# FEASIBILITY STUDY
## Internet Connectivity
## For the Nigerian Universities Network
## (*NUNet*)

Project: 00-121

Prepared for

**COL International & The World Bank**

Vancouver, BC and Washington, DC

Prepared by:

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West Vancouver, BC

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# 1. INTRODUCTION

Anthony C. Gardiner ("the Consultant") has been retained by COL International ("COL") to undertake a World Bank ("the Bank") funded feasibility study, conceptual design and cost estimate for a project to support the Internet connectivity requirements of the Nigerian Universities Network (*NUNet*). Terms of reference are included in Appendix A. It is important to note that this study has focused primarily on the transmission aspects of *NUNet* connectivity to the Internet, as opposed to university and NUC Intranet (LAN, WAN, PC's) requirements.

The content of the various sections of this report focuses on the Internet connectivity requirements of the Nigerian Universities Commission, its member universities and, *de facto*, the Nigerian Universities Network - *NUNet*.

Documentation with respect to the telecommunications requirements of *NUNet* and the totally inadequate services available to Nigerian universities is prolific. A list of individuals and organizations interviewed by the Consultant is listed in Appendix B. A bibliography of the more relevant material reviewed by the Consultant is listed in Appendix C, and an up-to-date description of Internet status in contemporary Africa is included for reference purposes as Appendix D. Appendix F describes the groundwork behind the technology assessment and is fairly technical in nature; for this reason it is included as an appendix.

# 2. *NUNet* TODAY

## *a) NUNet* - The Organization

Dr Aminu Ibrahim, chairman of *NUNet* and a staff member of the Nigerian Universities Commission (NUC) has prepared a brief description of *NUNet*, which is included in the report as Appendix E. *NUNet*, for the past five years or so, has been and continues to be the driving force behind Nigerian universities and affiliated organizations attaining Internet connectivity. In addition to serving NUC and the Ministry of Education as the "front-end" manager of university networking, *NUNet* and its staff serve as a resource centre to assist universities - especially those with limited technical resources - in developing their local area networks (LAN's), inclusive of hardware and software.

Meetings were held with almost all NUC staff comprising *NUNet*. The Consultant found the skill level, expertise and enthusiasm for *NUNet* to achieve a high penetration of Internet connectivity to be very high. Dr Ibrahim is clearly the "champion" of bringing *NUNet's* objectives to fruition.

### *b) NUNet* - The Missing Link

Nigerian universities have barely emerged from the dark ages with respect to their access to telecommunications services, inclusive of telephone, facsimile and access to the Internet and other data networks. It would appear that there are several reasons for this unfortunate legacy. First, the present Telecommunications Act has precluded the universities from bypassing Nigerian Telecommunications Ltd (NITEL) and building their own communications infrastructures. Second, funding has not been readily available for reasons unknown to the Consultant. Third, Nigerian universities have been developed away from major urban areas, and consequently, removed from most of the country's existing telecommunications backbone arteries.

As many have so eloquently stated, in order for Nigerian universities to make their mark in terms of post-secondary education in Nigeria, and indeed all of Africa, they absolutely must have full and unrestricted access to the Internet. Unimpeded and reliable Internet connectivity will facilitate:

i. a fast-response exchange of E-mail within and beyond the universities;
ii. university-specific web sites with links to campus libraries, faculties, teaching staff and students;
iii. a medium to enable distance education institutions to truly teach students remote from teaching centres; and
iv. download capacity to import research material in a timely manner from the global network of research and educational institutions.

### *c) NUNet* - Solutions

The only way that full Internet connectivity can be made available to the universities is to provide properly dimensioned outgoing and incoming bandwidth capability between each campus and the Internet. This connectivity must be error-free, reliable, dedicated (i.e. not limited to certain times of the day or night but full-time or near full-time), and affordable.

At present, in the absence of high-capacity fiber optic submarine cable landings in Nigeria, and in the absence of any high-capacity microwave systems between Nigeria and the Internet-developed countries, the only vehicle to provide the necessary service is satellite, supported by terrestrial fiber optic cable and/or microwave links to interconnect local area networks in geographically dispersed campuses.

The options for connectivity are, therefore:

i. contract with NITEL to provide the required bandwidth capacity to the universities;
ii. contract with an existing ISP to provide service; or
iii. develop a dedicated university Internet infrastructure.

Arguments will be presented later in this report for disregarding the first option and proceeding with either ii) or iii).

## 3. POLICY & REGULATORY ISSUES

In order to conduct a study of the Internet connectivity requirements of *NUNet* it has been necessary to look at the present policy and regulatory framework of Nigeria, followed by an assessment of imminent policy changes that could be advantageous to *NUNet*. This was facilitated by meetings with senior officers of the Ministries of Communications and Education, the Nigerian Communications Commission (NCC), and the Chief Executive Officer of NITEL. Prior to these meetings, however, the Consultant familiarized himself with the new draft "National Policy on Telecommunications" and the House of Representatives' "Review of National Policy on Telecommunications - Preliminary Report." Both documents are too long to be appended to this report but are readily available in PDF format at the Consultant's office.

The draft policy document released in October 1999 is the outcome of a workshop sponsored by the Ministry of Communications and open to all stakeholders. The second document summarizes a four-day public hearing to gather input on the draft policy sponsored by the House Committee on Communications organized in November 1999 - open to stakeholders from the public and private sectors.

The Policy deals with substantial sector reform, acknowledging the meager performance of NITEL since its inception in 1985 and citing "....serious repercussions in terms of inefficiency, expensiveness and lack of universal access that have characterized the industry." One of its major objectives is to ensure that government divests itself of the financial interests in state-owned telecommunications entities. While the policy document is presently in draft form, the Ministry of Communications plans to release a finalized version by the end of July 2000.

The House Committee's report is very critical of the Ministry of Communications, NITEL and the NCC and, amongst many issues, recommends:

i) deregulation of the carriage of international traffic into and out of Nigeria;
ii) introduction of anti-trust laws and regulations to ensure fair competition and pricing;
iii) development of legislation which will protect the rights and privileges of the telecommunications consumer;
iv) definition of conditions for interconnectivity for Internet for all operators; and
v) approve and set in motion the immediate implementation of Nigerian Universities Network (*NUNet*) with a view to "..ending the intellectual isolation of Nigerian students, teachers and researchers."

The policy and regulatory portion of this project considers:

i) the legality of *NUNet* being licensed to transmit and receive frequencies for both terrestrial and satellite facilities for national and international communication;
ii) the legality and availability of NITEL, other government agencies operating telecommunications infrastructures and NITEL competitors to provide services to *NUNet*; and
iii) the probability of acceptance of the draft policy and subsequent revisions to the Telecommunications Act.

Under present law the only entity in the country permitted to operate an international gateway in Nigeria is NITEL. However, the Act was written when almost all international traffic was voice. Early administrations (in the 1990's) did, in fact, license a number of Internet Service Providers (ISP's) - in essence violating the Act - several of which are substantial service providers today.

Toward the end of 1990 the House of Representatives held an open forum to review a new draft policy on telecommunications. Both government officials and the private sector sharply castigated NITEL for its inability to meet the demand for telecommunications services stating "...the likes of NITEL, NNPC, Nigerian Railways and NPA have neither brought succor to the Nigerian subscriber nor information technology based improvements in the efficiency of these government-owned agencies."

Even the CEO of NITEL acknowledged that his company will be privatized within the next few years and will be required to operate within a competitive framework in which other private operators are licensed to provide voice and data communications services.

In summary, it is the Consultant's view that *NUNet* will be able to pursue a program of

Internet connectivity deployment independent of other government and non-government agencies, using those entities where economically and technically viable.

## 4. NITEL AS A *NUNet* INTERNET SERVICE PROVIDER

With its current telecommunications infrastructure throughout Nigeria NITEL should be the candidate of choice to provide Nigerian universities with high capacity Internet bandwidth. However, the reality is that:

i) NITEL's international tariff structure is amongst the highest in the world with rates that would make Internet access completely unaffordable to *NUNet*;
ii) the number of NITEL POP's is limited as several existing ISP's and other private operators requiring ES-1 service (1.544 Mbps) have found out, limiting many universities to dial-up service with throughput speeds of 2400 bps to a maximum of 56 kbps;
iii) since the majority of the university campuses tend to be remote from cities, outside or external plant is lacking, compounding the difficulty of accessing the Internet;
iii) existing dial-up service to those universities which are fortunate enough to have it, tends to be extremely **unreliable**;
iv) existing dial-up service to those universities which are fortunate enough to have it, tends to be extremely **expensive**;
v) many of the NITEL exchanges to which the universities are connected are analogue and very congested resulting in frequent busy circuit signals and loss of service during transmission;
vi) maintenance and customer support has been poor and undependable;
vii) bills are not given to the subscriber universities and NITEL frequently terminates services when bills are held for questioning;
viii) bills are extremely difficult to **pay**, with NUC dedicating two desk-officers **full-time** to handle financial transactions with NITEL; and
ix) applications for new lines require months to process and in many cases NUC must pay for the construction of new poles and cables in order to get service.

For the above reasons, and since minimal infrastructure would be duplicated by implementing a private VSAT system, the Consultant discourages any consideration of NITEL as a provider of Internet services to *NUNet*.

## 5. NUNet CURRENT DEVELOPMENT PLAN

Various faculty staff at Nigerian universities have proposed Internet connectivity plans, perhaps the most comprehensive of which are "Draft of *NUNet* National Topology" by E E Ekuwe, Lanre Ajayi and Mike Osamor, and "The Nigerian Universities Network (*NUNet*) Project" by Dr M A Ibrahim and.

The former plan identifies four scenarios. The first scenario assumes five points of presence: Lagos, Abuja, Bauchi, Kaduna and Port Harcourt, and is highly dependent on the NITEL network to carry traffic. The second assumes the use of ISP's by the universities and is also dependent on dial-up connections through NITEL. The third scenario has only the NUC in Abuja connecting to an ISP with the universities accessing NUC via the NITEL network. The fourth is a hubbed VSAT network but still depends on NITEL as an ISP.

Dr Ibrahim's proposal limits itself to VSAT solutions and estimates the EF&I (Engineer, Furnish and Install) cost, and the annual recurring costs for a single location at a speed of 1 Mbps.

After a comprehensive analysis of the policy, regulatory and existing transmission infrastructure in Nigeria, the Consultant endorses Dr Ibrahim's approach and takes it to a much more detailed level of design, costing and presentation of options.

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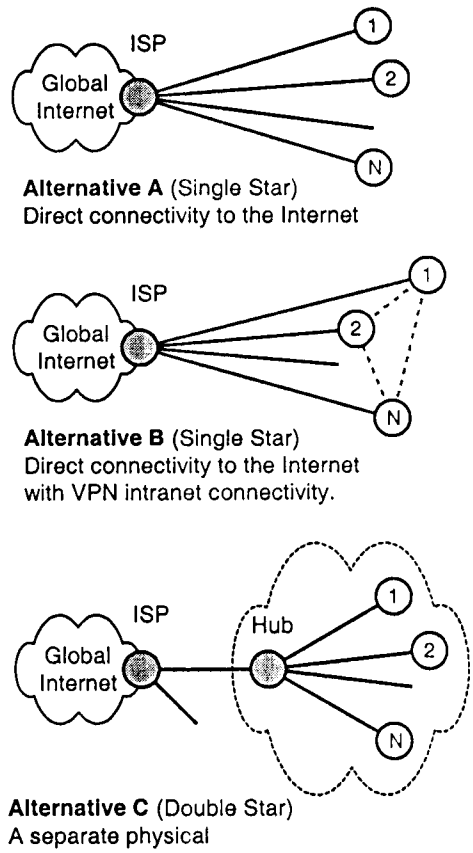
# 6. RECOMMENDED INTERNET CONNECTIVITY PLAN & COSTING

## NUNet Configuration Alternatives

Extending the above discussion and as shown in Figure-1, we see that the *NUNet* can be implemented in a variety of ways, specifically:

- **Alternative A:** As a single star physical topology with direct connectivity to the Internet.
- **Alternative B:** As a single star physical topology with direct connectivity to the Internet and a virtual private network (VPN) for the intranet function.
- **Alternative C:** As a double star physical topology with a separate physical intranet linking the universities together. While this would be a star topology, some high-end systems would permit direct physical connectivity to be implemented on links with high direct traffic (i.e., "mesh" connectivity).

