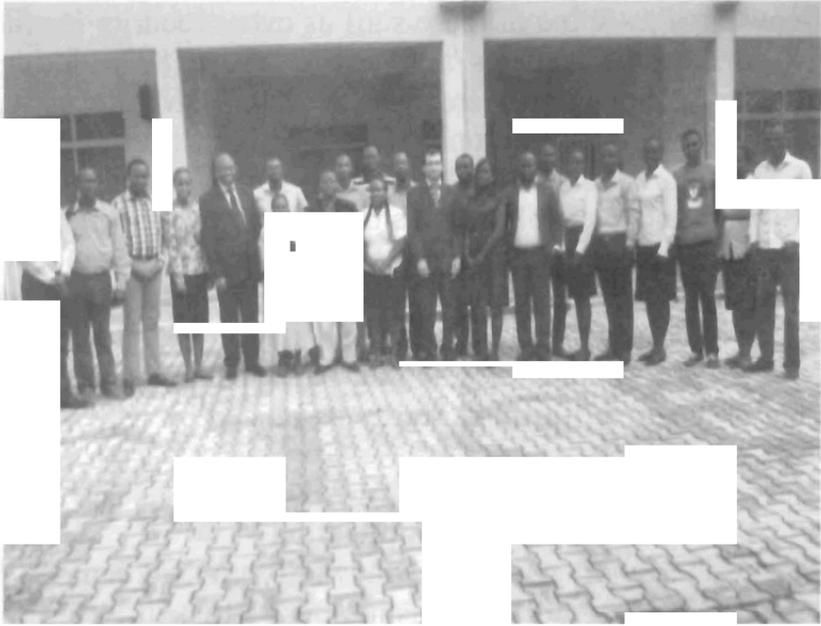


Plate 6: The training participants during capacity building in the area of cyber security.

On the other hand, to subscribe to Internet connectivity via GSM or CDMA modem requires between ₦1,000 – ₦10,000 per month per user connection, depending on usage. In spite of the huge investment in Internet data connectivity, the user-end throughput is insignificant and below the minimum data rate supported by video streaming protocol implemented in common applications such as Realplay, Ms-Media Players and iTunes. Thereby rendering user-end derived utility insignificant and eroding all value for money invested. The reason is not far-fetched from the limited services-email and information search. To increase user-derived utility, such slow-speed networks should support applications such as webinar, video-conference-driven applications in teaching, learning, information and entertainment.

In 2013, a research team (to which I belong) led by Dr. Oluwatope implemented appropriate technology which adapted video streaming based application designed for fast-speed networks to slow speed networks typical in developing countries. The research was supported by TETFund. The research was implemented in four

phases – the problem analysis, models development (rate adaptive, data compression and congestion control), implementation and testing phases. An appropriate software technology to reduce Internet speed mismatch effect was developed. The product of this research led to the eradication of the digital divide currently subsisting between the upper and the lower class of the society, and increase in the deployment rate of value-added services via Internet such as telemedicine, e-learning and video surveillance. The computer communication laboratory in the department was upgraded to accommodate the training of students and staff in this area of research and wealth creation.

Project VII: Open Source Software (OSS)

Africa in general, and Nigeria in particular, is underrepresented in the development of high-tech products and technology solutions to drive our economies through exports. In this research, we argue that OSS development and the attendant productisation of resulting software could provide for us a fairly straightforward way to develop intellectual capital and technical expertise that can foster high-tech industries, products and services, which in turn will lead to gainful employment and wealth creation. We also noted that proprietary software, protocols and data formats tend to lead to vendor lock in and generally pose a risk due to over-dependence on such proprietary systems by government departments, which might have national security implications. In this research, a proof-of-concept technology product that is based on Open Source Software was developed to demonstrate a capability that with the appropriate guidance and exposure, Nigerians can develop competitive home-grown technologies that are locally applicable and globally relevant.

Our proof-of-concept product was the first Nigerian-developed smartphone and tablet operating system that can compete favourably with similar products from technology giants such as Apple Computer's iOS, Google Inc.'s Android and Microsoft Corp.'s Windows Phone and tablet operating systems. Our objective has the following strands:

1. Development of an intellectual capital, through tutelage and guidance, in the research students and staff involved in the project to demonstrate end-to-end process of designing and building innovative products locally (similar to how many Silicon Valley entrepreneurs started their now globally-dominating products in various garages in the US).
2. Development of a proof-of-concept secure-by-design smartphone and tablet operating system product that demonstrates the ability to deliver a technologically-engaging product at low cost provisions that solves real problems at a price-point that works in Nigeria. This involved not only technical skills, but also business acumen and maturity.
3. Investigation of barriers to engaging young undergraduates and graduates, and women in particular in software development and contribution to open source software.
4. Development of spin-off companies and engagement with the University's business development units to engender a culture of research outcome productisation.

The architectural model of the mobile and tablet operating system, which was developed on the core principles of usability, localisation and security, is shown in Figure 6.

We are still shopping for investors to invest on this project to realise our dream of making OAU the Silicon Valley of Africa.

