ICT DEVELOPMENT AND FUTURE PLANS IN AFRICA

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1 INTRODUCTION

There is no doubt that Information and Communication Technology (ICT) holds the promise of transforming the ways we live into new and more powerful ways. ICT has become a strategic resource, a commodity and foundation of every activity from technology, communication, health to entertainment.

ICT now plays a major role in education, learning and research in general, agriculture, health, commerce and even in poverty alleviation by generating or creating new jobs and investment opportunities. Africa as a continent is besieged by poor infrastructural facilities especially in area of telecommunications. The continent therefore started later than the rest of the continents in imbibing ICT as a tool for development and economic emancipation.

Furthermore until some few years back, developments in ICTs is rather quite slow compared to the rest of the world. But lately the potential of ICTs to transform development is now receiving greater attention by African countries. Using the catch phrase "Bridging the Digital Divide", national governments, NGOs, corporations, and global compacts such as the UN and the G8 are all marshalling resources to use ICTs for improving development in the underdeveloped worlds.

As a result of the convergence of information, telecommunications, broadcasting and computers, the ICT sector now embraces a large range of industries and services hence National Information and Communication Infrastructures must be developed for integration into the Global Information Infrastructure (GII).

Although a large number of international funding agencies have ICT initiatives in Africa, the continent has not fully responded to the clarion call for giving ICT necessary priority in the national development. However, the situation is changing rapidly in recent times, especially after the African Development Forum (ADF'99), held in Addis Ababa in 1999, with the theme 'Challenge to African Globalisation and the Information Age'. It is therefore necessary to note that though many African countries lack basic facilities like fresh water and primary education, the continent remains a "perfect case" for the application ICTs.

2 ICT INFRASTRUCTURE IN AFRICA

2.1 INTERNET & TELECOMMUNICATIONS

While the impact of the information revolution is tremendous, the existing infrastructure, social-economic, cultural, and political situations pose major difficulties in introducing, implementing and diffusing the new technologies for internetworking. The technology and funds are not necessarily the major inhibiting factors, but the will and awareness until lately do not seem to be present in the continent, although the poor telecommunication system has made the matter worse. The African still finds himself in a state of isolation and stagnation. With the new wave of awareness on the continent, Africa could seize the opportunities of the new information technology. This will amongst other advantages allow the region to fight disease, poverty and ignorance in all directions.

The "digital divide" however, is still at its most extreme in Africa. In absolute terms, networked readiness is still at a very early stage of development compared to other regions of the world. Of the approximately 816 million people in Africa in 2001, it is estimated1 that only[1]:

1 in four has a radio (200 million);

1 in 13 has a television (62 million);

1 in 35 has a mobile telephone (24 million);

1 in 39 has a fixed line (21 million);

1 in 130 has a personal computer (PC) (5.9 million);

1 in 160 uses the Internet (5 million);

1 in 400 has pay-television (2 million).

[1] The figures represent the 2001/2002 statistics. It sure gives a good reflection of the present statistics.

These figures do not take into consideration the widespread sharing of media that takes place in Africa (often ten people may read the same newspaper or share an Internet account, and a whole village may use a single telephone line or crowd around a television set at night); nevertheless, it appears that sub-Saharan Africa may be slipping behind when compared to south Asia, the other least developed region.

But because the region is so diverse, it can be misleading to generalize about Africa. The averages given above obscure the great variation between countries, but it can be said that most of the continent's population are amongst the poorest in the world (Africa had US$766 in gross domestic product (GDP) per person in 2000), with the divide between urban and rural areas being particularly marked. Most services are concentrated in the towns, while the majority of Africans (70 to 80 percent) reside in smaller communities scattered across the vast rural areas. In some countries, more than 75 percent of the country's telephone lines are concentrated in the capital city. Irregular or nonexistent electricity supplies are also common in Africa, especially outside major towns.

In spite of these, the Internet usage and its applications continue to grow rapidly in Africa. The rate of growth in users is still on the increase as seen in the 1990s but has slowed down in some most countries, as the bulk of the users who can afford a computer and telephone have already obtained connections. In Africa, each computer with an Internet or email connection usually supports a range of three to five users. This puts current estimates of the total number of African Internet users at around 5-8 million, with about 1.5-2.5 million outside of North and South Africa. This is about 1 user for every 250-400 people, compared to a world average of about one user for every 15 people, and a North American and European average of about one in every 2 people. (The UNDP World Development Report[1] figures for other developing regions in 2000 were: 1 in 30 for Latin America and the Caribbean, 1 in 250 for South Asia, 1 in 43 for East Asia, 1 in 166 for the Arab States).

Shared/public access and the use of corporate networks is continuing to grow at greater rates than the number of dialup users. This can be seen in the deployment of international Internet bandwidth, which is still expanding substantially – up over

100%, from just over 700 Mbps of available outgoing bandwidth in 2001 to 1 500 Mbps in 2002 (although this is still slower than the rest of the world, which averaged 174% growth in 2001, with Latin America at 479%).

There are a variety of reasons for greater increases in international bandwidth, most notably: the increasing use by ISPs of low-cost bandwidth via satellite to augment their existing links, the greater demand by a maturing user-base for more bandwidth (including for VOIP), growth in use of public access facilities (cybercafes, business centres). Also, the pricing for international bandwidth has dropped due to greater competition in the sector caused by new supplies from satellite providers and the establishment of new marine fibre cable along West Africa connecting to Europe and Asia. With the recent launch of new low-cost service offerings such as 2-way Ku-band VSAT and GPRS mobile data, it appears this growth will continue. Nevertheless, this growth is off a very low base – even Latin America has 10 times as much International bandwidth (16 132.5 Mbps)and the average North American resident has access to around 570 times more international bandwidth than the average African citizen.