**Figure-1**
**Alternative NUNet**




**Alternative A** (Single Star)
Direct connectivity to the Internet

**Alternative B** (Single Star)
Direct connectivity to the Internet with VPN intranet connectivity.

**Alternative C** (Double Star)
A separate physical intranet linking the universities together.

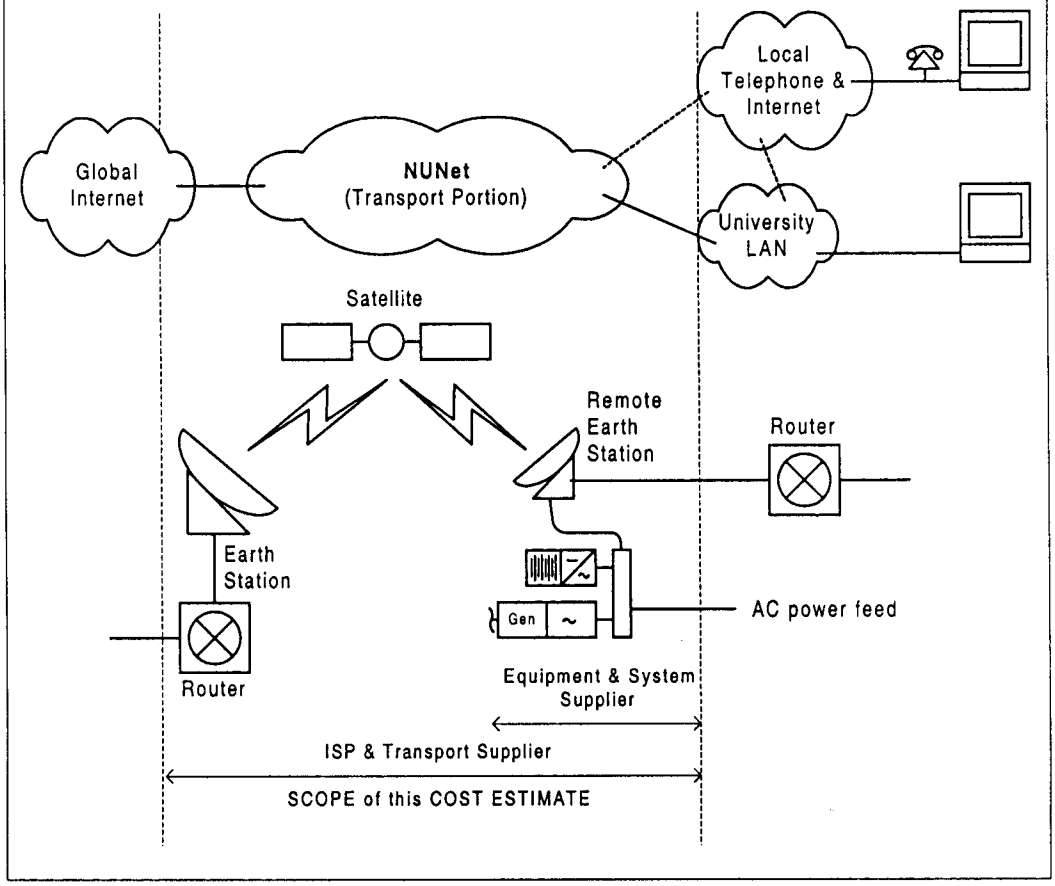
Which alternative to choose depends on the relative importance attached to evaluation criteria such as costs, security and network ownership and control issues. Two vital points: first, costs depend on traffic volumes; and second, the alternatives are not mutually exclusive -- i.e., the network can be a mix of configurations and/or begin as configuration A and progress to configuration C in phases.

Considering that initially most traffic will be with the global Internet, a phased progression from Alternative A to C would be logical (see Appendix F, Figure-F7 for a cost trade-off graph). How fast and how far this progression proceeds will depend on traffic levels and budgets. Beginning with Alternative A also minimizes the performance risks associated with TCP over 2 satellite hops. And clearly as next generation broadband satellite access networks emerge, transition strategies can be evolved.

## NUNet Cost Estimate

Preparing a preliminary design upon which to base a cost estimate for the NUNet project was hampered by a lack of traffic forecasts. In the absence of these forecasts, or adequate data upon which to make forecasts, in this report we have provided cost estimates for a range of terminal earth station solutions with different capacities (see Figure-3). It should be noted that Ku band systems are listed in Figure-3; however, as noted in Appendix F, there is currently a lack of Ku band coverage over Nigeria.

**Figure-2**
**Scope of NUNet Cost Estimate**




Many components are necessary to provide a complete end-to-end system. Figure-2 illustrates the scope of our cost estimate. The following are key assumptions upon which the estimate is based:

- The project will have access to wholesale carrier rates for transponders, especially on international routes.
- Direct global Internet connectivity (single star).
- There is provision in the costs for standby power (UPS and/or diesel generator set), essential at Nigerian universities.
- Adequate building floor space, including air conditioning or sufficient ventilation, is assumed available.
- There is no provision for any costs associated with land acquisition for the antennas.

Cost data was obtained from in-house resources and informal information requests from a sample of prospective suppliers.

**Figure-3**
**Cost Estimate for a Range of Earth Station Terminal Solutions**

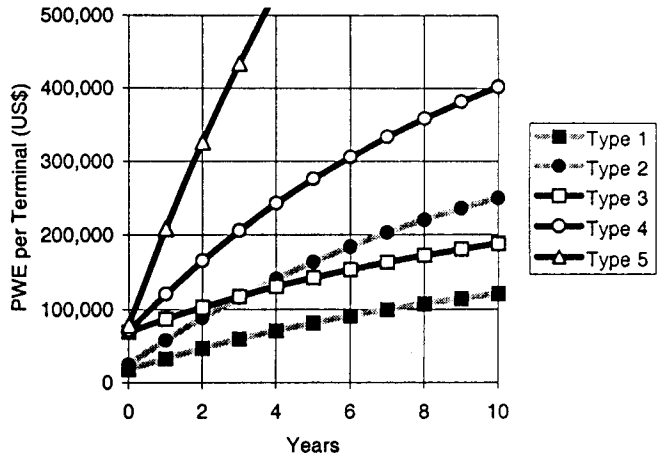
| # | Description | Note | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 |
|---|---|---|---|---|---|---|---|
| | TERMINAL CHARACTERISTICS | | | | | | |
| 1 | Link Types | | | | | | |
| | Up Link | | Dial-Up | Dial-Up | Satellite | Satellite | Satellite |
| | Down Link | | Satellite | Satellite | Satellite | Satellite | Satellite |
| 2 | Frequency Band | N01 | C | Ku | C | C | Ku |
| 3 | Capacity Range (kbps) | N02 | | | | | |
| | Up Link | | ~ 8 - 30 | ~ 8 - 30 | ~ 10 - 40 | ~ 30 - 128 | ~ 128 - 384 |
| | Down Link | | ~ 64 - 128 | ~ 128 - 1024 | ~ 64 - 128 | ~ 184 - 1024 | over 1024 |
| 4 | Nominal Capacity (kbps) | N03 | | | | | |
| | Up Link | | 10 | 10 | 16 | 64 | 128 |
| | Down Link, Minimum | N04 | 90 | 350 | 64 | 256 | 1,024 |
| | Down Link, Maximum | N05 | 400 | 2,048 + | 1,024 | 1,024 | 10,000 |
| | TERMINAL COSTS | N06 | | | | | |
| 5 | Capital Investment | N07 | | | | | |
| | Equipment Supply | | 9,500 | 13,000 | 36,000 | 37,000 | 41,000 |
| | Installation Complete | N08 | 6,500 | 8,800 | 24,500 | 25,200 | 27,900 |
| | Contingency | N09 | 2,400 | 3,300 | 9,100 | 9,300 | 10,300 |
| | Total Capital Cost | | 18,400 | 25,100 | 69,600 | 71,500 | 79,200 |
| 6 | Annual Operating | | | | | | |
| | Transponder | N10 | 14,000 | 31,000 | 15,000 | 45,000 | 122,000 |
| | Maintenance | N11 | 500 | 700 | 1,800 | 1,900 | 2,100 |
| | Contingency | N09 | 2,200 | 4,800 | 2,500 | 7,000 | 18,600 |
| | Total Annual Cost | | 16,700 | 36,500 | 19,300 | 53,900 | 142,700 |

Notes

N01 Ku band transponder coverage is generally not available over Nigeria at this time.
N02 The capacity range is the typical range for this type of terminal.
N03 The nominal capacity is the capacity used to calculate transponder costs.
N04 The minimum down link rate is the average carrier capacity available to a user on a shared link.
N05 The maximum down link rate is the total carrier capacity (burst rate).
N06 All costs are per terminal.
N07 Capital costs assume an existing hub; otherwise see N12.
N08 Installation includes allowances for the following:
engineering, integration, shipping, installation, test, training, spares, test equipment, special tools & project management.
N09 An overall contingency of 15% has been applied.
N10 For Type 1 & 2, transponder cost includes dial-up allowance for the return (up) link.
N11 **Maintenance has been calculated based on 5% of Equipment Supply costs.**
N12 If a hub station is required, then add $400 thousand to $1 million overall or add $10 to 25 thousand per terminal, assuming 40 terminals total.

The cost estimate is summarized in Figure-3. To illustrate the costs of networks based on each type of terminal, Figure-4 shows the cash flow in present worth of expenditure of usage very quickly dominates total project cost. Figure-5 compares the relative cost per unit of capacity.

**Figure-4**
**Present Worth of Expenditures Cash Flow Comparison**

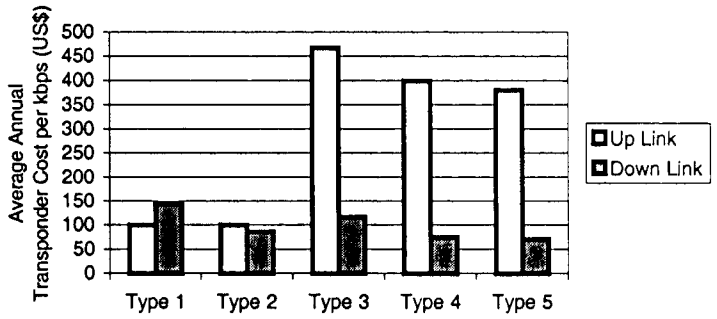



Note The PWE (Present Worth of Expenditures) is based on a discount rate of 10%. See Figure-11 for Types.

All terminals need not be the same; however, they should be compatible and from a single product line1. Therefore, depending on specific needs, a range of terminals and delivery capacities may be easily implemented and flexibly changed with time.

Actual costs may vary widely depending on the specific requirements specified, the scale of the procurement, degree of competition engendered by the procurement process, and the vendors perceived risk (e.g., a function of funding certainty). For example, a small 2 or 3 terminal project in isolation will attract limited competition and result in higher unit costs. For a full scale (40-campus) procurement, which may be in phases, the cost estimates are accurate to within a budgetary accuracy of +/- 20% with a 90% confidence level.

**Figure-5**
**Relative Cost per Unit of Capacity Comparison**




Note: This is based on figures and terminal types from Figure-11.

In summary, the total capital and operating costs for *NUNet* to achieve full Internet connectivity are included in Figure 3. These are unitary costs and may be extrapolated for any number of university campuses. Obviously larger quantities will yield greater

1 Compatibility provides reconfiguration and redeployment flexibility, and minimizes training and sparing issues.

discounting of the overall service, especially through the mechanism of international competitive bidding.

Should *NUNet* proceed with this project it is recommended that build-operate-transfer (BOT), build-transfer-operate (BTO) or build-operate-own (BOO) options be considered which allow for a ten to fifteen year period of technology transfer and eliminate the requirement for *NUNet* to muster the large capital resources required for such a large investment.

## 7. RECOMMENDED INTERIM PLAN (6 MONTHS)

The previous section has dealt extensively with Internet connectivity solutions, their implementation issues, capital and operating costs. This section outlines a six-month program of activities designed "....to get *NUNet* well underway prior to the formal commencement of the eventual World Bank project."

The Consultant recommends that an Intranet[2] Expert be retained for a continuous period of six months whose duties will include:

i) a comprehensive review of the Intranet facilities of all of the campuses scheduled for Internet connectivity;
ii) working with *NUNet* and the MIS supervisors of the universities to develop designs, capital and operating costs for Intranet facilities required to accommodate Internet connectivity;
iii) develop and present a series of training seminars to be hosted by *NUNet* and made available to MIS staff from all of the universities; and
iv) work with an Internet Connectivity Expert to develop specifications and tender documents suitable for a BOT/BTO/BOO contract, direct purchase by NUC, contract through an ISP or hybrid contract.

The Consultant recommends that an Internet Connectivity [3] Expert be retained for a

[2]Defined as all facilities inclusive of local area networks, wide area networks, hubs, routers, structured cable facilities, PC's, network software (Windows NT, Unix, Novell, Linux, etc.), PC hardware configurations and a general and wide variety of applications software.

[3]Inclusive of satellite transmission facilities (star, mesh, hub stations, etc.) and service providers, especially VSAT, Internet access, ISP's, power systems, terrestrial microwave links, fiber optic systems (aerial and buried) and routers.

continuous period of six months whose duties will include:

i) expand on the alternatives presented in the previous section of this report, update as required and fine-tune new technology options which will be available in 2001 and 2002;
ii) conduct a number of seminars at NUC on Internet connectivity including technical issues, service-providers, terrestrial microwave planning including transmission path analysis, RF frequency planning, antenna & power systems, tower design and positioning, multiplexing, fiber optic cable planning including fundamentals of light transmission, wave modes, amplifiers, transmitters, receivers, regenerators, power systems, router termination and construction planning (aerial and buried); and
iii) work with an Intranet Expert to develop specifications and tender documents suitable for a BOT/BTO/BOO contract, direct purchase by NUC, contract through an ISP or hybrid contract.