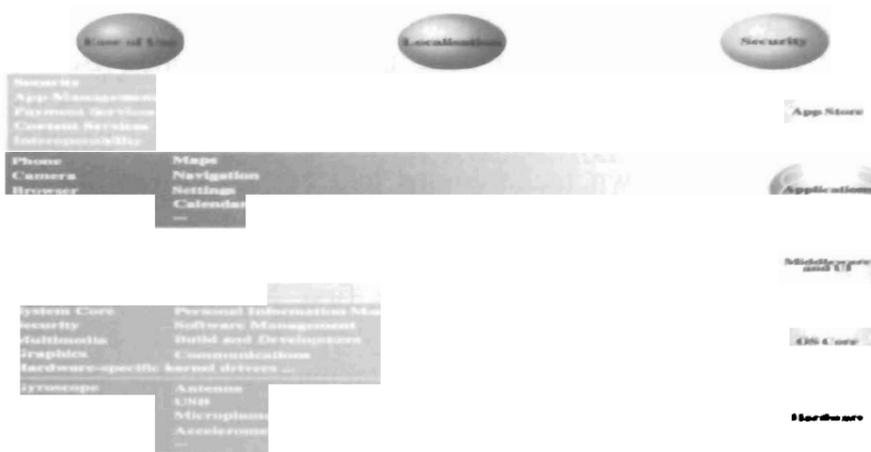


Figure 6: Architectural Model of the Phone and Tablet Operating System

Project VIII: Advanced Anti-Money Laundering

Money laundering has been affecting the global economy in general, and Nigeria's economy in particular, for many years. Large sums of money are laundered every year, posing a threat to our economy and its security. A basic definition of money laundering involves a series of often illegal activities that are used to make illegally-acquired funds and assets to appear as if they were legal and their legitimisation through clever exploits of financial systems and instruments. This often involves very clever schemes used to conceal and disguise the deceptive practices around particularly sophisticated money laundering activities. There are many potential motivations behind money laundering, but the main drivers include: corruption, terrorist financing, organised crime, financial fraud, smuggling, drugs/sex trade and arms dealing.

From the above, it is clear that these underlying drivers are harmful to the economy, peace and security of any nation. According to Canada's Financial Transactions and Reports Analysis Centre in 2009, there are three stages observed as commonly used by money launderers:

1. **Placement:** this involves placing unlawful cash proceeds with banks and other financial institutions using deposits, wire transfers, or other financial instruments. The objective is to legitimise illicit funds by introducing it into the mainstream financial system.
2. **Layering:** this stage involves converting the proceeds of illegal activities into other forms and creating complex layers of financial transactions. The intent behind layering is to blur and obfuscate the audit trail of the financial sum involved. By doing so, money launderers make it difficult to trace the source and ownership of financial assets for example through the buying and selling of stocks, commodities, and properties.
3. **Integration:** this step attempts to provide a seemingly legal explanation for the placed and layered financial assets. It is used to distribute laundered funds back to the criminals.

Various false transactions and fake invoices are used to enable the transfer of this money.

The Global Financial Integrity report of December 2014 on illicit financial outflows finds that between 2003 and 2012, US\$6.6 trillion flowed out from developing countries, and in 2012 alone US\$991.2 billion flowed out of developing and emerging economies. In particular, Sub-Saharan Africa suffered the biggest losses as percentage of GDP, losing on average 5.5% of GDP annually in illicit outflow of money, when compared to the global average of 3.9% of GDP. This is a big problem for Nigeria because this illegal outflow could be put to good use building medical centres, schools, critical infrastructure, and the development of our rural communities. Of the top 10 worst losers to illicit financial outflows, Nigeria and South Africa are the only African countries, standing at the 9th and 10th position respectively. Over the period, Nigeria lost an estimated US\$157.5 billion of illicit financial outflow. This is only a conservative estimate.

The sophistication and crafty nature of financial frauds and money laundering today calls for a more advanced methodology for tackling the issues that traditional techniques, in their current forms, cannot deal with. These individual techniques, which have been shrink-wrapped for a generalist economic scenario, lack the breadth and the depth of expressiveness to capture end-to-end assurance requirements that can reason about and cope with the physical, technological, and social aspects of cyber-physical financial frauds and multi-layered money laundering schemes that have been designed to obfuscate what is going on and to evade detection. In fact, technology alone will not be sufficient to deal with all the possible ways that money launderer, 419 scammers and cyber fraudsters can seek to circumvent defences and exploit legitimate financial processes and instruments to achieve their objectives. It is for this reason that research towards the understanding and the development of advanced analytical models for detecting and mitigating the problem of money laundering and

financial frauds in the Nigerian financial services and associated sectors is very crucial.

In 2016 we embarked on an end-to-end protective monitoring capability model that is underpinned by a sound culture-sensitive, cyber-physical understanding of financial networks that cuts across cyberspace (information technology), physical space (geo-spatial environments) and social space (people, society and processes). One prototype 'ArtOfSteal' was developed. The ArtOfSteal is a security tool focused on detecting, managing and mitigating information leaks in organizations using Android phones

The potential impact of the outcomes of this research project will provide a significant boost to the Nigerian economy and send a positive and clear message internationally that Nigeria is not a soft target for illicit money launderers. We hope if the result of this research is properly embraced by the Government of the day, the research will generate significant intellectual capital with potential for wealth creation by the export of attendant technologies and tools to other Sub-Saharan African countries that are equally plagued by money laundering activities in addition to the potential economic benefits that will result from stopping the illicit outflow of money from the national economy. Given that Sub-Saharan African countries suffer the most with respect to the relative percentage GDP loss due to illicit money outflows, this research stands not only to benefit Nigeria, but many developing African countries as well, positioning Nigeria as a thought and technology leader in this area of fiscal prudence.

Project IX: OAU ICT-Driven Knowledge Park

Science, Technology and Innovation have become key factors contributing to economic growth in both advanced and developing economies. ICT sector plays an important role, notably by contributing to rapid technological progress and productivity growth. It is now clear that ICT now render international boundaries irrelevant whereby several modern activities transcend

international boundaries, which, connotes that we live in a boundless world that is becoming a smaller place.