There are now about 39 countries in Africa with 1000 or more dialup subscribers, 20 countries with more than 5000 and 16 countries with 10 000 or more subscribers. Clearly a number of countries such as those in North Africa and Southern Africa have more highly developed economies and better infrastructures which naturally result in larger populations of Internet users. Most of these countries were also among the first on the continent to obtain Internet access and so have had the most time to develop the user base.

Nevertheless, some countries such as Senegal and Cap Verde are bucking the trend, and have much higher levels of connectivity than their GDP/capita would suggest. Also, after many years of relative inactivity, the recent opening up of the Nigerian Internet market has begun to have an impact on the African internet picture. With a fifth of Sub-Sahara's population, the country was still a relatively small player in the Internet sector until mid '98 when it only had a few dialup email providers and a couple of full ISPs operating on very low bandwidth links. The national regulator has since licensed about 250 ISPs to sell services, the most popular inlcude (Linkserve,

21st Century, Hyperia, Cyberspace, Infoweb, Sioel, Nova and Nitel). In the major cities there are now many thousands of cybercafe/business centres run by small entrepreneurs who are allowed by the regulator to provide VOIP services as part of their cybercafe license, which costs about $500 a year.

Nevertheless the extremely sparse and unreliable fixed line network in Nigeria, which also suffers from severe inter-exchange congestion, is still a major impediment to widespread Internet uptake. Some of the wireless local loop operators which have been licensed in the urban areas have promised to provide data services over their subscriber links, but have yet to launch them. The GSM subscriber base licensed only in 2001 has already eclipsed the number of fixed line subscribers nationwide (400 000) and if the mobile providers make low-cost GPRS services available on their network this could have a major impact on Internet use. On of the GSM operators, GlobaCom has recently introduced a low-cost GPRS Internet service. The privatisation of the public telecom operator, Nitel (which also has a new GSM license) and the introduction of a second network operator is expected to accelerate Internet use further, however this has been subject to further delays. M-Tel is the sister company of NITEL operating but operates the GSM service. Nevertheless the encouraging news is that Nigeria has moved from a tele-density of mere 0.5 to 2.0 in just three years with the introduction of GSM and the emergence of 2nd National Operator, GlobaCom.

Changes in the telecommunications sector in Africa are much more remarkable. A substantial increase in the rate of expansion and modernisation of fixed networks is taking place along with the explosion of mobile networks. The number of main lines grew about 9% a year between 1995 and 2001. However this is off a very low base – the overall fixed line tele-density of 2001 is still only about 1 in 130 inhabitants in Sub-Saharan Africa(excluding South Africa).

Also, most of the existing telecom infrastructure cannot reach the bulk of the population - 50 percent of the available lines are concentrated in the capital cities, where only about 10 percent of the population live. In over 15 countries in Africa, including Cote d'Ivoire, Ghana and Uganda, over 70 percent of the lines are still located in the largest city.

The situation is not quite as bad as it would appear however, because of the penetration of mobile networks, where subscribers have now surpassed fixed line users in most countries, underlining the pent-up demand for basic voice services. Because of the low cost and long range of the cellular base stations, many rural areas have also been covered. But the high cost of mobile usage (about US0.20c-0.40c/minute on average) makes it too expensive for most local calls or Internet access in relation to average income.

Overall, the number of fixed lines increased from 12.5 million to 21million across Africa between 1995 and 2001. North Africa has 11.4 million of these and South Africa another 5 million lines, leaving only 4.6 million for rest of the continent. The sub-Sahara thus contains about 10 percent of the world's population (626 million), but only 0.2 percent of the world's 1 billion telephone lines. Comparing this to all of the low-income countries, (which house 50 percent of the world's population and 10 percent of the telephone lines), the penetration of phone lines on the sub-continent is about 5 times worse than the 'average' low income country.

Nigeria before the introduction of GSM was dependent on NITEL the incumbent national operator and telecoms carriers for telephone services (fixed and mobile) and bandwidth for most dialup services. The fixed line capacity was about 700,000 with only about 70% of these operational. The introduction of GSM by MTN and Econet Wireless increased the number of mobile subscribers to 500,000 subscribers in just one year. Presently with the licensing of the 2nd National operator GlobaCom, Nigeria telecommunications industry now enjoys an impressive 2.4 million subscribers with the demand still on the increase. The potential of telecommunications in Nigeria and indeed Africa cannot be over-emphasised. In the year 2000, Nigeria was described as a sleeping giant in telecommunications. But with the increasing awareness, Nigeria is now the fastest growing telecommunications market in the world.

Nevertheless, some cellular operators are providing value added services, such as data transmission, short message sending, WAP based Internet access and even financial transactions. While data transmission is limited to 9.6Kb at the moment, the new GSM data protocol, GPRS, will soon be widely available in places like South Africa, which pushes data speeds to 384Kbps. This will substantially advance the

utility of the GSM network, especially when combined with the sophisticated GSM handsets that are essentially becoming a multi-function personal computing and communication device. These trends in the GSM sector suggest that once competition and technical advances have forced the price of hand sets and usage down sufficiently, the fixed line operators may end up passing on most of their end-user customer services to the mobile operators and concentrating on the provision of broadband national and international connectivity.

Smart-card or 'scratch-card' and other PIN-based public and cellular phones are becoming more widely adopted across the continent, creating a new revenue stream in the sale of telephone air-time by small shops and telecentres. This infrastructure can also form the basis for more advanced value added telephone-based services, including e-commerce, as is already the case in Zambia and South Africa where mobile phone based bill-payment systems have been launched.

Smart card applications are getting quite significant in Nigeria. Last year saw the birth of the Smart Card Society of Nigeria (SCCN) which becomes a platform for bringing together companies involved in different smart applications to develop a super card.