The Intranet expert should have a minimum bachelor's degree in computer science (or equivalent) from a recognized university and at least five years experience in the planning, design, tendering and training consistent with the requirements outlined above. Some experience in developing countries would be an advantage and fluent writing skills are essential.

The Internet Connectivity expert should have a minimum bachelor's degree in electrical engineering from a recognized university and at least ten years experience in the planning, design, tendering and training consistent with the requirements outlined above. Some experience in developing countries would be an advantage and fluent writing skills are essential.

It is also recommend that a procurement specialist, familiar with World Bank international competitive bidding (ICB) procedures be retained for a period of one month (toward the end of the six-month period) to work with the two technical experts in developing tender documents.

It is further recommended that a four-wheel drive vehicle be provided to the Intranet Expert and available to the Internet Connectivity Expert whilst in-country, with sufficient funding for fuel, service and maintenance support throughout the six-month period. It is suggested that this vehicle be turned over to *NUNet* at the end of the six months.

Finally, the Consultant recommends that approximately $100,000 be allocated to the provision of a VSAT earth station to be installed on the premises of the NUC, capable of providing at least 1 Mbps up/down capacity - the exact details for which will be scoped

by the Internet Connectivity and Intranet Experts in consultation with the *NUNet* team. This budget should be inclusive of all EF&I costs for equipment and one year's operating costs (inclusive of space segment and Internet access charges).

## TABLE 1 – COST ESTIMATE FOR 6-MONTH TECHNICAL ASSISTANCE

| Item | Description | Cost/mo | Months | Total |
|---|---|---|---|---|
| 1 | Intranet Expert | $30,000 | 6 | $180,000 |
| 2 | Internet Connectivity Expert | 30,000 | 6 | 180,000 |
| 3 | Procurement Specialist | 20,000 | 1 | 20,000 |
| 4 | Airfare (3 trips @ $5,000 ea) | | | 15,000 |
| 5 | 4-wheel drive vehicle (2) | 30,000 | | 60,000 |
| 6 | Domestic travel incl'g vehicle expenses | | | 20,000 |
| 7 | VSAT Earth Station inlc'g one year's operating costs | | | 100,000 |
| | **TOTAL:** | | | $575,000 |

**Note:** Costs for Experts inclusive of accommodation & living allowance.

# APPENDIX A

# CONSULTANT'S TERMS OF REFERENCE

TERMS OF REFERENCE

# Feasibility Assessment of the Nigerian Universities Network (*NUNet*)

Commonwealth of Learning International
(Lead consultant: Anthony C. Gardiner)

## BACKGROUND

Nigeria's federal university system comprises 24 national institutions of higher learning, nearly 300,000 students, 13,000 academic staff, and an oversight parastatal body called the National Universities Commission (NUC). The National Universities Commission is responsible for financial planning and budgeting for the system, approving the physical development plans for each campus, endorsing the introduction of new degree programs, accrediting university courses, approving the establishment of private universities, and advising the Government on higher education matters.

In late 1996 the forward-looking Executive Secretary of the NUC used the remnants of funding remaining under a seven-year World Bank project in support of the federal universities system to provide a few university staff with an introduction to computerized electronic networking at the International Centre for Theoretical Physics in Trieste, Italy. Some 20 persons participated in an intensive one-month course. They returned to the NUC with computers and associated hardware that were used to mount a network training laboratory at the NUC.

During the past four years the NUC has continued to develop the Nigerian Universities Network, or *NUNet*, as it is called. Funds have been limited and development has been slow. Nevertheless, significant advances have been made. *NUNet* currently functions as a dial-up email system that connects 23 of the 24 federal universities to a server at the NUC that is in turn linked to the ICTP in Trieste. Each campus contains a small computer room where staff may establish personal email accounts and access the network on a first-come, first-served basis. Internet connectivity does not exist at this time. *NUNet* committees have been established at each university to promote and coordinate these networking facilities.

More importantly, a National Technical Consultative Committee (NTCC) for *NUNet* was created in 1997 to plan and develop the system. This Committee includes representatives from four universities, the Nigerian Communications Commission, the Nigerian Internet Group, the ICTP, and the *NUNet* Chairman at the NUC. The NTCC has developed several draft proposals on choices of technology, organization topology, and costs of setting up the *NUNet* national backbone structures. A field survey questionnaire has been developed to assess the state-of-readiness among universities for Internet connectivity and the survey will be undertaken shortly.

During 1999 the NTCC benefited from the guidance of an American Fulbright Scholar, Clifford Missen, who was based at the University of Jos. The proposals developed with Mr. Missen's collaboration are posted at: http://www.widernet.org/nigeriaconsult and at: http://www.widernet.org/proposals

In the effort to build a subscriber base and a broader foundation of political support for *NUNet*, the NUC recently invited other educational and research institutions in Nigeria to participate in this network. Favorable replies have already been received from the Federal Ministry of Science and Technology, the National Planning Commission, the Nigerian Examinations Council, the Nigerian Institute for Social and Economic Research, and the National Teachers' Institute.

The Government of Nigeria recently requested World Bank support for a second project in support of the federal university system. A major priority is the establishment of the *NUNet* and associated Internet connectivity. This is seen as a way of significantly improving communications among institutions and researchers, of overcoming the inadequacies of university libraries by enabling access to "digital libraries," of updating and expanding educational offerings through participation in "virtual universities," and of reducing the pressures for brain drain by enabling researchers to participate in international research teams and consultancies. For its part, the World Bank views *NUNet* as an essential tool for good project management (e.g., project procurement, activities coordination, and financial management). For this reason, financial support for *NUNet* implementation is likely to form the basis of the Bank's first actions under this project.

## OBJECTIVES

The consultant is expected (a) to assess the technological feasibility and cost-effectiveness of the current development plan for *NUNet*, (b) to recommend appropriate modifications that may improve performance and/or reduce cost, and (c) to design and budget a six-month "step one" action plan intended to move *NUNet* as far towards Internet connectivity as possible prior to project commencement in early 2002.

## ISSUES

- What technology and organizational topology are likely to prove most reliable under Nigeria's diverse and often uncertain power supply and telecommunications constraints?
- What are the legal and regulatory impediments to the proposed plans for *NUNet* and how might these best be addressed?
- What can be done to maximize the possibilities for establishing a financially sustainable electronic network?

- What is the most appropriate management structure for *NUNet*? The most appropriate governance structure?

- What key capacities (e.g., staffing profiles, equipment specifications) must be put in place (e.g., at the NUC, at the universities, elsewhere, etc.) in order to ensure the success of this undertaking?

- What kinds of human resource development activities should accompany the development of *NUNet*?

- What types of local and international partnerships, if any, should be pursued in order to bolster this undertaking?

## METHODOLOGY

The consultant will work with a NUC-assigned counterpart, Dr. Aminu Ibrahim, the current NUC Chairman for *NUNet*. They will be assisted by Mr. Peter Ijeh, manager of the electronic network in the World Bank office in Abuja. Consultations will be undertaken in Nigeria with NTCC members, relevant government regulatory agencies (e.g., National Communications Commission, National Frequency Management Board, National Broadcasting Commission, etc.), and the 10 *NUNet* engineers trained at ICTP during 1999. Visits to four university campuses (Jos, Zaria, Nsukka, Lagos) will be included. Prior to departure for Nigeria, the consultant is requested to hold telephone consultations with Dr. Aminu Ibrahim, with the appropriate ICTP representative in Trieste, with Mr. Clifford Missen at the University of Iowa, and with Mr. Peter Ijeh and William Saint of the World Bank. The NUC is requested to propose a tentative schedule and logistical/travel arrangements for these various meetings and visits.

## OUTPUTS

The consultant is expected to produce the following outputs by July 15, 2000:

1. A written report that assesses the feasibility and cost-effectiveness of the current *NUNet* development plan, and that proposes technical and organizational modifications to the plan considered necessary to assure its technical and financial sustainability.

2. A written plan of action and associated budget for an initial six-month period of activities designed to get *NUNet* well underway prior to the formal commencement of the eventual World Bank project. This plan and budget will serve as the basis for a Project Preparation Facility (essentially an advance against the eventual approved project financing) of no more than USD 600,000. The Project Preparation Facility will be discussed during the World Bank Identification Mission scheduled to begin on July 18th.

| | | |
|---|---|---|
| Consultations in Nigeria | | 10 days |
| Report preparation | | 5 days |
| | TOTAL | 23 days |

h Airways is the required airline for Bank staff and consultants traveling to Abuja, Nigeria since it is y international airline that services Abuja.

# APPENDIX B

# PERSONS INTERVIEWED (CHRONOLOGICAL)

## PEOPLE INTERVIEWED (Chronological order)

| Name | Title | Organization |
|---|---|---|
| Dr M A Ibrahim | Deputy Director of Research | National Universities Commission |
| Fidelis Onwuhne-Osuji | Chief Programmer | National Universities Commission |
| Matthew Ezeh | System Administrator | National Universities Commission |
| Richard Kwalmi | Asst System Administrator | National Universities Commission |
| Faruk Mal. Lawal | Research Officer | National Universities Commission |
| Olatunji Popoola | Academic Planner | National Universities Commission |
| Adamu M Ibrahim | MIS Unit | National Universities Commission |
| Abohulsafami Ritwannu | Library Unit | National Universities Commission |
| Sam Onazi | Principal Finance Officer | National Universities Commission |
| John Mairafi Ahmadu | Snr Personnel Officer | National Universities Commission |
| Prof Munzali Jibril | Executive Secretary | National Universities Commission |
| John Mairafi | Secretary | National Universities Commission |
| Tunde Adekola | Education Consultant | World Bank |
| Peter Ijeh | | World Bank |
| Hon Nduka Irabor | Dep Chairman-Com on Comms | Nigerian House of Representatives |
| Ginigaeme Mbanaefo | Vice Chancellor | University of Nigeria at Nsukka |
| R.O. Ogbuji | Deputy Vice Chancellor, Academic | University of Nigeria at Nsukka |
| C C Chukwu | Deputy Vice Chancellor | University of Nigeria at Nsukka |
| Mr Ukaonu | Bursar | University of Nigeria at Nsukka |
| Mr Ikegbune | Chief Librarian | University of Nigeria at Nsukka |
| Dr A N Nzeako | *NUNet* Chairman | University of Nigeria at Nsukka |
| Prof F O Okafor | Deputy Vice Chancellor | University of Nigeria at Enugu |
| Prof B C Okafor | Provost, School of Medicine | University of Nigeria at Enugu |

| | | |
|---|---|---|
| Goodluck M Nwamarah | Director of MIS | University of Nigeria at Nsukka |
| Prof Uche Modum | Director, Information Tech Centre | University of Nigeria at Nsukka |
| Yayale Ahmed | Permanent Secretary | Ministry of Education |
| Guda Abdullahi | Director Planning & Research | Ministry of Communications |
| Sadeeq Omar | Mgr Admin & Personnel | National Centre for Women Development |
| Florence T Heme | Mgr Training & Development | National Centre for Women Development |
| Prof Monday Manguwat | Vice Chancellor | University of Jos |
| Inusa Daniel Yakmut | *NUNet* Administrator | University of Jos |
| E G Eseyin | Director, Computer Centre | University of Jos |
| Prof L S O Liverpool | Chairman, Computer Services | University of Jos |
| John Athasson | Management Information Systems | University of Jos |
| Daniel Madubuko | Engineer at Computer Centre | University of Jos |
| Edele Anionwu | Administrative Officer | University of Jos |
| Stephen Akintunde | System Librarian | University of Jos |
| Dan Morakinyo | Deputy Director, Commercial | Bureau of Public Enterprises |
| A A Ijasan | Deputy Director | Bureau of Public Enterprises |
| Scholastica Anuta | Deputy Director, MIS | Bureau of Public Enterprises |
| Abdulkareem Adesokan | Deputy Director, Power | Bureau of Public Enterprises |
| Dr O.B. Ojeba | Managing Director & CEO | NITEL |
| John McNeish | Counsellor | Canadian High Commission |
| Abdul-Rahman Ado | Director, Commercial | Nigerian Communications Commission |
| Michael Osime | Chairman | BT Limited |
| Israel Oyeleke | Managing Director & CEO | BT Limited |
| Jean-Pierre Kabanda | Director of Sales, Africa | NEWSkies Satellites (UK) Ltd |
| Ladi Williams | Executive Director | Motophone Communications |
| K G Laxman | Technical | Motophone Communications |
| Adejare Adegbenro | Sales Manager | Motophone Communications |
| Prof Tunde Adeniran | Honourable Minister | Ministry of Education |