In 2014, there was a request for proposal from the World Bank through Association of African Universities (AAU) /National Universities Commission (NUC) to set up 19 Africa Centres of Excellence in West and Central Africa in three different areas: Science, Technology, Engineering and Mathematics (STEM), Agriculture, and Health Sciences. OAU team put up a proposal to set up OAU Knowledge Park. This was in line with the university's desire to setup a knowledge park. However, the international reviewers observed that the proposal was not focused. The team met again and we eventually agreed to narrow it down to focus on ICT. Mr. Vice-Chancellor Sir, I am happy to inform you that out of the 59 proposals submitted only 19 were approved by the World Bank. Out of the 19 approved, 10 came from Nigeria, and OAU got 1 out of the 10. OAU is now designated as Africa Centre of Excellence in ICT. The Africa Centre of Excellence code-named OAU ICT-Driven Knowledge Park aims to create a regionally-recognised and acknowledged model that is driven by high quality postgraduate education for uptake and commercialisation of research and technology to advance the growth of ICT industry. The primary goal is to provide excellent training for national and regional students for Master and PhD degree programs in ICT and related disciplines. Specifically, the objectives of project are to:

- i. Develop a center of excellence in ICT as a training hub in software engineering for Nigeria and other countries in the sub-region.
- ii. Develop the next generation of scientists, researchers, teachers, entrepreneurs and product developers in the area of ICT through appropriate practice-anchored capacity building measures and enrolling new postgraduate students from Nigeria and the sub-region.
- iii. Stimulate creativity and excellence in research and innovation in ICT applicable to other fields and related to

- regional developmental objectives, in postgraduate students, with opportunities for industrial research uptake through the Centre model.
- iv. Expand learning opportunities for postgraduate students in all the sectors, by deploying existing and new developments in ICT, for which OAU is leading in the sub-region.
 - v. Leverage on the intellectual infrastructure and output of the university to serve as the launch pad for start-up ICT companies borne out of university research activities, by partnering companies.

Based on the foregoing, the Governing Council of OAU, on December 8, 2015, approved additional 4 postgraduate programmes (Computer Engineering, Intelligent System Engineering, Information System, and Software Engineering). The NUC Accreditation Team visited the Department of Computer Science and Engineering between 19th and 22nd of March, 2017 to accredit the 4 programmes and the existing Computer Science programme. It gladdens my heart to inform you that all the 5 programmes were given FULL accreditation. The Department of Computer Science and Engineering at OAU is now the 1st Department of Computer Science and Engineering in Nigeria to be granted full accreditation by NUC at the postgraduate level. Also, Gap analysis of 3 postgraduate programmes (Computer Engineering, Software Engineering and Intelligent System Engineering) was carried out between 21st June and 23rd June, 2017 by the Accreditation Board for Engineering and Technology (ABET) Foundation from United State of America.

Mr. Vice-Chancellor Sir, I have provided in Table 2, the summary of the funds attracted by myself or in conjunction with others to support the various projects and researches enumerated above.

Table 2: Summary of funding attracted to the University

S/N	Project	Organization	Amount (\$)	Amount (N)	Year
	Airtime Switch Application	British Council	16,700.00	2.5M	2004-2006
2.	Achieving Accelerated Learning with Foundation Courses in Computer Engineering	Hewlett Packard (HP)	100,000.00	15M	2008-2010
3	Enhancement of ICT Potentials for Teaching, Learning, Research and Services (Phase III)	Carnegie Corporation of New York	940,000	141M	2009-2012
4.	Centre of Excellence in Software Engineering Research	World Bank	5,500,000	880M	2010-2013
5	ICT Building Project	Skye Bank	1,125,000	180M	2010-2013
6.	Cyber Security	TETFund	120,000	24M	2014-2016
8	Video Streaming Application	TETFund	40,000	8M	2013-2015
9	SAP/ERP Project	CPTU	25,000	5M	2013-2015
10.	OAU ICT-Driven Knowledge Park (Performance Based)	World Bank	8,000,000	1.576B	2014-2018
11.	Cyber Security (Risk Management)	University Research Committee	1,500.00	300K	2014-2015
	Total		15,868,200	2.8318 B	2004 -Date

I am bold to declare that with the political will of the OAU management and the commitment of the Centres, the IT facilities in the University are capable of generating N200,000,000.00 per year and create employment for over 500 youths every year. I am happy today because I have succeeded in laying the foundation to establish an ICT Park for Obafemi Awolowo University, the 1st and only ICT Park in any Nigerian University that will further serve as vehicle for capacity building and job creation through Information Technology. Plate 7a and 7b shows the 3-D of the

proposed OAU ICT-Driven Knowledge Park and progress of work in the park respectively. I do hope this model can be replicated in other 5 geopolitical zones of the country.



Plate 7a: 3D of the proposed OAU ICT-Driven Knowledge Park



Plate 7b: Progress of work in the park

4.0 My Contributions to Obafemi Awolowo University (University Administration)

I wish to turn now very briefly to my modest contributions in the areas of administration. When in August 1, 2004, I became the Acting Head of Computer Science and Engineering, there were only three Ph.D holders in the department, Dr. E.R. Adagunodo (now Professor E.R. Adagunodo), my humble self, and Dr. H.A, Soriyan (now Professor H.A, Soriyan). The Department then was always called the Department of Graduate Assistants. Immediately I became the Acting Head of Department I set in motion a conducive academic environment that stimulated research and career progression such that most staff became motivated and determined to complete their academic program. In the last one decade, I have been privileged to produce the under listed at doctoral level (Plate 8).