The super card project has four components which include [7]:

- **Smart Status** which involves the provision of advanced electronic smart chip ID cards, and the provision of comprehensive and authentic pictorial demographies of all students in Nigeria.
- **Cyber Centre** for the provision of free 50 - 100 systems per institution in cyberlabs; provision of free 5 - 10 hours PC/Internet access time per student per session; and internet access for students' registration and result checking.
- **Financial** - The Super Card will provide electronic banking services via electronic purses and debit cards, as well as provide access to discounts in bookshops, restaurants, stores, transporters.

The Super Card will also provide access to good healthcare facilities in the campus through the Health Insurance component of the project. It will also provide access to professional specialist healthcare facilities nationwide while on holidays or on trips. The Super card system has been adopted by some universities in Nigeria.

The usage of international lines in Africa is still relatively high compared to income levels, reflecting the large size of the African Diaspora and the arbitrary borders within the region. In 2000, the average for international outgoing calls in Africa was 110 minutes per subscriber per year, compared to a world average of 118, and 178 for high income countries. While many telecom operators are beginning to reduce tariffs and large number of International calls, means that despite their inefficiencies, African telecom operators enjoy substantial profits on their lines. The world average in 2000 was $942 revenue per main lines per year, and in Africa it was $868.

The use of fibre optic cable for international traffic is still in its infancy in Africa and most international telecom connections are carried via satellite. Currently, two submarine cables provide some international fibre connectivity to Africa. These cables are Sat-2/3 WASC, and SEA-ME-WE1/2 connecting most of the North African and West African coastal countries from South Africa to Morrocco, to the global backbones in Europe. All remaining international bandwidth is provided by satellite providers, primarily Intelsat, New Skies and Panamsat. According to the ITU, the total number of 64Kbps international circuits in Africa was close to 59 000 in 2000, 4% of the world total.

Currently the availability of specialist training in telecommunications is extremely limited on the continent. In Africa there are only two major regional centres for training in telecommunications - ESMT in Senegal for francophone countries and AFRALTI in Kenya for Anglophone countries. Through an ITU support programme they are expected to be transformed into Centres of Excellence in Telecommunications Administration (CETA). CETA is intended to provide senior-level, advanced training and professional development in the areas of telecoms policies, regulatory matters and the management of telecommunications networks and services. The National Information Technology Development Agency (NITDA) in collaboration with Hewlett Packard (Hp) is setting six pilot centres of excellence around the six geo-political zones of the country. The centres will offer specialised training in various areas of Information Technology and Telecommunications.

A number of telecommunication operators maintain their own training schools but these usually suffer from the same lack of financial resources being experienced by

the operators themselves. The German international technical training assistance agency, Carl Duisberg Gesellschaft (CDG), has sent a large number of telecom trainees from Africa to Germany over the last 20 years, and many other development agencies have similar, if smaller such programmes. At a global level, an initiative that may have an impact in the future is the ITU's Global Telecommunications Academy. This will operate as a brokerage service for distance learning courses. Once established, the Academy is to be self-financed through a fee payable by every course participant. The Academy aims to create a cooperative network of partners by pooling existing resources in universities, training institutes, financing bodies, governments, regional organizations and telecommunications operators. In Nigeria, the Nigerian Communications Commission (NCC) recently put a International Training Institute for telecommunications training. The centre will start operations in few weeks.

STATUS OF BROADCASTING IN AFRICA [4]

Radio communication is still the most dominant mass medium in Africa with ownership of radio sets being much higher than that of any other electronic device. Going by UNESCO's 1997, radio ownership in Africa was estimated to be close to 170 million with a 4% per annum projected growth rate; there should be about 200 million radio sets in the continent. Compare this with only 62 million TVs.

Estimates have it that over 60 percent of the population of the sub-continent are reached by existing radio transmitter networks while national television coverage is largely confined to major towns. Many countries still do not have their own national television broadcasting. Botswana just launched their national TV broadcasting last year while Nigeria has over 100 state owned television stations, and several private television stations.

An increasing number of commercial stations are being setup following the liberalization of this sector in many countries. However most of the news and information from these stations are often either re-broadcasts from the national broadcaster's network or of an international broadcaster or news agency.

Satellite-based broadcasting has seen major activity on the continent in the last few years. In 1995 South African company M-Net launched the world's first digital direct-

to-home subscriber satellite service called DSTV. DSTV subscribers have access to over 30 video channels and 40 audio programmes on C-band to the whole of Africa and low-cost KU-band to Southern Africa and later to other parts of Africa. Other satellite launches include:

- South Africa's Public broadcaster (SABC) launch of the Channel Africa, a new satellite-based news and entertainment channel aimed at the continent in 2001;
- In 1998, North Africa started receiving Direct-to-home (DTH) TV broadcasts from Egyptian Nilesat, the continent's first locally owned geostationary satellite, capable of broadcasting up to 72 digital TV programmes simultaneously.
- The US-based company WorldSpace launched a digital radio broadcasting satellite called AfriStar in late 1998. The satellite is now broadcasting about 40 channels using uplink hubs in South Africa, Ghana and London. Broadcasters in Europe, the US and many other parts of Africa have signed up to provide content. WorldSpace ultimately aims to make a suite of over 80 audio channels available to anyone on the continent who can afford the $50 for the special radio. They have available 16kbps AM mono stations; 128Kbps CD quality music channels as well data services through Direct Media service.
- World Space has developed an Interface card and simple antenna that provides receive-only information from the Internet via their satellites. Subscribers to World Space can access information from the Internet by connecting the interface card to a computer.