# APPENDIX C

# DOCUMENTATION REVIEWED

## DOCUMENTATION REVIEWED

| Title | Author | Date | Description |
|---|---|---|---|
| Federal Republic of Nigeria Official Gazette | Nigerian Govt | 1992-12-31 | Mandate of Nigerian Communications System |
| Position Paper | Dr A N Nzeako, UofN, Nsukka | 2000-06-27 | Internet position & requirements |
| Aide Memoire | W S Saint, World Bank | 2000-04-17 | Nigerian University Initial Mission Report |
| Project Document | World Bank/NUC | 1999 | Sector Investment Credit Project |
| Feasibility Study on Electronic E-mail | National Universities Commission | 1995-02 | Evaluation of E-mail Requirements by Universities |
| Project Report on E-mail Feasibility | World Bank | 1995-11 | Feasibility of E-mail Requirements by universities |
| Two-Day Orientation Workshop | Ministry of Education | 2000-05-09 | Future directions of universities |
| Address by the Minister of Education | Ministry of Education | 2000-05-08 | Address to the President |
| Report No: 20309 | World Bank | 2000-05-18 | Country strategy to the Executive Directors |
| Organizing Campus Information Technologies | L S O Liverpool | 2000-06 | Technology planning for University of Jos |
| Secretariat Statistical Information | NUC | 1998 | Statistical information on universities |
| *NUNet* Linkage Project | M A Ibrahim | Undated | PowerPoint presentation of telecoms infrastructural reqts |
| The Nigerian Universities Network Project | M A Ibrahim | Undated | General description of *NUNet* |
| Entering the Information Age Progress Report | University of Jos | 1999-05 | Progress report on Jos Intranet facilities |
| UNN/CBN Internet Project | University of Nigeria | 1999-12 | Implementation details |
| Proposal for Nigerian Universities Digitization | C C Missen | Undated | Various reports on *NUNet* requirements |
| VSAT Proposal | BT Limited | 2000-06-03 | Proposal for VSAT services |
| Internet Connectivity via VSAT | Motophone | 1999-11-22 | Proposal for VSAT services |
| Point to Point Wireless Facilities | Teledon | 2000-02-18 | Proposal for wireless facilities - NUC and NITEL |
| Proposal for NUC Web Site | Richard Sanusi | Undated | Proposal to design a NUC web site |
| Draft of *NUNet* National Topology | E E Ekuwem | Undated | Options for securing Internet connectivity |
| Review of Nat Policy on Telecommunications | House of Representative | 1999-12 | Minutes of the Communications Sub-Committee's rpt |
| National Policy on Telecommunications | Ministry of Communications | Undated | Most recent policy on telecommunications |
| Nat Centre for Women Devel. | Nat Centre for Women Devel. | Undated | Description of functions of the NCWD |
| About *NUNet* | M A Ibrahim | Undated | Description of *NUNet* |

# APPENDIX D

# AFRICAN INTERNET STATUS

# African Internet Status

May 2000

**Mike Jensen- mikej@sn.apc.org**

The Internet has grown rapidly on the continent over the last few years. At the end of 1996 only 11 countries had Internet access, but by March this year 51 countries had achieved permanent connectivity, with only Somalia and Liberia remaining without local Internet services (Liberia was connected last year, but lost its link when the ISP failed to achieve commercial viability). Nevertheless Internet access in Africa has been largely confined to the capital cities, although a growing number of countries do have POPs in some of the secondary towns (currently 16 - Algeria, Angola, Botswana, DRC, Egypt, Ghana, Kenya, Madagascar, Morocco, Mozambique, Namibia, Nigeria, Tanzania, Tunisia, Zambia and Zimbabwe) , and South Africa has POPs in about 100 cities and towns.

Howeier, In some countries the national telecom operators have made a special policy to provide local call Internet access across the whole country. To do this, the operator establishes a special 'area-code' for Internet access that is charged at local call tariffs, allowing Internet providers to immediately roll out a network with national coverage. With the massively reduced costs for those in remote areas that this provides, it is surprising that so far only 15 of the 53 countries have adopted this strategy - Benin, Burkina Faso, Cap Vert, Ethiopia, Gabon, Malawi, Mali, Mauritius, Mauritania, Morocco, Senegal, Tchad, Togo, Tunisia, and Zimbabwe.

The total number of computers permanently connected to the Internet in Africa (excluding South Africa) finally broke the 10 000 mark at the beginning of 1999 and in Jan 2000 it stood at almost 12 000, an increase of 20% as measured by Network Wizards. The figure may actually be closer to 25 000 to 30 000 due to the measurement technique which cannot count hosts which are not referenced in domain name servers and those that are registered under the generic TLDs - .com, .net, .org. Nevertheless this still means Africa has about as many hosts on the Internet as a small Eastern European country such as Latvia, which only has a population of 2.5 million (compared to the 780m people in Africa's as estimated by Unicef 1998, about 13% of the total world population).

The recent opening up of the Nigerian Internet market is beginning to change this picture as the telecom regulator has licensed 38 ISPs to sell services and about 12 are currently active. With a fifth of Sub Sahara's population, Nigeria has been one of the slumbering giants of the African Internet world which until mid '98 only had a few dialup email providers and a couple of full ISPs operating on very low bandwidth links - few were able to afford the $130 000 a year for an international 9.6Kbps leased line. Nitel has now established a POP in Lagos with a 2MB link to Global One in the US and has put POPs in 4 other cities..

It is difficult to measure actual numbers of Internet users, but figures for the number of dialup subscriber accounts to ISPs are more readily available, for which it is estimated that there are now over 650 000 subscribers in Africa. Of these, North Africa is responsible for about 200 000 and South Africa for 350 000, leaving about 100 000 for the remaining 50 African countries.

Each computer with an Internet or email connection supports an average of three users, a recent study by the UN Economic Commission for Africa (ECA) has found. This puts current estimates of the number of African Internet users at somewhere around 2 million in total, with about 1 million outside of South Africa. This works out at about one Internet user for every 750 people, compared to a world average of about one user for every 35 people, and a North American and European average of about one in every 3 people. (The UNDP World Development Report figures for other developing regions in '99 are: 1 in 125 for Latin America and the Caribbean, 1 in 200 for South East Asia & the Pacific, 1 in 250 for East Asia, 1 in 500 for the Arab States and 1 in 2500 for South Asia). No studies have been made in Africa of the number of rural vs urban users, but it is safe to say that users in the cities and towns vastly outnumber rural users. (See Tables and Graphics for country comparisons).

There are now about 28 countries with 1000 or more dialup subscribers, but only about 11 countries with 5000 or more - Cote d'Ivoire, Egypt, Morocco, Kenya, Ghana, Mozambique, Nigeria, South Africa, Tunisia, Uganda and Zimbabwe. Clearly a number of countries such as those in North Africa and Southern Africa have more highly developed economies and better infrastructures which would 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 market. There are now local Internet Society chapters in all of the African regions and in

most of the countries with large Internet user populations.

Currently, the average total cost of using a local dialup Internet account for 5 hours a month in Africa is about $50/month (usage fees, telephone time included, but not telephone line rental). Nevertheless ISP charges vary greatly - between $10 and $100 a month, largely reflecting the different levels of maturity of the markets, the varying tariff policies of the telecom operators, and the different national policies on private wireless data services and on access to international telecommunications bandwidth. According to the Organization for Economic Cooperation and Development, in '97, 20 hours of Internet access in the U.S. cost $29, including telephone charges. Although European costs were higher ($74 in Germany, $52 in France, $65 in Britain, and $53 in Italy) these figures are for 4 times the amount of access, and all of these countries have per capita incomes which are at least 10 times greater than the African average.

Most African capitals now have more than one ISP and in early 2000 there were about 450 public ISPs across the region (excluding SA, where the market has consolidated into 2 major players with 90% of the market and 40-50 small players with the remainder). Seven countries had 10 or more ISPs - Egypt, Kenya, Morocco, Nigeria, South Africa, Tanzania and Zimbabwe - while 20 countries had only one ISP. Although Ethiopia and Mauritius are the only countries where a monopoly ISP is national policy (i.e. where private companies are barred from reselling Internet services), there are other countries in which this practice still continues, predominantly in the Sahel sub-region where markets are small.

In response to the high cost of full Internet based services and the slow speed of the web, and also because of the overriding importance of electronic mail, lower-cost email-only services have been launched by many ISPs and are continuing to attract subscribers. Similarly, because of the relatively high cost of local electronic mailbox services from African ISPs, a large proportion of African email users make use of the free Web-based services such as Hotmail, Yahoo or Excite, most of which are in the US. These services can be more costly and cumbersome than using standard email software, because extra online time is needed to maintain the connection to the remote site. But they do provide the added advantages of anonymity and perhaps greater perceived stability than a local ISP who may not be in business next year.

There is also a rapidly growing interest in kiosks, cybercafes and other forms of public Internet access, such as adding PCs to community phone-shops, schools, police stations and clinics which can share the cost of equipment and access amongst a larger number of users. Many existing 'phone shops' are now adding Internet access to their services, even in remote towns where it is a long-distance call to the nearest dialup access point. In addition a growing number of hotels and business centres provide a PC with Internet access.

The rapidity with which most African public telecom operators have moved into the Internet services market is also noteworthy. In the last three years PTOs have brought Internet services on stream in 31 countries and similar moves are afoot in three others (Liberia, Somalia and Tanzania). This follows trends in the developed countries where almost all of the PTOs have established Internet services. In many Francophone countries the PTO operates the major value added service provider as a joint venture with France Cable and Radio, called Telecom-Plus in many countries and DTS in Madagascar.

In all the countries where the PTO has established the international Internet backbone, it is the sole International link provider except in Côte d'Ivoire, Nigeria, Mozambique, South Africa and Zambia where they compete with private sector international links. Usually the PTOs operate the international gateway and access to the national backbone, and leave the resale of end-user Internet access to the private sector. In a few countries the PTO also competes with the private sector in the provision of end-user dialup accounts, namely, Cameroun, South Africa and Zambia.

As far as the multinational ISPs are concerned, AfricaOnline (http://www.africaonline.com), is the largest operation. The group is consolidating its year of growth which saw local branches open in Swaziland, Tanzania, Uganda and Zimbabwe, adding to its stable in Ghana, Kenya, and Côte d'Ivoire. AfricaOnline has plans to open up in additional countries over the coming months. The other three multinational ISPs which operate subsidiaries or franchises in the region are now trailing considerably with UUNET just in South Africa, Swaziland, Zimbabwe and Namibia, while Swift Global is in Kenya, Tanzania and Uganda. South African ISP Mweb has recently entered the African market, purchasing ISPs in Namibia, Uganda and Zimbabwe.

Due to high international tariffs and lack of circuit capacity, obtaining sufficient international bandwidth for delivering web pages over the Internet is still a major problem in most countries. Until recently very few of the countries outside of South Africa had international Internet links larger than 64Kbps, but today 24 countries have 512Kps or more, and

15 countries have outgoing links of 1Mbps or more - Botswana, Egypt, Ghana, Kenya, Libya, Madagascar, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, South Africa, Tanzania and Tunisia. Excluding South Africa, the total international outgoing Internet bandwidth installed in Africa is about 55Mbps. However this means that on average about 6 dialup users must share each 1Kbps of international bandwidth, making for slow connections to remote sites.

As a result, a growing number of African Internet sites are hosted on servers that are in Europe or the U.S. This is especially necessary for countries where ISPs operate their own independent international links without local interconnections (peering), such as in Kenya and Tanzania, which means that traffic between the subscribers of two ISPs in the same city must travel to the US or Europe and back. This makes it more efficient to host outside-country, and is also being encouraged because web hosting costs can be very high, while there are even a number of free hosting sites in the US and Europe.

One response to the bandwidth problem is that incoming bandwidth is now starting to outpace outgoing bandwidth following the increasing use of data broadcasting services which are now being installed by ISPs in Africa. These use a DirecPC-type system providing incoming bandwidth of 64Kbps for about US$30-$1000/month (depending on usage). The assymetric service can deliver up to 8Mpbs incoming, while the normal terrestrial phone circuit or leased line is used for all outgoing traffic. This arrangement uses a standard digital KU-Band or C-Band satellite television antenna costing $175-$500 (depending on size required) and a decoder card for the PC costing US$450.

In Southern Africa the service is provided by four South African companies - Infosat (http://www.infosat.co.za), Siyanda (http://www.siyanda.co.za), Hixsat (http://www.hixsat.co.za) and GIT (http://www.git.co.za). A similar service covering larger regions of Africa via different satellites is provided by Interpacket (http://www.interpacket.net).These systems allow ISPs to limit traffic on their expensive existing links to outgoing data only, and to use a low-cost TV satellite dish for receiving the higher volumes of incoming traffic. This can substantially reduce the operating costs for the ISPs and increases the speed of access to the web for their users.

Two-way satellite-based Internet services using very small aperture terminals (VSAT) to connect directly the US or Europe have also been quickly adopted where ever regulations allow. Namely in DRC, Ghana, Mozambique, Tanzania, Uganda and Zambia which all have ISPs that are not dependent on the monopoly telecom operator for their international bandwidth.

With the exception of some ISPs in Southern Africa, almost all of the international Internet circuits in Africa connect to the USA, with a few to the United Kingdom, Italy and France. However, Internet Service Providers in countries with borders shared with South Africa benefit from the low tariff policies instituted by the South African telecom operator for international links to neighbouring countries. As a result South Africa acts as a hub for some of its neighbouring countries - Lesotho, Namibia, and Swaziland.