1. Oluwaranti A.I: in wireless communication ('Development of Medium Access Control Protocol for Wireless Communication', 2007)
2. Oluwatope A.O: in Grid Computing ('The Development of a Network Topology Model for Grid Architecture' 2008)
3. Olajubu E.A: in Data Communication and Computer Network ('Development of Predictive Maintenance Model for Computer Communication Networks', 2008)
4. Ajayi A.O: in Data Communication and Computer Network ('Development of a Quality of Service Model for E-Commerce', 2008)
5. Awoyelu I.O: in Distributed System ('Development of a Distributed Data Warehouse System for Higher Institutions in Developing Countries', 2010)
6. Bello S.A: in Grid Computing ('Development of a Grid-based Software for SME in Developing Countries', 2011)
7. Ojesanmi O.A: In Telecommunication System (Development of Congestion Control Scheme for Global System for Mobile Communication Network', 2011)
8. Akinwunmi A.O: in Cloud Computing ('Development of a Multi-Agent Based Trust Enabled Cloud Service Model Discovery', 2014)

9. Adeyelu A.A: in Grid Computing System ('Development of a Job Coordination Model for Wireless Grid Computing Architecture', 2014)
10. Ogundoyin I.K: in Cyber Security ('Development of An Intelligent Model For The Management of CyberSpace Threats',2014)
11. Akinyemi B.O: in Cyber Security ('Development of A Performance Prediction Model For Network Security Risk Management', 2014)
12. Akinboro S A: in Data Communication and Computer Network ('Development of A Trust Management Model for Mobile Ad-Hoc Home Network'. 2014)
13. Odukoya H.A: in Web Technology ('Development of Browser Embedded Security Policies for Web Applications' 2016)

Plate 8 shows photograph of all doctoral students I supervised and graduated to date. Apart from the 1st candidate who was co-supervised by me and Professor L.O. Kehinde of the Department of Electronic and Electrical Engineering, the rest were solely supervised by my humble self. Furthermore, 8 of the candidates (candidates 1-6, 11 and 13) are staff in the Department. Candidate number 8 is now the Vice-Dean Faculty of Science, Benue State University, while candidates number 7 and 11 are the current Acting Heads, Department of Computer Science, Federal University of Agriculture Abeokuta and The Bell University of Technology, Ota. respectively.



Plate 8: Photograph of all supervised and graduated doctoral students to date.

What was then referred to as the Department of Graduate Assistant in 2004 is now becoming Department of Professors. Of the 32 academic staff in the department, the department can now boast of 24 PhD holders in Computer Science. Furthermore, during my tenure as the Acting Head of Department in 2005, I completed the setup of the Faculty of Technology Computer Engineering Laboratory sponsored by the Carnegie Corporation of New York. The Laboratory was commissioned by the then Vice-Chancellor, Professor Roger Makanjuola.

While still serving as the Acting Head of Department, I was appointed on the 1st of August 2005, as the Deputy Director, Information Technology and Communications Unit (INTECU). In January 2008, I was appointed Acting Director, INTECU, when the then Director Professor L.O. Kehinde went on sabbatical leave. INTECU is responsible for conceiving, designing and implementing ICT strategies for the university via the development of human capacities and provision of critical infrastructure and

network services. The unit has been actively involved in the process of building one of the fastest growing academic networks in the country. When I took over as the Acting Director, I met only four 4 Engineers and 1 Technologist. Mr. Vice-Chancellor Sir, by the end of my tenure on July 31st, 2016, we had 10 Engineers, 6 Software Developers and two Technologists. Under my leadership, two of the staff got their Ph.D. while 7 got their M.Sc. Furthermore, the following achievements were recorded during my tenure as the Director,

- The installation of additional battery-based inverter and solar backup systems have reduced the local network down-time to 0%;
- The expansion of fibre optic cable backbone and introduction of wi-fi network has improved access to network resources for both staff and students;
- The increase in bandwidth from 6.5Mbps to 800Mbps (aggregate) (Figure 7) has already enhanced the quality of research output of our academic staff, reduced the access time to get materials from the Internet, also provided opportunity to use some services that were not possible with the old bandwidth;
- The computerisation of Bursary under Carnegie;
- The students' portal has facilitated e-registration and e-payment and reduced long queues at students' advisers' doors;
- OAU was ranked consistently top in the webometric ranking of Nigeria Universities (July 2006 – January 2016) Figure 8;
- Resuscitation of ITU-ITC-OAU CISCO Networking Academy – Plate 9;
- Establishment of IFE/OSUN research and education network (REN) currently being coordinated by Professor L.O. Kehinde – Figure 9;
- Fund generation through Internet access card which led to the creation of indirect 17 jobs for students and the university community