ICT HARDWARE AND SOFTWARE

Statistics in 2001 has it that Africa has about 7.5 million personal computers. But due to limited capacities for industry monitoring and the large number of machines smuggled in to avoid duties, these figures are notoriously unreliable. Some studies, such as the ACCT (1995) survey, indicate that official figures may be an overestimate by between 3 and 6 times, making the average closer to 1 per 500 people. Account should also be taken of the number of users sharing a single computer, which is much greater than in the more developed regions.

Under-utilization of existing computer resources is also common, often caused by the preponderance of many stand-alone computers in the same office with no use of Local Area Networks (LANs). Often an office may have many machines, but only one with a modem connected to the Internet. This usually means that there is

competition for the machine and a shared email account, which is not conducive to effective use of the Internet.

More generally, the high cost of computer hardware is a major issue as this is often the largest component of their startup budgets. This situation is likely to become an even more critical bottleneck now that low-cost bandwidth is becoming increasingly available, such as through Ku-Band VSAT and spread spectrum wireless (WiFi) links. As a result, increasing attention is being directed toward the use of recycled PCs, thin clients, set-top boxes, or other low-cost Internet 'appliances', and Open Source.

Other features of the African Hardware and Software industry include:

- Almost all of the PC equipment uses Intel or Intel-compatible processors except for the publishing industry where there are significant numbers of Apple Macintosh PCs.
- With the great lack of resources in the public sector in Africa, the penetration of computers is generally much lower in government, with by far the majority of PC equipment being used by private companies. Computers are mainly used for accounting and word processing, although spreadsheets are used to some extent for forecasting or as a simple database application. The limited number of database systems often use Microsoft Access, but many national documentation centres and archives, as well as small university and NGO libraries, use the UNESCO/IDRC developed ISIS / microISIS package for bibliographic data. Geographic Information Systems (GIS) and digitization facilities are beginning to be installed by some universities, and ministry planning departments and municipalities.
- Outside of South Africa there are only handfuls of mini and mainframe computers, and most of these are confined to Ministries of Finance for government payroll, and a few of the larger parastatals, telecom operators, banks and insurance companies.
- Few of the international companies operate offices in Africa, but Bull, Compaq, IBM, NCR, Oracle and Microsoft have some form of local representation in most countries. Microsoft now has its own offices in Cote d'Ivoire, Kenya, Morocco, Nigeria and South Africa.

PC equipment is often clone equipment imported from Asia, but Compaq, Dell, IBM and ICL also have significant shares of the market and Dell South Africa is now selling via the Web.

3 PROBLEMS WITH DIFFUSION OF ICTS IN AFRICA

Africa is a continent still struggling with the challenges of socio-political and economic development. Based on this, the option left for the continent to leapfrog into the Global Information Society is to fully embrace all the fruits of ICTs. Africa needs to take advantage of the phenomena and unexplored resources offered by ICT in order to sustain its developmental efforts.

Some of the factors resulting in poor IT penetration in Africa include (Ref. 2):

- Communication Regulatory environment. The national regulatory environment in Africa varies greatly, from relatively open competition in Internet service provision or even mobile services and local loops to long-term monopolies in all these areas.
- The extent of the existing ICT infrastructure and the cost of access to it. This affects both the potential new entrants in the provision of basic services and those to provide value-added services.
- The existing usage of the radio spectrum. Many of the countries in Africa do not have adequate facilities to manage their radio spectrum allocation for use by telecommunications and Internet operators, either nationally or regionally. This has resulted in congestion in some wavebands and lack of a transparent process and difficulties in obtaining spectrum from the regulators.
- The market orientation and openness of the national government to private sector investment. Many countries in the continent are still coming up from "nationalisation era" and many sectors of the economy are still dominated by inefficient parastatals with close links to government executives.
- The general investment climate in the country, such as the level inflation, import duties, access to local capital and foreign currency

- The resources the national government and their international cooperating partners are allocating to national information and communication projects.

- **Electricity Supplies**

  Irregular or non-existent electricity supplies are a common feature and a major barrier to use of the ICTs, especially outside the major towns. Many countries have extremely limited power distribution networks, which do not penetrate significantly into rural areas, and power sharing (regular power outages for many hours) is a common occurrence, even in some capital cities such as Accra, Dar es Salaam and Lagos. There is need for other alternative power supply sources like solar to be exploited in solving this problem.

- **Transportation**

  The road, rail and air transport networks are limited, costly and often in poor condition, resulting in barriers to the increased movement of people and goods, needed both to implement and support a pervasive ICT infrastructure, but also for the increased economic and social activity which would be stimulated through greater use of ICTs. Congested border posts and visa requirements add to these difficulties. These barriers make it all the more difficult for e-commerce and other Internet-age developments to blossom.

4 ICT & AFRICA: PRESENT & FUTURE PROSPECTS

ACCESS TO THE INTERNET

The potential of the Internet in Africa is staggering. Large-scale sharing of information resources is a dominant feature of the African media landscape. A given copy of any newspaper might be read by more than ten people at the least, there are usually perhaps 3~5 users per dial-up Internet account, and it is not uncommon to find most of a small village crowded around the only TV set, often powered by a car battery or small generator. The art of sharing resources is part of the African culture. Why not shared public Internet terminals?

In Sub-Saharan African, Internet can actually help break the deadly information famine that besets the continent. Close observation of recent trends in the continent has shown that this is already happening.