The major international Internet suppliers are AT&T, BT, Global One/Sprint, UUNET/AlterNet, MCI, NSN, BBN, Teleglobe, Verio and France Telecom/FCR. A number of other links are provided by PanamSat and Intelsat direct to private and PTO groundstations in the US and UK, circumventing local PTO infrastructure.

Aside from the South African hub and a link between Mauritius and Madagascar, there are no other regional backbones or links between neighbouring countries. The main reason for this is that the high international tariffs charged by telecom operators discourages Internet Service Providers from establishing multiple international links. As a result ISPs are forced to consolidate all of their traffic over a single high cost international circuit.

Roaming dialup Internet access is now a reality for travellers to most African countries courtesy of SITA, the airline co-operative, which has by far the largest network in Africa. SITA's commercial division, SCITOR (recently renamed Equant), which was formed to service the non-airline market, now operates dialup points of presence in 40 African countries. Subscribers to Internet service providers who are members of IPASS (a group of ISPs, including SITA, who share their POPs) can access their home ISPs for about $0.22c a minute. See http://www.ipass.com.

The only country in the region with an X.400 service is South Africa. Other advanced services such as ISDN and video conferencing are also generally not available on the continent - the only countries able to provide ISDN services are Egypt, Tunisia, Morocco, the Seychelles, and South Africa, (which had 35 000 subscribers in 1996).

Voice over Internet (VOIP) services are not officially available anywhere in the region, and none of the telecom

operators have implemented voice over IP technology for their traffic except for Egypt Telecom which is routing some of its voice traffic to the US over IP and is expecting to trial consumer-based VOIP services shortly. Demand for most of these services is only expected to increase once there is a broader penetration of computers and data processing equipment on the sub-continent.

The American Registry for Internet Numbers (ARIN) has now taken over administration of Internet IP Address space for Africa (along with North America, South America, and the Caribbean). This means that address space is no longer free and until a local African Registry can be set up, networks will now be required to pay ARIN USD$2500 per year to obtain a Class-C address. A proposal for an Africa Network Information Centre (NIC) has been discussed for some years only now is progress beingmade, partly because of the lack of on-the-ground national networking associations to support it and the political difficulties of identifying the appropriate host country and organisation to operate it.

There have been few attempts to establish email-to-fax gateways in Africa despite the apparent need, given the low penetration of the Internet. Currently the co-operative project known as the Experiment in Remote Printing (TPC) only has two African countries among the 27 in its coverage list - South Africa and Botswana. Likewise, none of the commercial services have local delivery facilities outside of South Africa.

Evidence gathered by ECA suggests the average level of Internet use in Africa is about one incoming and one outgoing email per day, averaging 3 to 4 pages, in communications which are most often with people outside the continent. Surveys indicated that about 25 percent of the email is replacing faxes, while 10 percent are replacing phone calls and the other 65 percent are communications that would not have been made in the absence of an email system.

The highest number of users surveyed belonged to non-government organizations (NGOs), private companies and universities. The ratio of nationals to non-nationals varied between countries: 44 percent of users surveyed in Zambia were nationals as compared to 90 percent in Ghana. Most users were male: 86 percent in Ethiopia, 83 percent in Senegal, and 64 percent in Zambia. The large majority of users were well educated: 87 percent of users in Zambia and 98 percent in Ethiopia had a university degree.

A recent South African survey of the Internet found similar results: the average user was male, 26 to 30, spoke English, was high-school or university-educated, earned between US$24,000 and US$45,000 per year and worked in the computer industry. This indicates that the high number of users in the country is largely attributable to the previously advantaged sector of the population.

Email is used for general correspondence and document exchange, technical advice, managing projects, arranging meetings, and exchanging research ideas, although its use is still limited for accessing formal information resources. Across the continent, users report that email has increased efficiency and reduced the cost of communication but as yet it is used almost exclusively for contacting individuals in other regions. The Web is still a relatively under-utilised resource, although 40 percent of Zambian users questioned had conducted literature searches on the web.

Universities were initially at the vanguard of Internet developments in Africa and most of them provide email services, however in early 1999 only about 20 countries had universities with full Internet connectivity. Because of the limited resources and high costs of providing computer facilities and bandwidth, full Internet access at the universities where it exists is usually restricted to staff. Post graduates are often able to obtain access but the general student population usually has no access.

In the area of Internet content development, the African web-space is expanding rapidly and almost all countries have some form of local or internationally hosted web server, unofficially or officially representing the country with varying degrees of comprehensiveness. However, there are still generally few institutions that are using the Web to deliver significant quantities of information.While increasing numbers of organisations have a Web site with basic descriptive and contact information, many are hosted by international development agency sites, and very few actually use the Web for their activities. This is partly explained by the limited number of local people that have access to the Internet (and thus the limited importance of a web presence to the institution), the limited skills available for digitising and coding pages, and also by the high costs of local web hosting services.

It can be observed that the French speaking countries have a far higher profile on the Web and greater institutional connectivity than the non-French speaking countries. This is largely due to the strong assistance provided by the

various Francophone support agencies, and the Canadian and French governments, which are concerned about the dominance of English on the Internet. ACCT's BIEF and AUPELF-UREF/REFER's Syfed Centres, which are building Web sites of local information as well as providing access, are the two dominant content developers in this respect.

Although there are a few notable official general government web sites, such as those of Angola, Egypt, Gabon, Mauritius, Morocco, Mozambique, Senegal, Togo, Tunisia and Zambia, there is as yet no discernible government use of the Internet for existing administrative purposes. Web presence is higher in some sectors, particularly those involved in tourism and foreign investment, and these often have more mature sites, aimed at developing an international market presence. While most ministries and national research centres may have access to electronic mail, very few have a web site. Reflecting the limited resources of the public sector, the ECA survey found that government employees made up only one percent of users in Ethiopia and only six percent in Zambia.

As far as regional intergovernmental agencies are concerned, so far ACMAD, ADB, CEDEAO, COMESA , ECA, IGAD and SADC have built web sites with a substantial amount of information on their activities and their member states.

There are about 140 electronic mailing lists and UseNet newsgroups on the Internet which discuss issues relating to Africa (although a significant proportion of them are more closely affiliated with US African-American issues). These lists and newsgroups are almost entirely hosted off-continent except for a number in South Africa, North Africa and Kenya. There is a list for almost every nation as well as others on more general topics ranging from African Cinema to Post Colonialism. In the area of ICTs in Africa, AFRIK-IT is the only notable public list, and it is run from Ireland by the University College of Dublin (which happened to be where the person who started the list was studying).

There are other announcement and discussion lists with a smaller circulation, many of which focus on some of the programmes the international communities are carrying out in Africa, such as the African Information Society Initiative's AISI-HITD-CL and its associated African Technical Advisory Committee ATAC-CL, the PICTA-CL and SCAN-ICT-CL mailing lists hosted by Bellanet.

There are also some more specialised lists relating to African ICTs in particular sectors, regions or countries, notably:

AFAGRICT-L - The use of ICTs in agriculture and natural resource management in Africa, initiated by CTA and hosted by Bellanet
AFRINIC-DISCUSS - The list of the Interim Committee and interested parties to establish Africa's NIC, hosted by ISP UUNET/Iafrica in Johannesburg.
IOZ - The South African Internet Service providers list hosted by ISP Citec in Johannesburg
EAIA - The East African Internet Service Providers Association, hosted by UNON in Nairobi.

Linux user-group lists hosted in Nairobi, Durban and Johannesburg.

The news media are now relatively well represented on the web. The US Columbia University African Studies department has identified in the region over 120 different newspapers and news magazines that are now available on the Internet, of which over 60 percent are published on the sub-continent, in about half of the countries (23). Those most well represented in this area are again those with more advanced Internet sectors - Côte d'Ivoire, Egypt, Ghana, Kenya, Senegal, South Africa, Tanzania, Zambia and Zimbabwe. Also of note are the efforts to host daily newspapers by the ISP AfricaOnline which has offices in 6 countries.

There are two major continent-wide African news agencies, both of which extensively use electronic media - Inter Press Service (IPS) and the Pan African News Agency (PANA). Sub-regionally, Southern Africa has the only active regional news agencies using ICTs - the Southern African Broadcasters Association (SABA) and the Media Institute of Southern Africa (MISA. In other regions, use of ICTs amongst the media is much lower, but in West Africa, WANAD (West African News Media and Development Centre) is assisting journalists and media outlets to adopt the use of ICTs.

Of course international news correspondents in Africa are heavily dependant on ICTs to deliver material to their operations in the US and Europe. CNN and the other international television news companies regularly rent

temporary space segments all over Africa with the local representatives of IntelSat and PanamSat to deliver reports and live coverage. Radio journalists (even freelancers) are now sending edited sound files by email to agencies such as the BBC World Service.

Two web search engines specialising on Africa have emerged over the last year - Orientation Africa -http://af.orientation.com and Woyaa - http://www.woyaa.com. As with other similar services elsewhere, these are run by commercial companies which generate revenue through advertising. Orientation is run by Hong Kong based BlackBox and Woyaa by a UK company.

On a sub-regional basis, Southern and North Africa are the most advanced regions in terms of their use of ICTs, followed by East and West Africa with Central Africa lagging furthest behind.

In Southern Africa, South Africa, followed by Angola, Botswana, Mauritius, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe, are at the top end the scale, with some institutions having leased lines and connectivity outside of the capital. These countries are followed further behind by Malawi, which just beginning to expand connectivity, and Lesotho, which has only just established a public access in Maseru. The institutions providing the most leadership in the use of ICTs in Southern Africa are the South African Department of Communications (Ministry of Posts, Telecommunications and Broadcasting), Department of Arts Culture Science and Technology, CSIR, SangoNet and UniNet (South Africa), ZamNet (Zambia) and CIUEM (Mozambique).

In North Africa, Tunisia is the leading country, followed by Egypt and Morocco which are also relatively well advanced in their use of ICTs, followed by Algeria, which is lagging behind for obvious reasons. The champion agencies in these countries are ATI (Tunisia), ONPT and the local Internet Society Chapter (Morocco), and IDSC/RITSEC (Egypt).

In East Africa, Kenya and Uganda are the most advanced countries, followed by Tanzania and Ethiopia, with Burundi, Rwanda, Somalia and Sudan falling far behind. Leading ICT support institutions in the sub-region are UN DHA, the East African Internet Association (EAIA) and HealthNet (Kenya), the East Africa Help Desk (Uganda), UN-ECA (Ethiopia) and COSTECH (Tanzania).

In West Africa, Senegal and Ghana are the leaders, followed by Benin, Burkina Faso, Côte d'Ivoire, Mali and Niger. Further down are Guinea and Guinea-Bissau, with Liberia and Sierra Leone last. The leading ICT support agencies in West Africa are UCAD, ENDA and ORSTOM (Senegal) and NCS (Ghana).

Central Africa is still at a very low level of development in ICT use with Cameroon and Gabon being the most advanced countries, followed by Nigeria, Chad, Central African Republic, Equatorial Guinea and then the DRC and Congo. The leading ICT support institutions are NACETEM (Nigeria) and ENSPY/UniYaoundel (Cameroon).

Aside from Mauritius, and the Seychelles, the island countries are all at relatively low levels in the development of ICT use, with Madagascar being the most advanced of the remainder. The leading agency in this area is the Mauritius National Computer Board.

## Current and Planned initiatives to improve Africa's Information Infrastructure

Regional collaboration between being increasingly seen as an important means of addressing the need for improved ICT infrastructure. Action has been seen on a number of fronts in this area, starting with the Conference of African Ministers of social and economic planning who requested the UN Economic Commission for Africa to set up a 'High-Level Working Group' to chart Africa's path onto the global information highways. Hosted by the Egyptian Cabinet Information and Decision Support Centre (IDSC) in Cairo, an expert group developed a framework document entitled the African Information Society Initiative (AISI), which was adopted by all of Africa's planning Ministers at the subsequent meeting of the Conference of African Ministers in May 1996.

AISI calls for the formulation and development of a national information and communication infrastructure (NICI) plan in every African country, driven by national development priorities, and proposes co-operation among African countries to share the success of experiences. The countries that have so far begun the process for developing in-depth national information infrastructure and communication development plans are Benin, Burkina Faso,

Cameroon, Comoros, Ethiopia, Lesotho, Namibia, Mozambique, Rwanda, South Africa and Uganda. The experience developed by these countries in trying to formulate new policies will be of considerable interest to others considering the same undertaking.

Since then, communications ministers from over 40 African countries have provided high-level endorsement for telecommunications development policies encapsulated in their common vision document published last year called the African Connection. (see Infrastructure Summary)

The next stage of the project is to open an African Connection Telecentre in all 52 African states. This is in concert with recent efforts to improve accessibility to ICTs in rural areas through the use of shared public access facilities which exploit the convergence of technologies to provide cost effective services in under-serviced and remote locations. Some of the these services have grown out of existing public phone shops, such as in Senegal where about 70 phone shops now provide Internet access. The concept has also received considerable support from the ITU and other members of the international community, as well as a number of national governments and public telecom operators.