OAU BANDWIDTH PURCHASE 2008 -2016

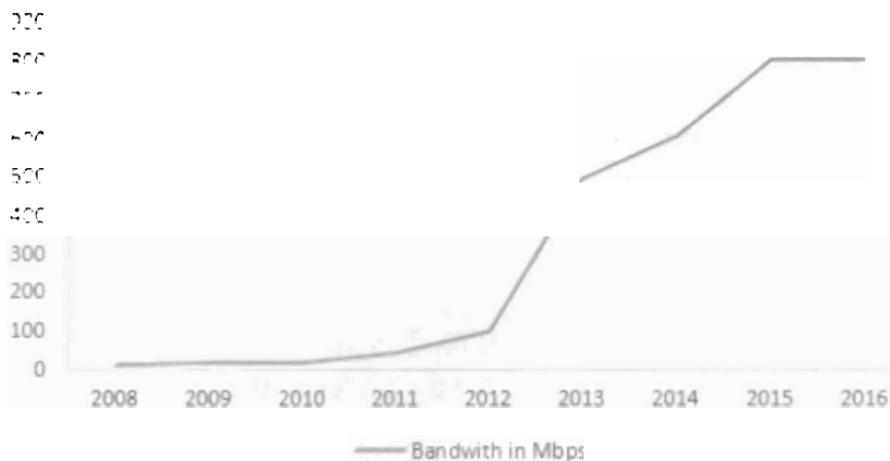


Figure 7: OAU Bandwidth Analysis 2008-2016



Figure 8: OAU Webometric Ranking 2006-2016

5.0 My Contributions at the Professional Level

My contributions have not been limited to the university. In all modesty, I have also tried to use my knowledge and experience to assist my professional bodies. I have trained many generations of students in other universities in Nigeria during my academic forays to these universities as Visiting Professor/Adjunct Professor. Many of these former students are now established as professional IT experts in the public and private sectors.

I was a member of the National Executive Council of the Nigeria Computer Society, the umbrella body of all IT professionals in Nigeria where I served as Chairman Publications, Standard, Research and Development (2007-2011), Chairman Conferences Committee (2011- 2013) and Deputy President (2013-2015). I became the National President in July 2015. One of the cardinal objectives of NCS is to address the problem of weak university-industry linkage by actively encouraging research in the advancement of Computer & Information Science, Information Technology Systems and practice; and disseminate results of scientific works carried out in industry, military and education sectors. The 19th National Executive Council under my leadership encouraged our corporate members to setup an IT Innovation Centre in our National Secretariat, Alausa, Ikeja. This is with a view to resolving the above mentioned problems and creating employments for our youths. Furthermore, we have suggested various strategies to implement e-government and the use of IT to tackle insecurity in Nigeria to the Federal Government of Nigeria under the leadership of President Muhammadu Buhari.

As a registered IT professional and Engineer, on several occasions, I have served as a member of COREN/CPN/NUC Accreditation Teams to several Universities in Nigeria to accredit Computer Science and Engineering programmes. Some of these universities, just to mention a few, are: Ladoke Akintola University of Technology, Ogbomosho (COREN Accreditation, 2003), Igbinedion University, Okada (COREN Accreditation, 2003), Ajayi Crowther

University, Oyo (NUC Accreditation, 2012), Nnamdi Azikiwe University, Oka (NUC Accreditation, 2012), Michael Okpara University of Agriculture, Umudike (NUC Accreditation, 2012), Ambrose Alli University, Ekpoma (NUC Accreditation, 2012), Obong University, Uyo (NUC Accreditation, 2014), Samuel Adegboyega University, Ogwa (NUC Accreditation, 2014), Baze University, Abuja (NUC Accreditation, 2014), Rivers State University of Science and Technology, Port-Harcourt (NUC Accreditation, 2016), Enugu State University of Science and Technology, Enugu (NUC Accreditation, 2016), Bells University of Technology, Ota (CPN Accreditation, 2014), Afe Babalola University, Ado-Ekiti (CPN Accreditation, 2015), Wesley University of Science and Technology, Ondo (NUC Accreditation, June 2017), and Achiever University, Owo (NUC Accreditation, June 2017).

I have served as External Examiner for undergraduate and postgraduate degrees in Computer Science and Engineering at several Nigerian Universities including University of Lagos, Akoka; University of Ibadan, Ibadan; University of Ilorin, Ilorin; Federal University of Technology, Akure; Federal University of Agriculture, Abeokuta; Bowen University, Iwo; Ajayi Crowther University, Oyo; Fountain University, Osogbo; Crescent University, Abeokuta; Covenant University, Ota; The Bells University, Ota; University of Maiduguri, Maiduguri; Kano State University of Science and Technology, Wudil; Benue State University, Makurdi; and Afe Babalola University, Ado-Ekiti, to mention just a few. I was a member of the team that developed the Curriculum for Computer Science Programme at Babcock University, Ilishan, Ogun State; and the National Open University, Lagos in 2000.

Currently, I serve as the Chairman, Computer Resource Centre, Federal University of Technology, Akure (2012 -Date), where we developed various ICT policies for the university; ICT Consultant to Ekiti State University, Ado-Ekiti (2016 - Date); Federal Polytechnic, Ede (2016 - Date); Board Member, Digital Literacy Council (2016 - Date); Member, Steering Committee of the Africa

Internet Policy Research Group co-hosted by Google and Ibadan School of Government and Public Policy and most recently Member, Implementation Committee, proposed University of Information and Communication Technology (April, 2017). I was appointed as Technical Advisor for Osun State during the 2017 Unified Tertiary Matriculation Examination (UTME). I am a Fellow of Nigeria Computer Society, COREN-Registered Engineer, Member, Nigerian Society of Engineer, and Member, Computer Professional Registration Council of Nigeria (CPN).

In continuation of my service to mankind, I have given several lectures and speeches to various organisations across different discipline. In December 2013, I was one of the guest speakers at the 2013 edition of the Nigerian National Merit Award programme.