- In National Library of France's paper archives, scanned pages are beamed by satellite from Paris to the data centre in Rabat where they were processed by a large team of low-cost keypunchers and then sent back.
- In Senegal, more than 10,000 small businesses across the country that provide public telephone services now provide Internet access and other PC-based business services.
- The African Virtual University (AVU) project, based in Nairobi Kenya has over 34 Learning Centers in 17 African countries. Students are linked to classrooms and libraries world-wide via satellite. Many through this project have obtained degrees in computer science, computer engineering and electrical engineering. Visit http://avu.org/section/about/default.cfm for more details about the achievements of the project.
- Craft-makers around Africa are selling their wares all over the world via the Internet through such nonprofit groups like **PeoplLink**, which sends digital cameras into the bush so that pictures of the crafts can be emailed back to the web site (www.peoplelink.org).
- Miners use the AfriOne Internet Centre in Jos, Nigeria as a showcase for selling their merchandise to foreign prospectors. Using the facilities in the centre, they scan pictures of their wares which are then sent electronically to their oversea customers. Valuing and other negotiations are done through emails and business conducted through different forms of electronic money transfer.
- Products from research efforts like the web-to-email should be exploited for low bandwidth access to the Internet. www4mail is an Open Source application written in Perl. It was developed at The Abdus Salam International Centre for Theoretical Physics (ICTP). www4mail allows people to surf the web, fill in forms, use search engines, use web sites with cookies, in fact, do almost everything by email that one can do with a full Internet connection. Www4mail is robust, well documented, and free for non-profit users. This could be a very good tool to many African institutions that depend on slow dialup connection to distant ISPs probably in the capital cities for their Internet connectivity. Check http://www4mail.org/ for more details.

Sub-Saharan Africa is still by far, the least developed infrastructures in the world. Though there have been a lot of encouraging trends in the last few years, the differences between development levels in Africa and the rest of the world are especially wide in the area of ICTs,

TERRESTRIAL WIRELESS

Cellular

Cellular technology, originally designed for mobile services (such as communication from vehicles), is now used for personal communications with small portable handsets. Cellular service has become the first and only telephone service for people in many developing countries where it is available much sooner than fixed line service. In countries such as Gabon, Uganda, Morocco, Cote d'Ivoire, Rwanda, and Tanzania, and Nigeria there are now more cellular telephones than fixed lines. However, the bandwidth available on current cellular systems is very limited – 9kbps; it is possible to send short text messages and simple e-mail, but not to access the Worldwide Web.

Wireless Local Loop

Wireless local loop (WLL) systems can be used to extend local telephone services to rural schools without laying cable or stringing copper wire. WLL costs have declined, making it competitive with copper. Wireless allows faster rollout to customers than extending wire or cable. It also has a lower ratio of fixed to incremental costs than copper, making it easy to add more customers and serve transient populations. Wireless is also less vulnerable than copper wire or cable to accidental damage or vandalism. Examples of countries with WLL projects include Bolivia, Czech Republic, Hungary, Indonesia, South Africa and Sri Lanka. In Nigeria some of the wireless local loop operators, which have been licensed in the urban areas, have promised to provide data services over their subscriber links, but have yet to launch them.

WAP

Wireless Access Protocol has been developed to make it possible to transmit web pages and other data to cellular phones. It may be adapted for wireless services in developing countries so that Internet information can be transmitted to low bandwidth wireless systems.

SATELLITE TECHNOLOGIES

Very Small Aperture Terminals

Small satellite earth stations operating with geosynchronous (GEO) satellites can be used for interactive voice and data, as well as for broadcast reception. For example, Two-way C-Band satellite-based Internet services using very small aperture terminals (VSAT) to connect directly to the US or Europe has been quickly adopted by African ISPs wherever regulations allow. Namely in Mozambique, Nigeria, Tanzania, and Zambia, which all have ISPs that are not dependent on the local telecom operator for their international bandwidth. Uganda used to allow public VSAT Internet services, but following the sale of the second operator license; the issuing of new VSAT licenses has been suspended. The Nigerian Public Service Information Network (PSNET) Project being implemented by the National Information Technology Development Agency (NITDA) is based on a network of C-band VSATs in 9 state capitals.

A number of low-cost consumer oriented two-way VSAT services were launched in 2001 by companies such as Afsat Kenya, Web-Sat and IVS Africa, which are expected to see rapid uptake where regulations allow. These services make use of the new high-powered Ku-Band footprints now covering Africa, and are similar to services currently available in the US and Europe such as Tachyon and Starband. Initial pricing is expected to be $1500-$3000 for the VSAT equipment and $200 /month for 'better than dialup' speeds (i.e 56Kbps outgoing and 200-400Kbps incoming). Web-Sat's service, which is based in Ireland, has been operational for some years in North Africa and West Africa, making use of the edge of the footprint from the European satellite Eutelsat and Panamsat's PAS1R.

Internet via Satellite

Internet gateways can be accessed via geostationary satellites. For example, MagicNet, an Internet Service Provider (ISP) in Mongolia and some African ISPs access the Internet in the U.S. via PanAmSat, and residents of the Canadian Arctic use Canada's Anik satellite system, while Alaskan villagers use U.S. domestic satellites. However, these systems are not optimized for Internet use, and may therefore be quite expensive. Also, there is a half-second delay in transmission via

GEO, although this is a more obvious hindrance for voice than data. Several improvements in using geosynchronous satellites are becoming available:

DirecPC

This system designed by Hughes uses a VSAT as a high-speed downlink from the ISP, but provides upstream connectivity over existing telephone lines. Some rural schools in the U.S. are using DirecPC for Internet access.

An ISP, Direct on PC (DOPC) is offering cheap VSAT facilities to small establishments (with about 10 computers) in Nigeria. This is based on small 1.2m dish Ku-band VSAT dishes, 2 interface cards and can support high speed connection over a shared bandwidth based on TDMA. DOPC facilities were used in the development of the Mobile Internet Units (MIUs) by the National Information Technology Development Agency (NITDA), Nigeria.