This has resulted in over 20 pilot telecentres scattered through the continent (with the majority in Ghana, Mozambique and Uganda, as well as in Benin, South Africa, Tanzania, Zambia and Zimbabwe) set up to test different models, means of implementation and mechanisms for sustainability. Development agencies active in this area include the British Council, IDRC, ITU, UNESCO, the World Bank and USAID.

At a sub-regional level, SADC and COMESA have both adopted a variety of measures to improve the use of ICTs, most notably:

SADC's model telecom legislation which has been adopted by a majority of member states and is therefore a legally binding protocol.
The formation of the Telecommunication Regulators Association of Southern Africa (TRASA) which acts as a forum for regulators in the region to exchange information and experience.
The ComTel project to develop the terrestrial telecommunication links between neighbouring states in COMESA, harmonise and upgrade the cross-border information systems in transport, customs, import/export and trade.

The region's telecommunication links to the rest of the world are also in for substantial change with a large number of international telecommunication infrastructure building initiatives having been announced in the last 2-3 years. Aside from projects aimed directly at the African market, a number of the LEO satellite projects planned for the much larger European and North American markets will also cover Africa. See the Infrastructure summary for further details.

With the worldwide recognition of the importance of ICTs in accelerating development, a number of other recent international development assistance initiatives have improved the prospects for wider access to information and communication networks on the continent, especially in rural areas. Many of the initiatives are part of the AISI Framework Sub-programme on Connectivity being co-ordinated by ECA and UNDP. In addition, to address the growing need for co-ordination and collaboration, donors and executing agencies involved in ICTs in Africa have agreed to establish an ongoing forum for information exchange on projects called Partnerships for ICTs in Africa (PICTA).

A larger list of ICT development projects in Africa is listed here. Of the general projects identified, among the potentially most important are:

The UN Secretary General's System-Wide Initiative on Africa, which includes ICTs as one of the major components in a $11.5 million programme called 'Harnessing Information Technology for Development' (HITD/SIA), and is supported by the various UN partners.

The US's USAID/Leland Initiatives which are assisting with developing Internet connectivity in 20 African countries in return for agreements to liberalise the market to 3rd party Internet service providers and to adopt

policies which allow for the unrestricted flow of information. New initiatives for Leland announced by vice president Al Gore recently include a programme for: '1 Million PCs for Africa, 1000 schools connected and 100 Universities connected'. In June '99 new initiative to increase Internet access and use in developing countries was announced. The ten targeted developing countries include Guatemala, Jamaica, Bulgaria, Egypt, Morocco, Ghana, Guinea, Uganda, South Africa, and Mozambique. The U.S. is actively encouraging other interested countries to join in this initiative, which is part of a broad effort by the U.S. to foster the information industry worldwide. Through the initiative, these countries will collaborate with the U.S. government, the private sector, multilateral organizations, and non-profits to help them use electronic-commerce and the Internet as tools for economic development. Specific aims of the initiative include fostering the deployment of specific Internet applications such as micro-e-commerce, telemedicine, distance education, and improved access to government services.

The ITU's programme for Africa which involves various rural, community telecentre, health and satellite projects emanating from the Buenos Aires Action Plan, is being conducted in co-operation with UNESCO, IDRC, WHO and others.

The World Bank's activities to assist in telecommunication and ICT development in about 25 countries in Sub-Saharan Africa. Initiatives include the African Virtual University (AVU), Economic Toolkit and Workshops for Internet Connectivity in Africa, the Rural Telecommunications Field Trial and Commercialization Pilot in Kenya, and the Global Connectivity in Africa Conference. The Bank expects to be heavily involved in sector reforms and privatization over the next few years with a view to mobilizing private participation for public objectives, to help remove market imperfections, and, where necessary, to attract private investment. It will focus on the rural sector and on information strategies, building infrastructure and applications.

IDRC's Acacia programme which has allocated CAN$60m over the next 5 years to developing the use of ICTs in local communities in Africa.

UNESCO's IIP programme, which has already (with funding from the Italian and Dutch Governments) been executing the RINAF (Regional Informatics Network for Africa) project to develop a self-governing programme of cooperation with African Member States in this area.

UNESCO has also recently established the Creating Learning Networks for African Teachers project to assist teacher training colleges develop literacy in ICTs and their use for education, and to connect them to the Internet. The project,already been implemented in Zimbabwe, is being initiated in Senegal, and is intended to be extended to twenty countries with extrabudgetary support.

The multi-donor InfoDev fund established by the World Bank, which has supported the South African Telematics for African Development Consortium and the $1 million African Virtual University Project.

UNDP's Africa Bureau has agreed to a $6m fund to improve Internet connectivity in Africa in a project called the Internet Initiative for Africa (IIA). The countries currently participating are: Angola, Burkina Faso, Cap-Verde, Gambia, Mauritania, Namibia, Nigeria, Democratic Republic of Congo, Sao Tome et Principe, Swaziland, Chad and Togo.

UNDP's Sustainable Development Networking Programme (SDNP) has 10 operational nodes in Africa - Angola, Benin, Cameroon, Chad, Gabon, Malawi, Morocco, Mozambique, Togo and Tunisia. National SDNP projects are funded for 2-3 years and are expected to provide seed money towards sustainability, either through sale of services or adoption within government budget.

UNEP's Mercure project which uses VSAT technology to establish an environmental information exchange network in Africa. UNEP is co-operating with the ITU to examine the possibility of using the spare bandwidth of the network for other functions.

The UN Office for Outer Space Affairs is proposing the COPINE project to donate groundstations and transponder time to African research institutions.

The various activities of Agence de la Francophonie and related international organisations such as

ORSTOM, AUPLEF, UREF, REFER, which are providing support for ICTs in Francophone countries, most of which are in Africa. Recently the AFRINET project was launched which is providing web servers and related support at a ministerial level to Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Madagascar, Mali, Mauritius, Mauritania and Senegal. Also, the Banque Internationale d'Information sur les Etats Francophones (BIEF) project is establishing web servers in Benin, Tunisia, Mauritius and Morocco where databases and information from a number of other countries is hosted.

SEE Maps and Tables

African Internet Infrastructure Home Page

# APPENDIX E

# ABOUT *NUNet*

# ABOUT NUNet

The National Universities Commission (NUC) started to plan an electronic communication network for Nigerian Universities on 16th October 1994, when a Committee was constituted to study the feasibility of introducing Email services. The Email Committee subsequently presented its report to the first *National Workshop on Electronic Networking of Nigerian Universities* in October 1995. This workshop resolved on 31st October 1995, that the needs of the University System were far beyond email and that a computer-based *Nigerian Universities Network* (NUNet) should be established with zonal hubs and a gateway at NUC, Abuja, and with full Internet connectivity. NUC and all Federal universities under the ambit of NUC constituted their NUNet Committees as a further consequence of this Workshop.

The initial goals and objectives of NUNet included the following:

- to end the isolation of Nigerian academic staff and students from each other and from the global academic community;
- to encourage the sharing of resources, foster academic and research collaborations among Nigerian universities, and with their counterparts throughout the world;
- to provide universities with access to electronic data-bases, journals and books, many of which are increasingly available only in digital formats;
- to serve as a vehicle to expand access to education at minimal cost of capital building expenditure; and
- to place Nigerian universities at the forefront of the information revolution in Nigeria, that they might serve their proper roles as foci for National development.

With the impending transformation of NUNet to serve all Nigerian Educational, Academic & Research (*NEAR*) institutions, these objectives and goals now apply to all academic and research communities in Nigeria, as well as to institutions, agencies and associations who must frequently interact with *NEAR* institutions. We have already received indications to join the network from five such institutions and agencies.

## *Administration of the NUNet Project*

The day to day operations and implementation of technical plans in each member institution, is handled by a Network Centre/Secretariat, which should be adequately equipped and staffed with competent qualified IT and support staff. In each member institution, the project is planned and administered by the institution's Network Committee whose Chairman is senior enough to interact freely with, and report directly to the Chief Executive or Management of the Institutions.

Each partner institution is responsible, within broad National Network Policy guidelines, for the details of its network policy, plans, implementation and the provision of access and services to its communities.

National Network Management, plans and services, as well Inter-connectivity to the National Network Centre and backbone, are fashioned by an inter-institutional *National Technical Consultative Committee (NTCC)* and implemented by the NUNet Committee and Secretariat at NUC.

The *National Technical Consultative Committee (NTCC),* whose meetings are convened by the NUC NUNet Chairman, has the following membership:

| | | | |
|---|---|---|---|
| 1. | Dr. M.A. Ibrahim | Chairman NUNet at NUC | Chairman |
| 2. | Dr. E.E. Ekuwem | ICTP Italy Representative | Member |
| 3. | Mr. C.U.M. Osamor | NCC Representative | Member |
| 4. | Mr. Lanre Ajayi | Nigeria Internet Group Rep. | Member |
| 5. | Prof. G.A. Ajayi | OAU Ife | Member |
| 6. | Dr. I.S. Diso | BUK, Kano | Member |
| 7. | Dr. A.N. Nzeako | UNN, Nsukka | Member |
| 8. | Mr. G.A. Wajiga | F.U.T. Yola | Member |
| 9. | Mr. John Mairafi | Secretary, NUNet at NUC | Secretary |

The NUNet Committee at NUC, which from 1999 has had the following membership, currently provides system wide coordination of the project:

| | | | |
|---|---|---|---|
| 1. | Dr. M.A. Ibrahim | Deputy Director (R&D) | Chairman |
| 2. | Mr. F.O. Osuji | Chief System Analyst | Member |
| 3. | Alh. R. Abdulsalami | Principal Librarian | Member |
| 4. | Mr. S. Onazi | ~~Senior~~ Principal Finance Officer | Member |
| 5. | Mr. M.C. Ezeh | Senior System Analyst | Member |
| 6. | Mrs. E. Dzoho | Principal Architect | Member |
| 7. | Mal. Adamu Ibrahim | Senior MIS Officer | Member |
| 8. | Mal. Lawal Faruk | Snr Research Officer | Member |
| 9. | Mr. O. Popoola | SNI Academic Planning Officer I | Member |
| 10. | Mr. John Mairafi | Senior Personnel Officer | Member/Secretary |

N/B: This Committee was served throughout 1999 by Mr. Remi Joseph as Secretary.

From 1996 to 1998, the NUNet Committee at NUC had the following membership:

| | | | |
|---|---|---|---|
| 1. | Dr. D.C. Onyekwelu | Director (Data Management) | Chairman |
| 2. | Dr. M.A. Ibrahim | Deputy Director (R&D) | Member |
| 3. | Eng U.A.S. Maska | Principal Hardware Engnr. | Member |
| 4. | Mrs. E. Dzoho | Senior Architect | Member |
| 5. | Engr. M. Lawal | Academic Planning Officer I | Member |
| 6. | Mr. M.C. Ezeh | System Analyst I | Member |

N/B: This Committee was served first by Mr. O.E. Oleka and later by Mr. Remi Joseph as Secretary.

Inaugurated first as an E-mail Committee in 1994, the first NUC NUNet Committee functioned from 1995- 1996, with the following membership:

| | | | |
|---|---|---|---|
| 1. | Mr. Akin Sawyerr | Deputy Director (Data Management) | Chairman |
| 2. | Dr. M.A. Ibrahim | Chief Research Officer (R&D) | Member |
| 3. | Eng U.A.S. Maska | Senior Hardware Engnr. | Member |
| 4. | Mrs. E. Erepetan | Architect I | Member |
| 5. | Mr. M.C. Ezeh | System Analyst II | Member |

Mr. B.C. Odum, a Personnel Officer II, served as Secretary during this period.

## *Status of the NUNet Project*

In 1996, NUC signed an MoU with the International Centre for Theoretical Physics (ICTP) in Italy; trained 16 NUNet engineers/Chairmen at ICTP; secured 3 IDD and 9 other telephone lines for NUNet; procured equipment; registered a Domain Name, and introduced dial-up email services. The following year (1997), NUC inaugurated the NUNet Technical Consultative Committee (NTCC), and a National NUNet capacity-building workshop (NCBW) was also organized, involving 42 persons (at OAU Ife) and 32 persons at NUC.

In 1998, the NUNet Secretariat and computer laboratory was commissioned during the second National Capacity-building Workshop, while 7 NUNet engineers (including 5 from universities) were further trained at ICTP in Italy. This year, 10 NUNet engineers from NUC and 7 universities were also trained for two months at ICTP, on Networking and Radio-Communications.

Other proposals for international linkages and donor support involving capacity building on Information and Communications Technologies (ICT) are being explored with the MacArthur Foundation, UNESCO, the Republic of South Africa's CSIR, and the University of Iowa in the United States.