Conclusion and Recommendations

Mr. Vice-Chancellor Sir, unemployment is a threat to democracy and the nation's future. Generating sufficient jobs for present and youthful population is integral to Nigeria's economic revival. The changes that IT brings to economies and to employment are inevitable and global. To neglect IT is to waste the potential and opportunity that our massive youth population represents. While there is no magic wand for dealing with unemployment, impact and success can only be achieved by ensuring information technology is at the center of national job creation policies and strategies. With a comprehensive strategy on IT job creation, Nigeria's population, especially the youth, will transform the nation. The following are my recommendations on what we need to do if we must resolve unemployment crisis in Nigeria through information technology:

For Higher Education Institutions

There is the urgent need for higher education institutions to:

- (i) Develop clear expectations for University graduates at both undergraduate and graduate level by employing a powerful and coherent educational philosophy. This

- philosophy should be used to guide university investments in learning;
- (ii) Use a strategic planning and budget model. In this regard university needs to free up funds for innovation and redesign of essential programs and support structures, and also invest in programs that make university distinctive;
 - (iii) Introduce a culture of evidence, that is, foster a habit of continuous learning and improvement and utilise an experimental approach to change, and guide change with evidence of impact;
 - (iv) Build support for scholarship, expand university research and assessment, and define clear academic and administrative priorities and introduce rigorous performance expectations;
 - (v) Promote productive collaborations and partnerships (both internal and external) by focusing on strategic societal issues (e.g. renewable energy, health care, community development, diversification of the economy, arts/cultural programs), and creating learning opportunities for our students;
 - (vi) Foster interdisciplinary work within the administration as well as across academic programmes in higher institutions of learning;
 - (vii) Seek additional sources of external support: portfolio of grant support, expand graduate/postgraduate programmes, fund-raising through workshops, conferences, partnership/collaboration, and consultancy services;
 - (viii) Reintroduce and strengthen the system of mentoring, apprenticeship and tutelage which existed in the past to facilitate acquisition of research proposal writing and publication skills;
 - (ix) Encourage split-site arrangements to enable young researchers to be acquainted with new trends, globally, and

- (x) Spend a considerable portion of institution's budget on global promotion activities.

For Federal Government of Nigeria

There is the urgent need for the Federal Government of Nigeria to urgently:

- (xi) Attract Multi-National Companies (MNCs) to establish IT facilities, provided the IT products are developed for export;
- (xii) Develop the IT industry through research centres, technology parks, and incubators to facilitate collaboration between researchers and industry, and the sharing of research results;
- (xiii) Provide more reliable and affordable information technology infrastructure;
- (xiv) Provide fiscal incentives for indigenous software developers in form of tax and tariff rebates;
- (xv) Create a special fund to assist start-up businesses as well as grow existing developers;
- (xvi) Protect the indigenous IT industry through the enactment of a law that mandates MDAs to patronize indigenous hardware and software,
- (xvii) Urgently implement national policy on hardware and software development which should be derived from National IT policy framework, and;
- (xviii) Create a one-stop-shop entrepreneurship website where IT entrepreneurs would turn for information, advice, and guidance on business models

Acknowledgements

I now wish to make few acknowledgments. First and foremost, I thank God Almighty for making today a reality. He has always given me His love and protection and has blessed all my endeavours. I thank Him and praise His holy name for all He has done for me.

I thank my father, Late Pa Tijani ADEROUNMU of Agbero's Compound, Tede, in Oyo State who took care of me before he

slept in the Lord in 1972. As for my mother, words alone cannot express my gratitude to you for your prayers at all times. I thank my Uncle Pa Jacob Oketola, my aunt, Late Madam Asiawu Aderibigbe, and all my brothers and sisters for providing the environment that nurtured my ideals as a growing child. I sincerely thank Mrs. Funke Agboola who gave me ₦35 to purchase JAMB form in 1985, Sister Ronke Adeniran (my school mummy) at the Teacher's College who bailed me out with ₦50 to word-process my final-year project. At this juncture, let me appreciate Mr. and Mrs. Bimpe Akintunde's family who solved my accommodation problem in Lagos during my one-year mandatory National Youth Service. I thank all family members who challenged me throughout the years, and whose constant nudging drove me to the peak of my career. I appreciate my relatives and friends whose names I cannot mention here.

Thank to you all my mentors – teachers, academic and industry supervisors: Arch-Bishop Professor Adebayo Dada Akinde, Professor L.O. Kehinde, Professor E.R. Adagunodo, Professor F.J. Ogwu, Sir Demola Aladekomo and three other members of staff of Chams PLC, Mr. Tunji Gafaar, Mr. Femi Williams and Rev. Tony Akinyemi who provided the solid theoretical and practical foundation upon which I based my research at postgraduate level in the university.

Special appreciation goes to my research and project team members: Dr. O.A. Oluwatope, Dr. B.O. Akinyemi, Dr. A.O. Adetoye, Dr. A.T. Aladesanmi, Dr. E.A. Olajubu, Dr. S.A. Bello, Dr. M.L. Sanni, Dr. O.A. Awoyelu and Engr. T.O. Ajayi.

My sincere thanks also goes to the following past Vice-Chancellors: Professors Wale Omole, Roger Makanjuola, Michael Faborode, Bamitale Omole, and Antony Elujoba, and the current Vice-Chancellor, Professor E.O. Ogunbodede; former Deputy Vice-Chancellors: Professors A.A. Adeniran, Funmi Togonu-Bickesteth, and Ayobami Salami; and members of the university management present here today. I have enjoyed tremendous support from Mr. A.O. Ogunruku, Mr. Dotun Awoyemi, Mrs. Bukky Asubiojo, Mrs. Ronke Akeredolu, Professor L.O. Adekoya,

Professor T.A. Olugbade and Prof. Adigun of University of Zululand, Republic of South Africa. I appreciate the entire members of staff of the Department of Computer Science and Engineering under the leadership of Dr. O.A. Odejobi, staff of Information Technology and Communications Unit (INTECU) and the entire members of Faculty of Technology under the leadership of Professor Ben Imasogie for their supports. I recognise the role played by my students both present and past in advancing my teaching and research in the university; they have been sources of inspiration and motivation to me.