Interactive Access via VSAT

Several companies are developing protocols for fully interactive Internet access via satellite, to make more efficient use of bandwidth and thus lower transmission costs for users. Examples include VITACom, Tachyon, and Aloha Networks.

High Bandwidth LEOs

Future Low Earth Orbiting (LEO) systems are being planned to provide bandwidth on demand. Constellations of LEO satellites such as McCaw's Teledesic and Alcatel's Skybridge, and new generations of GEOs such as Loral's Cyberstar and Hughes' Spaceway will be designed to offer bandwidth on demand for Internet access, video conferencing, and distance education.

Global Mobile Personal Communications Systems

Using LEO satellites, these systems provide voice and low-speed (typically 2400 to 9600 bps) data virtually anywhere, using handheld transceivers. However, the price per minute for these services is typically much higher than

national terrestrial services, and the first generation of LEOs has very limited bandwidth.

Data Broadcasting by Satellite

GEO satellites designed for interactive voice and data can also be used for data broadcasting. For example, China's Xinhua News Agency transmits broadcasting news feeds to subscribers equipped with VSATs. Digital audio can also be broadcast by satellite. The WorldSpace geostationary satellite system delivers digital audio directly to small radios.

While one market for these products is people who can afford to subscribe to digital music channels, the system can also be used to transmit educational programmes in a variety of languages for individual reception or community redistribution. It can also be used for delivery of Internet content; participants identify which websites they want to view on a regular basis, and WorldSpace broadcasts the data for reception via an addressable modem attached to the radio. WorldSpace has donated equipment and satellite time for pilot projects at schools and telecentres in Africa. WorldSpace has also come up with a new product that allows direct connection to PCs using small external antenna for data reception from their satellites.

Store-and-Forward Messaging

Volunteers in Technical Assistance (VITA) has developed a satellite-based system called VITAsat, capable of delivering sustainable, low-cost communications and information services to remote communities. The system uses simple, reliable, store-and-forward e-mail messages relayed to the Internet via LEO satellites. Using compression technology and software that allows access to web pages using e-mail, VITAsat can make the Internet accessible virtually anywhere.

VITA's current two satellite systems have the capacity to serve about 2500 remote rural terminals that could be installed in schools, clinics, community centres and NGOs. VITA plans to include local skill and organisational capacity building and development of targeted information content and services

designed specifically to meet the needs of small businesses, local NGOs, educators, health workers, and other relief and development workers.

WIRE-LINE TECHNOLOGIES

Innovations in wireline technology make it possible to provide high speed Internet access over telephone lines, rather than having to upgrade existing copper networks. These technologies may be used in urban areas where basic telephone service is available.

Integrated Services Digital Network (ISDN)

Regular twisted pair copper telephone lines can carry two 64 kbps channels plus one 16 kbps-signalling channel. One channel can be used for voice and one for fax or Internet access, etc; or two can be combined for videoconferencing or higher speed Internet access. Several ISDN lines can also be combined, for example, for higher quality video conferencing. ISDN services is generally not been available in Africa, but recently a number of countries have added ISDN services. These are now available in Botswana, Cote d'Ivoire, Egypt, Kenya, Ghana, Mauritius, Morocco, the Seychelles, Sudan, Togo, Tunisia, South Africa and Uganda. But most of these countries do not have ISPs capable of providing ISDN connections and there were only about 40 000 ISDN subscribers across the continent in 2000, half of which were located in South Africa.

Digital Subscriber Line (DSL).

Several variations of DSL technology have been developed that provide data rates of up to 1.544 mbps (T1) downstream over existing copper pair for services such as limited video-on-demand and high speed Internet access. This technology can be used in urban areas where copper wire is already installed, but its range is limited. The DSL will soon be introduced to service homes and offices in Abuja, Nigeria.

Hybrid Fibre/Coax

A combination of optical fibre and coaxial cable can provide broadband services such as TV and high-speed Internet access as well as telephony; this combination is cheaper than installing fibre all the way to the customer premises. Unlike most cable systems, HFC allows two-way communication. The fibre runs from a central switch to a neighborhood node; coax links the node to the end user such as a school, home or residence. Developing countries with HFC projects include Chile, China, India, South Korea, and Malaysia.

Digital Powerline Communication

Recent developments have it that powerline communication is gaining more momentum by the day. Powerline communication digital signals connect the electronics in our home or office through the existing power lines within a building. This communication can be:

- High Speed digital communication
- Telephony
- Smart Homes
- Security
- Health Care Services
- Utilities

This is an interesting development because Africa at the present has a greater penetration of the electricity grid compared to the fixed telecom network. Using powerline communication technologies could have a significant impact on connectivity in the continent [10].

The Nigerian Electrical Power Authority (NEPA) is discussing modalities with a private firm on how to integrate powerline communication into the expansive Nigerian electricity grid.

OTHER TECHNOLOGIES

Other technological innovations that can be used to improve access to communication networks in developing regions include:

Digital Compression

Compression algorithms can be used to "compress" digital voice signals, so that eight or more conversations can be carried on a single 64 kbps voice channel, thus reducing transmission costs. Compressed digital video can be used to transmit motion video over as few as 2 telephone lines (128 kbps), offering the possibility of low cost videoconferencing for distance education and training.

Internet Telephony (Voice over IP)

Packetised voice communication can be transmitted very inexpensively over the Internet. Some carriers are now offering dial-up access to Internet telephony. The advantage of using Internet protocols for voice as well as data is much lower transmission cost than over circuit-switched telephony networks.

Although there is substantial grey-market use of VoIP services in Africa, wherever international bandwidth allows, these are not officially permitted for the end-user anywhere in the region except in Egypt where the national telecom operator provides a PC-to-Phone service. However many telecom operators are now using or planning to use VOIP as a transport layer on their international and internal national links, and operators in countries such as Egypt, Gambia, Nigeria, Senegal, South Africa and Zimbabwe have established joint ventures with international VOIP companies such as ITXC, GatewayIP and Ibasis to implement these facilities.