A vigorous connectivity-drive has been pursued by NUC, so that today 23 member institutions at least enjoy dial-up email services. As shown in the list below, all Nigerian universities regardless of their ownership, etc. are allowed unfettered access to NUNet:

1. Abubakar Tafawa Balewa University, Bauchi
2. Ahmadu Bello University, Zaria
3. Bayero University Kano
4. Benue State University, Makurdi
5. Enugu State University
6. Federal University of Agriculture, Umudike
7. Federal University of Technology, Akure
8. Federal University of Technology, Minna
9. Federal University of Technology, Owerri
10. Imo State University
11. National Institute for Nigerian languages, Aba
12. National Mathematical Centre, Abuja
13. National Universities Commission Liaison Office, Lagos
14. National Universities Commission, Abuja
15. Obafemi Awolowo University, Ife
16. University of Abuja
17. University of Benin
18. University of Calabar
19. University of Ilorin
20. University of Jos
21. University of Lagos
22. University of Maiduguri
23. Usmanu Danfodio University, Sokoto

New requests are received almost every week, and the Nigerian Defence Academy, Madonna University, and 15 members of the Association of Teaching Hospitals have applied for connectivity.

It is a measure of the success of the NUNet project, that following the conclusion of its Public Hearing on the new National telecommunications Policy, the House Committee on Communications included in its December 1999 report, a recommendation for the approval and full implementation of NUNet. Similarly, the Okorie Committee on the Review of NUC which submitted its report early in year 2000, recommended that NUNet should be encouraged and fully funded by Government as an inter-university project.

## *Problems, Needs and Plans*

NUC was considering establishing a full Internet gateway for NUNet when, in 1997, NITEL announced intention to set up a National VSAT Network backbone with 5 Internet Points of Presence (PoPs). Since then, the university system has been waiting, and as more users come on board and become better enlightened, there are increasing complaints about the lack of full internet services on NUNet, as well as the insensitivity of NITEL which tosses the NUNet lines used for access. There is further frustration that academic Internet uses being bandwidth intensive, the facilities planned by NITEL would still not be able to meet the requirements of Nigerian educational, academic and research institutions.

The major problem facing the NUNet project is the general poor state of National infrastructure for power and communications. Almost as a matter of deliberate policy, most Nigerian Institutions for HE & Research are particularly affected by inadequate supply of electricity and telecommunications. There are many university towns that have such a poor supply of telecommunication facilities, that it has not been possible to install NUNet facilities. So consistent is this phenomenon, that although Lagos, Port-Harcourt and Abuja have the best telephone exchanges in the country, it is difficult to reach the University of Lagos at Akoka, the University of Port-Harcourt or the University of Abuja at Gwagwalada.

Within the institutions themselves, very few have invested in communications infrastructure, and hardly any has even a functional Intercom supply to academic and residential areas for staff and students. Where computers are available, they are largely operated as stand-alones, used by secretarial staff mainly for word-processing, and can not handle modern multi-media applications.

Another problem is that although public tertiary education has been regarded as an essential service and the institutions banned from charging fees, the institutions are charged economic rates for infrastructure and other services they require, and are not granted any concessions. At the moment, for example, NUC pays NITEL tariffs amounting to about six million Naira per annum for NUNet lines. This does not include tariffs paid by connected universities at their end. As the number of users increases in universities, the cost of dial-up access will continue to increase because of the slow speed of NITEL telephone lines. This has forced some universities to charge staff and students

both for sending and receiving electronic mails, at up to N100.00 per printed page, thereby making the service unaffordable to the majority of academic staff and students.

Whereas NUC has invested massively in training IT staff for the NUC and Universities, there is still a great lack of skilled staff, and it has proved to be difficult to retain such staff in the service of the university system. To retain such staff, it would be necessary to provide them with incentives as well as to keep them busy and challenged at all times. The NUNet Committee hopes to introduce a staff exchange facility between NUC, the Universities and other member institutions of the new Network, so that the core staff could be rapidly deployed and better utilized by the Nation's education and research system as a whole.

The NUNet Committee plans and hopes for support to resolve some of these problems in a sustainable manner, thus. The basic National ICT Network infrastructure should be set up by deploying Internet VSAT ground stations at NUC and in 6 to 12 institutions strategically selected to serve institutions in the 6 geopolitical zones of the country, and connected to each other initially by dial-up proxy to ensure redundancy. These access centres will be encouraged and supported to develop their LANs and WANs. They will provide dial-up, cable or wireless connectivity and technical support to nearby institutions, as well as Internet laboratories for others to drive-in and enjoy high-speed access at speeds of at least 128kbps incoming and 64kbps out-going. More VSAT access terminals would be set-up as capacity and needs build up. There are university institutions without adequate telephone supply (such as FUT Yola, UNN, etc.) and which would have to be provided with direct access as they can not dial in to others, although others would also not be able to dial in to their networks. Such institutions will be provisioned with 64kbps incoming, as they would not be required to provide dial-up access to others.

To ensure sufficient user base, seed resources would be provided in the form of a revolving soft loan facility, to enable academic and other staff own their (laptop) computers with which they can enjoy Internet access in their offices and homes. This will free desktops on institutional networks for use by students and more junior staff, and accelerate the rate of positive change.

## *The Future of NUNet*

From Saturday 3rd to Sunday 4th June 2000, the Executive Secretary invited all management staff of the NUC (including Directors and Deputy Directors) participated in an intensive weekend retreat at the Chelsea Hotel in Abuja. The retreat produced guidelines for the restructuring of the NUC to streamline its staffing, structure, procedures and laws in order to function as a facilitator in the context of universities' autonomy and needs of 21st Century university education in Nigeria.

The Okorie Committee on the Review of NUC had recommended that in the context of autonomy and features of the 21st Century, the information generation and dissemination machinery of the NUC should be comprehensively enhanced. While it identified the need

for a properly structured Department of Communications and Liaison, however, the Okorie Committee failed to recommend its establishment.

The NUC Strategic Initiative Retreat decided to take the bull by the horn, and recommended that a new Department of Information and Communications should be established by the NUC in place of the existing Department of Data Management (DMD). The new department will consist of four major divisions, namely:

I. **Information Management Division,** which will run the MIS project which currently exists under the Director ES Office;
II. **Statistics and Data Analysis Division**, which already exists in the DMD;
III. **ICT Services and Maintenance Division,** which will add software development and maintenance to the existing DMD hardware division; and
IV. **Networking and Communications Division**, which will handle
   a) the NUC LAN presently under DMD;
   b) the NUC Secretariat PABX and Intercom system presently handled by Personnel and Physical Planning Department;
   c) the Voice Radio communication network that is presently managed by the Physical Planning Department; and
   d) NUNet as an Inter-Institutional Communication Network.

This arrangement was agreed upon in view of the on-going convergence of communication technologies and to remove administrative bottlenecks. The Consultant's visit and assembly of all our local resource persons at NUC and NUNet at this point in time and the assembly are a Godsend. It will allow us to assess the feasibility and determine needs for up-grades, technologies, and costs of this new arrangement before it comes in to effect.

# APPENDIX F

# TECHNOLOGY ASSESSMENT

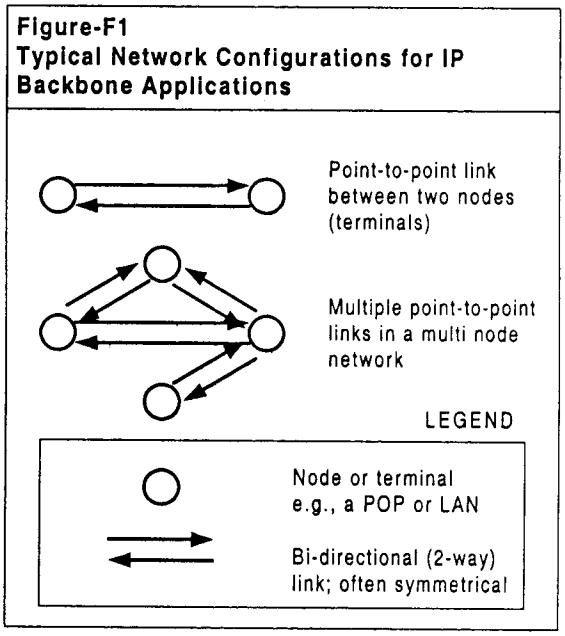
## TECHNOLOGY ASSESSMENT

There has been rapid growth of the Internet and Internet Protocol (IP) networks over the past decade. And although global telecommunications infrastructure has grown exponentially as well over this period, there are vast areas and population groups, especially in developing countries, that remain beyond the reach of adequate terrestrial communication infrastructures. Thus, there has been intense interest in developing satellite based IP networks -- for both Internet/Intranet backbone applications and for Internet access. This appendix briefly reviews the relevant technologies and configurations and concludes with a discussion of cost factors and trends.

### Applications & Network Configurations

Typical network configurations for IP backbone and Internet access applications are shown in Figures F1 and F2. Backbone applications tend to be higher capacity (because they link traffic aggregation points together) and the capacity is often more symmetric (same or nearly same in go and return directions). Typical backbone applications are to interconnect points of presence (POPs) or network access points (NAPs) for a backbone ISP, and to interconnect local area networks (LAN) for an enterprise -- i.e., a wide area network (WAN).

**Figure-F1**
**Typical Network Configurations for IP Backbone Applications**




Internet access refers to linking users to the Internet (Figure-F2). Users may be individual PCs or users clustered on a LAN. The dominance of Web (HTTP) traffic (70 to 80%) makes traffic asymmetric -- low to the Internet and high from the Internet ("click and dump").

In addition to basic Internet access, an access ISP is normally capable of providing related services such as e-mail, news groups, hosting web pages or sites and perhaps, implementing virtual private networks (VPN). The latter item, VPNs, is important because this capability enables the ISP4 to form "virtual" intranets for subscribing enterprises[5].

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4 Service providers that provide Internet applications may be referred to as application service providers (ASPs).

5 Loosely defined, an intranet is an IP network for a closed user group (e.g., a corporation or institution). An intranet may or may not be connected (through a gateway) to the Internet.

This clouds the simplistic delineation of backbone and access applications shown in Figures F1 and F2, respectively. Figure-F3 shows the VPN concept, where IP "tunnels" are used to provide secure direct logical connections between network points that may not be directly connected physically. When to use which configuration depends on a variety of factors. When cost is a dominant selection criterion then generally:

- Situations with high traffic within a closed user group (high community-of-interest) favour a separate physical network (Figure-F1).
- Situations with high traffic to the Internet favor direct Internet access (Figure-F2).
- In between these two extremes, there is a hybrid arrangement where the intranet is "virtual" (Figure-F3).

**Figure-F2**
**Network Configurations for Internet Access Applications**

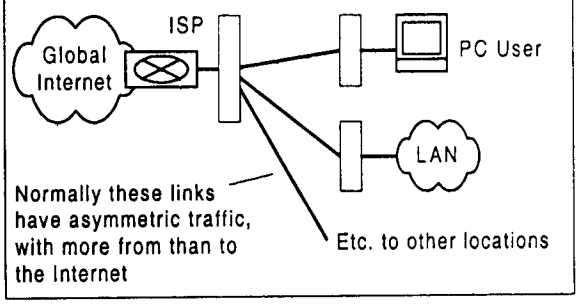
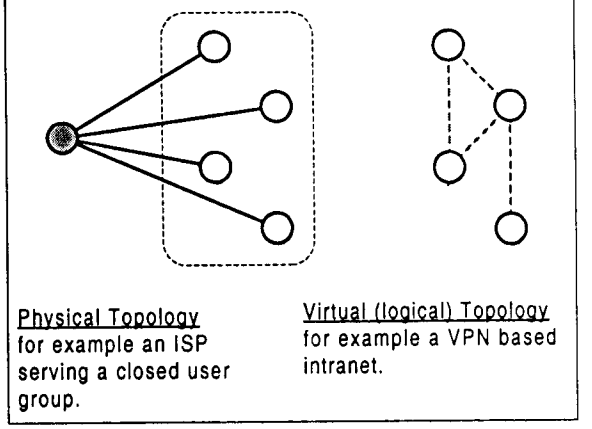



**Figure-F3**
**In a VPN, the logical topology can be quite different from the physical topology**




Direct Internet access (per Figure-F2) is a single star topology. In the case where an intranet is formed as a single star network, then Internet connectivity can be provided as another link (hop), which, in effect, forms a second star (hence the terminology of double star). Refer to Figure-F7 for an illustration of these approaches and a cost comparison graph.

## The Challenge of IP Over Satellite

Satellites' large "footprint" and inter-continental reach make single hop connectivity across large distances feasible. Satellites have inherent multi-cast and broadcast capability -- which is good for applications that disseminate information to multiple points. Channel asymmetry is relatively easy to accommodate efficiently. However capitalizing on these advantages for IP networks, means overcoming problems associated with the following:

- The original TCP/IP protocol set was not designed for satellite network characteristics and transmission inefficiency can result.

- The difficulty of dynamically coping with traffic that varies widely and tends to be unpredictable.
- Transponder bandwidth (capacity) is limited and tends to be expensive (and for most developing countries, the transponder cost is in scarce foreign exchange).

Research is ongoing to improve TCP (Transmission Control Protocol) and TCP/IP for use over satellite links. Issues include the slow start algorithm, the ability to deal with large bandwidth delay products, congestion control and error recovery mechanisms. For example, the effective throughput of TCP over a 2 Mbps satellite link can easily fall below 1 Mbps [1] assuming a typical window size of 51 K bytes and a bit error probability of $10^{-8}$ (i.e., one errored bit per 100 million bits). While work continues toward a standards based solution [2] through the Internet Engineering Task Force (IETF), a variety of interim and proprietary approaches exist. These approaches range from larger initial window sizes for TCP, to selective repeat acknowledgment, and the sending of premature acknowledgments (to trick or "spoof" TCP).