I hereby heartily thank the Minister of Communications, Barrister Adebayo Shittu, Director General of National Information Technology and Development Agency (NITDA), Dr. Isa Ali Patanmi, my professional colleagues at the Computer Professionals Registration Council of Nigeria (CPN) and Nigeria Computer Society (NCS) for affording me the opportunity to blend academics and professionalism. I thank most sincerely all past Presidents of NCS present here today, Provost, College of Fellows, President and Chairman of Council of CPN, and Fellows. Many friends have joined us today to celebrate this day with me: colleagues from other HEIs and the IT industry respectively; Club 20 of Lagos under the leadership of Mr. Bayo Oyaleke; 1991 Class of Computer Science and Engineering, OAU ably led by Dr. Kayode Elusoji. I thank you all. In the audience is one friend whom I have known for over 40 years. Both of us began primary school together and other than my family, he is the only person here today who has known me the longest; it is my pleasure having Mr. Rogba Onifade here. I must not forget to appreciate my in-laws, the Oyeneyin's family for giving me a beautiful and responsible daughter as wife.

Finally, a word of gratitude to my adorable wife, Temilade, for her love, prayers and for providing very strong support at the home front; and to my lovely children, Adeyemi, Taiwo and Kehinde, for being sources of joy to me always.

I thank you all for listening.

REFERENCES

- Adagunodo, E.R. (1993): Simulation and Analysis of a distributed Nigerian Network Operating System, Ph.D. Thesis, Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria, 245 pages.
- Aderounmu, G.A., Adagunodo E.R, and Akinde, A.D. (1999):** Weighted Round-Robin Cell Scheduling in ATM Networks: A New Approach. *Journal of Computer Science and its Applications*, 7(1): 35-39.
- Aderounmu. G.A., Oluwaranti, A.I, Akintola, A.A., Adagunodo E.R, and Akinde, A.D. (1999):** A Flexible Printer Controller for Mobile Terminal in a Wireless ATM Network. *Journal of Scientific Research and Development*, 4: 95-106.
- Aderounmu G.A., Oyeniyi, S.J., Adagunodo, E.R. and Akinde, A.D. (2000):** A New Buffer Management Scheme for Multi-QoS Traffic over ATM Switching Systems. *International Journal of Information and Computing Science*, 3(2): 57-68.
- Aderounmu, G.A. (2001):** Development of an Intelligent Mobile Agent for Computer Network Performance, Ph.D. Thesis, Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria, 245 pages.
- Aderounmu, G.A., Ogwu, F.J, Adagunodo, E.R, Akintola, A.A, Adetoye, A.O., and Mahanti, P.K. (2001):** Intelligent Hybrid Multi-Agent Computational Architecture for Resources Management in Complex Systems. *International Journal of Information and Computing Science*, 4(1):1-12.
- Aderounmu, G.A., Adagunodo, E.R, and Akinde, A.D (2002):** Performance Comparison of Data-Link Control Protocol for Wireless Asynchronous Transfer Mode Network *International Journal of Computers and Applications*, 24(3): 144-152.
- Aderounmu G.A., Ogwu, F.J., Adagunodo, E.R., and Adetoye, A.O. (2002a):** Stochastic Estimator-based ABR Traffic Control Schemes. *Proceedings of the ANNIE on Intelligent*

Engineering Systems Through Artificial Neural Networks, 12:853-860.

- Aderounmu G.A.**, Adagunodo, E.R. and Akinde, A.D. (2002b): Diagnostic Mobile Software Agent for Microcomputer System. Nigerian Journal of Engineering Management,3(2):71-75.
- Aderounmu, G.A.**, Ojesanmi, A.O. and Ogwu, F.J. (2003a): Improving the Quality of service guarantee in an Asynchronous Transfer Mode Network (ATM), IASTED International Conference on Wireless and Optical Communications. Pp 218 -234 July 14 -16, Banff, Alberta, Canada.
- Aderounmu, G.A.**, Ogwu, F.J. and Adetoye A.O. (2003a): A framework for Probabilistic QoS Guarantee in Mobile Ad Hoc Networks. International conference on Computer Communication and Control Technologies CCCT 03 pp 44-48 July 31 – August 2, Orlando Florida, USA.
- Aderounmu, G.A.**, Awoyelu, I.O. and Adetoye A.O. (2003b): Agent-based Approach in Selecting Views and Indexes in A Data Warehouse. Science Focus, 3: 61-68.
- Aderounmu, G.A.** (2004): Performance Comparison of Remote Procedure Calling and Mobile Agent Approach to Control and Data Transfer in Distributed Computing Environment. Journal of Network and Computer Applications, 27(2): 113-129.
- Aderounmu, G.A.**, Ogwu, F.J. and Onifade, O. (2004): A Dynamic Traffic Shaping Technique for Scalable QoS in ATM Networks. International Conference on Computing, Communications and Control Technologies; 332-337.
- Aderounmu, G.A.**, Adekiigbe A. and Iyilade J.S. (2004a): An Evaluation of Mobile Agent Paradigms. The Journal of Computer Science and Its Applications. 10(2): 107-116.
- Aderounmu G.A.**, Oyatokun, B.O., and Adigun M.O. (2006): Remote Method Invocation and Mobile Agent: A Comparative Analysis. Journal of Issues in Informing Science and Information Technology, 3, 1-11.