Community Radio

Small FM community radio stations can be important news sources for the community and can be used to broadcast educational radio programmes for listening both in school and at home or community centres. Some telecentre projects are combining computer facilities with community radio stations. Portable wind-up radio receivers are practical for school and community use.

Inmarsat Regional BGAM

Inmarsat's Regional BGAM satellite IP modem is the world's first low-cost, portable satellite modem. Similar in size to a modern laptop the recently

launched modem uses an IP-based packet data service to transmit data over a satellite connection.

Regional BGAN delivers GPRS-compatible data services in up to 99 countries worldwide (stretching from western Europe and the northern half of Africa, across central and eastern Europe, the southern CIS countries, to the Middle East and the Indian sub-continent) using 144Kbit/s shared channels.

GOVERNANCE AND POLICY ISSUES

Poverty is blamed as one of the major impediments to Internet use in Africa. But it isn't the main impediment. Africa governments are big barriers to progress in many areas of Information Communication Technology development.

There is general agreement among those with long experience trying to bring information communication technology to Africa that the difficulty is highly regulated telecommunications services, usually appearing in the form of moribund state-owned monopoly that is expensive and wary of change-especially a change embodied by a media as potentially subversive as the Internet. African governments have the power to alter these circumstances, and gradually, some are doing so. The response is encouraging.

The signs of progress are unmistakable. Six years ago only 11 countries had any Internet access at all. Now all 54 countries in the continent have permanent connections.

Nigeria for example is opening up its Internet market. With a fifth of Sub-Sahara's population, the country was still a relatively small player in the Internet sector until mid '98 when it only had a few dialup email providers and a couple of full ISPs operating on very low bandwidth links.

Although the relatively low level of ICT penetration amongst the public in Africa has so far limited the use of ICTs for governance purposes, many administrations are beginning to streamline their operations and improve internal efficiencies by adopting ICTs. For example the government of Lesotho recently declared that all announcements for cabinet and committee meetings would be made only by email. Administrations such as those in South Africa, Algeria and Tunisia now provide

immediate global access to tenders via the web. Health and education departments in many countries are beginning to electronically transmit operational (Management Information System) MIS statistics such as disease occurrences and pupil registrations. In South Africa, the results of blood tests are being transmitted to remote clinics that are off the telecom grid via mobile telephone text messages. As greater numbers of public officials are now gaining low-cost access to the web, the vast information resources available via Internet are becoming increasingly important tools in ensuring informed decision-making.

IMPLICATIONS OF WSIS TO NIGERIA/AFRICA

The WSIS process, which began about 2 years ago, had the first phase successfully concluded in Geneva, Switzerland from 10-12 December, 2003. It involved a lot of preparatory meetings at both the national, regional and international level.

In Nigeria two prepcoms were held in June 2002 and July 2003 under the auspices of National Information Technology Development Agency (NITDA), this was to formulate a position and give WSIS process the desired attention, focus and direction in Nigeria. This greatly accounted for high-level participation of Nigeria personally led by Mr. President, Chief Olusegun Obasanjo, GCFR.

In Africa, the Bamako bureau came up with a declaration on African position. The 10 priority areas for Africa were formulated and fine tuned in Tunis all for Africa to gain the advantage of the WSIS in order to leap frog to the newly emerging information society.

Globally prepcom 1-3 were held with prepcom 3 having 2 resumed sessions to fine-tune the two documents. An intersessional meeting was also held in Paris. High-level lobby and consultations were also held in order to have a successful summit.

The Declaration of Principles and the Plan of Action are the two main documents adopted at the WSIS. It took almost 2 years to get the documents ready because inputs were gathered from all stakeholders – 191 member states of the U.N, private sector, civil society etc. The preparatory meetings fine-tuned the documents to produce the best, all encompassing and generally acceptable documents for the adoption of heads of states and government at the WSIS.

While the declaration was made up of sets of policy statements and key principles on the vision of the Information Society we want; the plan of action states the objectives, goals and targets. It involves specific action lines for all stakeholders with benchmarks and provision for follow-up and evaluation of the actions.

The most significant event to have happened to the global Information Society was the WSIS in the sense that all stakeholders came together to address how to solve the problem of digital imbalance i.e. digital divide between countries in the North and those of the South, between the richest and the poorest nations, between the haves and the have not; and even within citizens of the same nationalities.

It was the most relevant opportunity for our heads of states/government to have first hand information on how the power of ICTs is shaping the newly emerging world. The three-day event convinced the heads of government and decision makers who attended from Nigeria, Africa and other developing countries that there is no excuse or escape route from the deployment of ICTs to drive their economy. It helps in getting business and governance done in a faster, cheaper and easier ways by breaking the barriers of space and time among others; thereby, enhancing productivity which are needed for growth and sustainable development.

With the attendance of Mr. President, Senate President, 4 Ministers and other top decision makers in Nigeria, the political will and commitment had been further enhanced. Already the IT Policy is in place and the National Information Technology Development Agency (NITDA) is already implementing it. The policy is very relevant and in line with the plan of action of the WSIS. With more funding in the years ahead, Nigeria will be part of countries to tell success story during the 2nd phase of the summit in Tunis in 2005. All African heads of government are aware that they will give account of their effort in Tunis in 2005 hence; they should definitely have a re-think and really focus on ICT development and deployment as the driving force of their economy.

The Digital Solidarity Fund is important in building capacity, infrastructure and technology transfer. African Heads of State should therefore be committed to it and make it work for others to emulate. Regional initiatives like NEPAD and AISI should also intensify efforts to enhance the implementation of the WSIS process in Africa.