Recently systems have been introduced for Internet multi-cast and broadcast applications that take advantage of DVB/MPEG-2[6] transport and web caching techniques on the down link [3]. By using technology developed for digital TV and satellite direct-to-home (DTH) TV broadcasting, which are becoming "commodity" products, lower cost down link delivery of Internet on highly asymmetric links is now becoming available (particularly at Ku band, where DTH systems are implemented).

Slightly longer term, but much more aggressive, is research on next generation satellite systems. System trade-offs under investigation include (i) a general move to Ka band to find additional spectrum; (ii) supplementing or replacing geostationary earth orbit (GEO) satellites with low earth orbit (LEO) and medium earth orbit (MEO) satellite constellations (to improve capacity and reduce transmission delay); and (iii) satellite based signal processing, switching and routing (i.e., "on-board" processing and "switch in the sky" concepts) to improve overall network efficiency. Some of these systems are scheduled to be operational within the next 1 to 3 years -- refer to the subsection below on "Emerging Future Systems".

**Frequency Bands**

Satellite services for telecommunications began in the C band, have expanded into the Ku band, and now, as these bands are filling up, future systems will expand into the Ka band. Figure-F4 briefly compares the characteristics of systems in these bands.

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6 DVB/MPEG-2 stands for Digital Video Broadcast / Motion Picture Experts Group, which are standards from ETSI and ISO/IEC respectively.

From Figure-F4 we note that, while C band has wide (continental) coverage and is not susceptible to rain fading, it is generally more expensive as satellite power is lower and thus the earth station antenna size is larger (for antenna sizes over 3 to 4 meters, the antenna can become a dominant earth station cost item).

**Figure-F4**
**Comparison of Systems by Frequency Band**

| # | Characteristic | C Band | Ku Band | Ka Band |
|---|---|---|---|---|
| 1 | Uplink Frequency Band (GHz) | 5.850 - 6.425 | 14.00 - 14.50 | ~ 28 - 30 |
| 2 | Downlink Frequency Band (GHz) | 3.625 - 4.200 | 10.95 - 11.70 | ~ 18 - 20 |
| 3 | Typical Coverage Area (footprint) | Global<br>Hemisphere<br>Continent | Regional Zones<br>Spot Beams | |
| 4 | Satellite Power (relative) | Low | High | |
| 5 | Earth Station Antenna Size (relative) | Large | Small | |
| 6 | Cost (relative) | High | Low | Lowest (?) |
| 7 | Susceptible to Rain Fade Outages | No | Somewhat | Yes |
| 8 | Systems & Service Available | Yes | Yes | Future |

Due to low demand over central and West Africa today, there is a lack of Ku band coverage. This is unfortunate as many of the lower cost technologies use Ku. Hopefully this situation will change (e.g., informal discussions with Newskies indicates that they may swing a Ku beam over the region for tests later this year).

### Available Technology and Suppliers

As noted earlier, for many Internet applications, the user (or base of users) has a higher demand for receive (down) capacity than transmit (up). Compared to a full duplex satellite transceiver (providing both up and down links to the satellite), it is relatively inexpensive to implement only the satellite receiver. Therefore there are a number of low cost solutions available that use satellite to receive inbound Internet traffic but use another medium to transmit to the Internet (usually telephone dial-up). These systems are commonly called "hybrids". For cost reasons, hybrids are usually implemented in the Ku band[7].

Because satellite is inherently a broadcast medium, a number of system designs feature sharing a high bit rate down link amongst a group of users. Usually there is a method of ensuring "fair" usage by all users, although it is up to the network provider to "provision" the system with sufficient capacity. Some systems provide a "managed bandwidth"

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7 Nonetheless, C band hybrids are available; for example from Lyman Bros. -- see www.lymanbros.com

capability so that each user can be "guaranteed" a minimum bit rate (in Frame Relay terminology, this is the Committed Information Rate or CIR). The advantage of sharing the downlink is that during periods of low traffic, users can access high speeds -- up to the full down link carrier rate. This improves overall link efficiency and, in well-managed systems, provides a higher overall quality of service (less delay).

There are also a variety of Internet level technologies available to minimize network capacity and improve quality of service. Generically these are "caching" techniques where data is moved as close as possible to the users. A simple example would be for *NUNet* as a direct Internet access network (single star topology). In this example, universities and NUC Web sites that are accessed often would be established and maintained on university facilities but then "mirrored" at the ISP. A variety of approaches exist for this, from full hosting to equipment co-location (i.e., the ISP manages cache equipment at its satellite gateway point of presence, but the equipment is "owned" by the customer).

Suitable technology for NUNet is readily available today from a competitive set of suppliers. In general, after initial procurement, there will be vendor lock-in as most systems are proprietary. A notable exception is the IBS (Intelsat Business Service) standard. However all systems feature standards-based terrestrial network interfaces (e.g., Ethernet) and this assures a good level of

**Figure-F5**
**Sample Matrix of Suppliers & Products**

This matrix is representative only and is not intended to represent all, the largest, best or any other supplier critieria in any sense. The lines of business are believed accurate as of July 2000.

| # | Name | Note | ISP - Global Backbone (a) | ISP-Global Access (b) | ISP - Nigeria (c) | ASP (d) | Satellite Transponder (e) | Equipment & Systems (f) | Integrators (g) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Alcatel | | | | | | | X | |
| 2 | BT | | | | X | | | | |
| 3 | Columbia Communications | | | | | | X | | |
| 4 | Concert | N01 | X | X | | | | | |
| 5 | Cyberspace | N02 | | | X | | | | |
| 6 | DirecPC (part of HNS) | N03 | | X | | | | | |
| 7 | Gilat | | | | | | | X | |
| 8 | Global One | N04 | X | X | | X | | | |
| 9 | Intelsat | | | | | | X | | |
| 10 | Hadatec Limited | | | | | | | | X |
| 11 | Hyperia | | | | X | | | | |
| 12 | Hughes Network Systems (HNS) | | | | | | | X | |
| 13 | Linkserve | N05 | | | X | | | | |
| 14 | Lyman Bros | | | | | | | | X |
| 15 | Motophone | N06 | | | | | | | X |
| 16 | Newskies | | | X | | | X | | |
| 17 | Nitel | N07 | | | X | | | | |
| 18 | NSI | | | | | | | X | |
| 19 | Panamsat | | | | | | X | | |
| 20 | PINet Informatics Limited | N08 | | | | | | | |
| 21 | Steineng | N09 | | | X | | | | |
| 22 | Teleglobe | | X | X | | X | | | |
| 23 | USEI / ATC | | | | | | | | X |

Notes
N01 A venture of AT&T & BT, who independently serve African locations.
N02 See www.bcisnet.com/aboutus.html
N03 A hybrid Ku band service; not available in Africa at this time.
N04 Provides Internet backbone service to Nitel. See www.global-one.net
N05 See www.linkserve.com.ng
N06 Located in Nigeria.
N07 Incumbent telephone company.
N08 See www.informatics.com.ng
N09 See www.steineng.net

"future-proofing". A variety of carrier types, multiple access modes, modulation and coding schemes are in use. Considerable innovation has been shown by system designers to creatively combine these techniques for Internet transport on satellite. Refer to Figure-F5 for a representative list of suppliers.

From the matrix it is evident that there is a competitive supply of all products needed for the NUNet project. A properly constructed request for proposals based on actual requirements should be used to conduct a proper and safe "technology neutral" procurement.

## Emerging Future Systems

The following table (Figure-F6), summarizes some of the current proposals for satellite based broadband access networks [4].

From Figure-F6, it is evident that several systems may be entering early commercial operations within the next two years. However, we need to carefully note that large, high-risk investments, such as these projects, often take longer than predicted. For example, in 1996, Teledesic was 2 years away from launch (i.e., in 1998) -- today, 4 years later, launch is still 2 years away.

**Figure-F6** Source [4]

**Summary of Proposed Broadband Access Satellite Systems**

| # | Characteristic | Cyberstar | iSky | Spaceway | SkyBridge | Teledesic |
|---|---|---|---|---|---|---|
| 1 | Number of Satellites | 3 | 2 | 16 + 20 | 80 | 288 |
| 2 | Type of Orbit | GEO | GEO | GEO + MEO | LEO | LEO |
| 3 | Frequency Band | Ka | Ka | Ku | Ka | Ka |
| 4 | Access Carrier Type | FDMA<br>TDMA | - | FDMA<br>TDMA | FDMA<br>TDMA<br>CDMA | TDMA |
| 5 | Network Protocol | IP/ATM/FR | IP/ATM | IP/ATM/FR | IP/ATM | IP/ATM |
| 6 | Network Capacity | 9,600 Mbps | - | 4,400 Mbps | - | 10,000 Mbps |
| 7 | On-Board Processing | - | - | No | No | Yes |
| 8 | Operational Target | 2001 | 2001 | 2002 | 2001 | 2002 |

Selected Abbreviations

| | |
|---|---|
| ATM | Asynchronous Transfer Mode |
| CDMA | Code Division Multiple Access |
| FDMA | Frequency Division Multiple Access |
| FR | Frame Relay |
| TDMA | Time Division Multiple Access |

## Cost Factors and Trends

Although conceptually satellite networks are simple, the wide variety of technologies and cost structures results in a relatively complex system design optimization problem. Factors that affect the total life cycle cost of systems include the network configuration

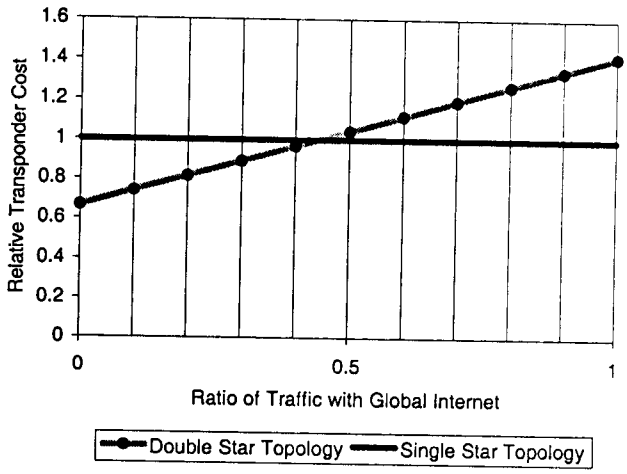
(topology), traffic patterns and volumes, and earth station antenna sizing. The effect of these factors on costs are illustrated in Figures 7 and 8, respectively.

From Figure-F7, we see that if a sufficiently high proportion of traffic is with the global Internet, then the two hop (double star) topology results in high transponder usage costs. And, it will also have a higher capital cost if a hub or control station is necessary (i.e., not able to use an existing hub).

From Figure-F8, we see that larger antennas, although having a higher initial capital cost, can have a lower life cycle cost as the satellite provider can charge less for transponder usage. Therefore a careful assessment of the project's expected economic life should be made during planning.

Next generation broadband access systems, see Figure-F6, are all attempts to lower the cost to establish and operate broadband networks for customers in low-density markets. Unfortunately how many of these systems, if any, will be operational by 2002, as noted earlier, remains an open question. And, considering the fate of Iridium, the longevity of those that launch will depend on their ability to hit market price points that are attractive enough to customers to sustain the business. Therefore, while cost trends are clearly downward, how much and how soon are unknown.

**Figure-F7**
**Affect of Network Physical Topology on Transponder Costs**




The cross-over point is a function of the relative transponder costs for each hop. As relative costs diminish (become similar), the cross-over point moves left -- i.e., to lower ratios of Global Internet traffic.

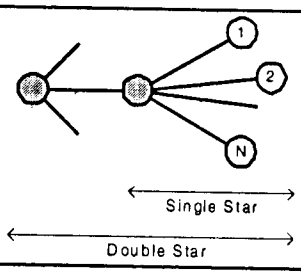
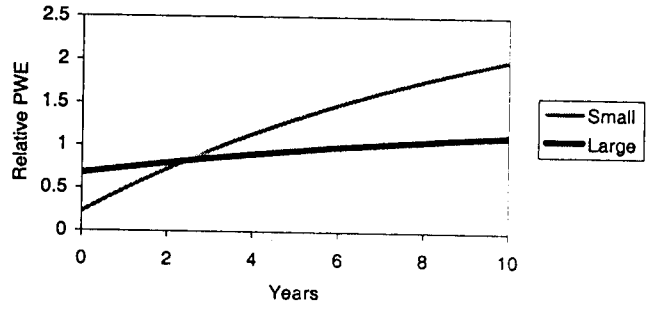



**Figure-F8**
**Affect of Antenna Size on Life Cycle Costs**




Notes: The cross-over point is also a function of bit rate. Lower bit rates push the cross-over out to later years.

## References

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[4] J. Farserotu & R. Prasad, "A Survey of Future Broadband Multimedia Satellite Systems, Issues and Trends", *IEEE Communications Magazine*, p.128-133, June 2000