- Aderounmu G.A.** (2013): Software Development for Employment Generation. Paper presented during the 6th Forum of the Laureates of The Nigerian National Order of Merit (NNOM), Merit House, Abuja, Nigeria. 3rd – 5th December, 2013, 6pages.
- Ajayi A.O., **Aderounmu G.A.**, and Adigun, M.O. (2004). Web-based Expert System for Property Valuation Using Mobile Agent Technology. In: Proceedings of the International Conference on Artificial Intelligence and Soft Computing (IASTED-04), November 22 24, St. Thomas, US Virgin Islands, pp. 26-33.
- Ajayi, A.O., **Aderounmu, G.A.**, Soriyan, H.A. and Amos, D. (2010): An intelligent Quality of Service brokering model for e-commerce. *Expert Systems with Applications*. 37: 816-823.
- Ajayi, A.O., **Aderounmu, G.A.** and Soriyan, H.A. (2010a): An adaptive fuzzy information retrieval model to improve response time perceived by e-commerce clients *Expert Systems with Applications*, 37(1): 82-91, Elsevier publisher, **Netherlands**.
- Akintola, A.A., **Aderounmu, G.A.**, and Owolarafe, O.K. (2002): Problems of Engineering Education and Training in Developing Countries: Nigeria as a case study. *EUR. J. ENGR.*, 27(4):393-400.
- Buchanan, W, and Wilson, A. (2001): *Advanced PC Architecture*. 1st Edition, Addison Wesley Press, England.
- Evans, W. (2012): The Nigerian Software Industry and National Economic Development. Paper presented at the 5th Forum of the Laureates of The Nigerian National Order of Merit (NNOM), Merit House, Abuja, Nigeria, November, 2013.
- Gibson, J.D. (1996): *The Mobile Communication Handbook*, CRC Press.
- Grossman, D. (2002): New terminology and clarifications for Diffserv !ETF RFC 3260. <https://www.ietf.org/rfc/rfc3260.txt>
- Gilbson, J.D. (1996): *The Mobile Communication Handbook*, CRC Press.
- Idowu, P.A, Adagunodo, E.R., Idowu, A.O., **Aderounmu, G.A.** and Ogunbodede E.O. (2004): *Electronic Referral System*

for Hospitals in Nigeria. *Ife Journal of Science*, 6(2):161-65.

- Iyilade J.S., **Aderounmu G.A.** and Adigun M.O. (2005): An Agent-Based Approach for Finding a Supervisor in an Academic Environment. The 3rd International Conference on Education and Information Systems: Technologies and Applications, pp 71-75.
- Mbonu, O.J. (2000): Practical Training of Engineering Personnel-Challenges Ahead. Proceedings of COREN 10th Engineering Assembly. International Conference Centre, Abuja. Pp 30-38.
- Nwana H.S., Ndumu D.T. (1997): An introduction to agent technology. In: Nwana H.S., Azarmi N. (eds) *Software Agents and Soft Computing Towards Enhancing Machine Intelligence*. Lecture Notes in Computer Science (Lecture Notes in Artificial Intelligence), vol 1198. Springer, Berlin, Heidelberg
- Ogwu, F.J. and **Aderounmu, G.A.** (2003): Improving the Performance of TCP/IP over ATM Network. Proceedings of the IASTED International Conference on Communication Systems and Networks, 489-494 Benalmadena, Spain.
- Olajubu E.A, **Aderounmu G.A** (2004): An Agent – Based Architecture for Students’ messenger: Obafemi Awolowó University as a case study. *The journal of Computer Science and its Applications* 10(2):107 – 116, Nigeria.
- Oluwaranti, A.I., **Aderounmu, G.A.**, Adagunodo, E.R, and Olateru R.O. (2006): An Implementation of a Web-enabled Home Devices Controller. *Ife Journal of Technology*, 15(2): 85-92.
- Oluwatope, A.O., **Aderounmu, G.A.**, Adagunodo, E.R. and Akinde, A.D. (2004): Stochastic Reward Net End-to-End Quality of Service (QoS) Simulation Modeling Across ATM Networks Using the Goodput Model. *IEE Telecommunication, Quality of Service: The Business of Success*, 165-172.

- Oluwatope, A.O.; Aderounmu, G.A., Akande O. and Adigun, M.O. (2004a): An Auction Scenario in a Stock Market Using M² Agent. Southern African Telecommunication Networks and Applications Conference, 1: 229-234.
- Oluwatope, A.O, Ojo, B., Aderounmu, G.A and Adigun, M.O. (2006): A Memory Optimized Public-Key Crypto Algorithm Using Modified Modular Exponentiation (MME). Journal of Issues in Informing Science and Information Technology, 3: 467-478.
- Romano, P., Quaglia, F., and Ciciani, B. (2004): A protocol for improved user perceived QoS in web transaction applications. In EEE international symposium on network computing and applications. Cambridge, MA, 69-76.
- Salawu, R.I. (2000): Practical Training for Engineering Personnel. Proceedings of COREN 10th Engineering Assembly, International Conference Centre, Abuja, Nigeria. 44-54.
- Tanenbaum, A.S. (1981): Computer Network. Prentice-Hall International Inc. Eaglewood Cliff, N.J.517p
- Vijayasri, G.V. (2013). The Performance of IT/ITeS Industry in India. International Journal of Advanced Research (2013), 1(6): 393-400.
- Wilkin, D. (1992): Patterns of referral: Explaining variation. In Hospital Referrals (eds, Ronald M. and Coulter, A.) Oxford University Press, Oxford, Pp67-93.