This should be done through more funding of formulation of national e-strategies and its implementation.

International organizations like the UNDP and other organs of the United Nations should be approached with well developed proposal on financing the implementation of the WSIS plan of Action and application of e-strategies in developing countries for them to be part of the "new world" being driven by ICTs.

ICT DEVELOPMENTS AND THE ACADEMIA.

The Internet has become a major tool for research and collaboration within the academia. It is becoming increasingly important to support the large numbers of scientists working in remote areas and having low bandwidth access to the Internet.

Unfortunately a large percentage of scientists from developing countries cannot or can only partially participate or benefit from electronic science due to lack of adequate network capacity or performance and awareness alternatives[8].

There have been efforts from various research centers to ameliorate the connectivity problems being experienced by scientists at the other side of the divide. Some of the low bandwidth applications include:

- **P**ing**ER/**e**JDS MONITORING**: This application makes it possible for researchers from world's poorest nations, where Internet connections can be slow or prohibitively expensive to receive some scientific papers free of charge via e-mail based ICTP electronic Journal Distribution Service (eJDS) [8]. The eJDS procedure is similar to that used when connected to any Web server by selecting hyperlinks. The PingER monitoring is used to do the initial performance monitoring of remote research sites before the deployment of eJDS.
- **Virtual Laboratory Approach [9]:** The VL approach is geared at promoting research and education in developing countries thereby helping reduce the technology gap of the digital divide. Virtual Laboratories are projects that involve collaborative research carried out over a distance, the performance of remote (or distributed) computing, and the sharing of data between groups of scientists, each of whom remain in their home institutions. Software applications that support
    - **Person-to-person (P2P) communication tools** which include email collaboration tools, Collaborative Document Authoring tools, Group and Community Calendars, on-line Discussions, VoIP tools etc. A toolkit on ***Virtual Laboratory*** was developed for UNESCO by the Institute for Informatics of

the Technical University of Freiberg (Germany) in cooperation with the COPINE Centre of the Obafemi Awolowo University (Ile-Ife, Nigeria) and the collaboration of the Shanghai Research Centre for Applied Physics (China).

- **Shared scientific data – synchronization** for exchange of scientific data among different computing environments using the Internet as a tool.
- **Shared WorkSpaces tools** that help scientists to share instruments and thoughts, scientific and technological programmes. These include Basic System for Collaborative Work (BSCW), Virtual Network Computing (VNC), Vmware, Collaborative Virtual Workspace (CVW), etc.
- Others include Instrument Control/Data sharing tools and peer-to-peer computing (metamachines).

GENERAL FACTORS

Tax

Most tax regimes still treat computers and cell phones as luxury items, which make these almost exclusively imported commodities all the more expensive, and even less obtainable by the majority. Although there have been notable efforts in some countries to reduce duties on computers, however communications equipment and peripherals are still often charged at higher rates.

Brain-Drain

Perhaps an even greater problem is that the brain drain and generally low levels of education and literacy amongst the population has created a great scarcity of skills and expertise (at all levels, from policy making down to end-user). Rural areas in particular suffer with even more limited human resources. Along with the very low pay scales in the African civil service, this is a chronic problem for governments and NGOs who are continually losing their brightest and most experienced to the private sector. This situation is not unique to Africa or other developing countries, but is also being faced by the developed world where infrastructure demands have outpaced the supply of experienced staff. However this is simply exacerbating the situation in Africa, because experienced technicians, even from the local private sector, are able to find much higher paying jobs in Europe and North America.

Bureaucratic Bottlenecks

Finally, the general business climate for increased investment in Africa, acutely needed for the ICT sector, has suffered from the well known problems of small markets divided by arbitrary borders, non-transparent and time-consuming procedures, limited opportunities (due largely to the historic pattern of monopolies and high levels of state control), currency instability, exchange controls and inflation.

The African Union and their programme, the New Partnership for African Development (NEPAD), supported by the international community, is addressing these systemic issues. This many-faceted effort is aimed at accelerating Africa's development and could as a result help to create an environment more conducive to the rapid adoption of ICTs. This great responsibility is vested on the ICT arm of NEPAD – the e-Africa commission. The e-Africa Commission will be responsible for developing policies and strategies and projects at the continental level as well as managing the structured development of the ICT sector in the context of NEPAD.

REFERENCES

1) **"Solving the connectivity problem", UNESCO Asia-Pacific Regional Bureau for Education**, Bangkok, Thailand.

2) **"Decision-Maker's Guide to Offering Web-to-Email Service in Your Institution"** Prepared by the **BELLANET INTERNATIONAL SECRETARIAT, 2001**

3) **"Internet Access & International Bandwidth ICT Maps, http://www3.wn.apc.org/africa/afrmain.htm#one**

4) **"The African Internet - A Status Report", http://www3.wn.apc.org/africa/afstat.htm**

5) **"AITEC Releases African Communications Infrastructure and Services Report 2002/03", http://www.apc.org/english/rights/africa/news-content.shtml?x=6639**

6) **"Africa goes online",** Daniel Akst and Mike Jensen, Carnegie Corporation of New York (2001). http://www.carnegie.org/reporter/02/africa/

7) **"Multi-Purpose Smart Card for Tertiary Institutions",** published by Vanguard Nigeria (Dec. 2002). http://allafrica.com/stories/200212110648.html

8) **"Monitoring the Digital Divide",** E. Canessa and W. Matthews (March, 2003)

9) **"Virtual Laboratory Strategies For Data Sharing, Communications And Development",** E. Canessa et. Al (Aug. 2002).

10) **"Digital visions for Africa",** Mike Jensen (Sept. 2002). An Article in **Computers in AFRICA.**

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