More Bandwidth at Lower Cost

An Investigation for the Partnership for Higher Education in Africa

Compiled by the Bandwidth Task Force Secretariat
University of Dar es Salaam
Dar es Salaam, Tanzania
October 2003
# Contents

List of Tables and Maps vii

Technical Acronyms and Abbreviations ix

Acknowledgements xi

Executive Summary xiii

The Importance of Bandwidth xliii

Bandwidth Study Rationale xiv

Task Force Members xv

Terms of Reference xv

Study Methodology xvi

Report Contents xvi

Recommendations xvi

What should the universities do? xvii

Using economies of scale to obtain more bandwidth xvii

National-level ICT planning and implementation xviii

Next steps for Partnership assistance xviii

## Background Information on Partnership Countries 1

1.1 An ICT Overview by Country 1

1.2 National Infrastructure, Planning, Telecommunication Regulatory Conditions, Pricing and Marketing 2

1.2.1 Tanzania 3

1.2.2 Uganda 3

1.2.3 Mozambique 3

1.2.4 South Africa 4

1.2.5 Nigeria 5

1.2.6 Ghana 6

1.2.7 Teledensity 7

1.3 ICT Training in Partnership Countries 8

1.3.1 Tanzania 8

1.3.2 Uganda 8

1.3.3 Mozambique 8
4.4.5 African Virtual University (AVU) 31
4.4.6 SHARE/Intelsat 31
4.4.7 Intelsat/Americas 31
4.4.8 Teleglobe/China Research Network 31
4.4.9 Clarke Institute Global Trust Fund for Tele-education 31
4.4.10 University of the South Pacific Network (USPNet) 32
4.4.11 Models for the Partnership 32

4.5 Satellite operators and providers in Africa 32
4.5.1 Intelsat 32
4.5.2 PanAmSat 32
4.5.3 KaliTel/Anatolia 33
4.5.4 Arabsat 33
4.5.5 Eutelsat 33
4.5.6 Loral Space & Communications 33
4.5.7 Europe*Star 34
4.5.8 Alcatel Space 34
4.5.9 Verestar/Interpacket (USA) 34
4.5.10 Tiscat 34
4.5.11 African Sky Communications 34
4.5.12 Hughes Network Systems (HNS) 35
4.5.13 Titan 35
4.5.14 RASCOM 35

Recommendations 37

5.1 Options for Improved International Connectivity at Sustainable Rates 37
5.2 Recommendations for Partnership Universities 39
5.3 The Role of Partnership Countries 40
5.4 Items for Partnership consideration 40

Appendix 1: Bandwidth Task Force Members 43

Appendix 2: Bandwidth Study Terms of Reference 45

Appendix 3: Papers Submitted by Task Force Members 49
List of Tables and Maps

Tables

1  Bandwidth in Partnership countries         xiii
2  Current bandwidth utilization in selected Partnership countries  xiv
3  Information infrastructure investment, 2002                   1
4  General ICT information for Partnership countries             1
5  Summary of national fiber optic backbone in Partnership countries  6
6  Teledensity in Partnership countries                          7
7  Number of networked computers in Partnership universities     11
8  Current bandwidth utilization by Partnership universities      15
9  Bandwidth requirements for accessing research information     16
10 AREN notional bandwidth targets based on campus characteristics 16
11 Types of ICT training required by Nigerian universities        19
12 Comparison between two-way services charges for African Internet Operators  28
13 Division of responsibilities                                   41

Maps

Partnership countries     xiii
SAT-3/WASC/SAFE landing point in Africa     25
# Technical Acronyms and Abbreviations

A full list of acronyms and abbreviations would be pages long. We have instead limited the list to technical terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADSL</td>
<td>Asymmetric Digital Subscriber Line. Works by utilizing the full frequency spectrum of the copper wire currently in use on a telephone line.</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>The rate of data transfer, i.e., the capacity of the Internet connection being used.</td>
</tr>
<tr>
<td>Bit</td>
<td>The smallest unit of computerized data. Bandwidth is usually measured in bits, kilobits, megabits, or gigabits per second. It is important to remember that bits and bytes are not the same. One byte equals approximately eight bits.</td>
</tr>
<tr>
<td>Burstable bandwidth</td>
<td>Some Internet Service Providers permit customers to use more bandwidth than is contractually allotted to them for a short period of time. This is called burstable bandwidth.</td>
</tr>
<tr>
<td>CBT tape</td>
<td>CBT tape is a collection of freeware, almost all for open-source distribution for the IBM mainframe MVS and OS/390 operating system environment. It was developed at the Connecticut Bank and Trust Company, thus the initials.</td>
</tr>
<tr>
<td>CD-ROM</td>
<td>Compact Disc-Read Only Memory</td>
</tr>
<tr>
<td>C-band and Ku-band</td>
<td>C-band and Ku-band are two common satellite frequency bands. C-band uses between 4 and 6 Ghz for transmission. Ku-band earth stations use the 14 Ghz frequency band to transmit and the 12 Ghz frequency band to receive.</td>
</tr>
<tr>
<td>Digital infrastructure</td>
<td>The digital infrastructure of telecommunications is a maze of glass fiber, copper wire, and invisible radio signals interspersed with specialized computers that direct the flow of information. The pathways and computers work together to move the streams of digital bits that encode all information and communications, whether voice, video, or computer data like World Wide Web pages from the Internet.</td>
</tr>
<tr>
<td>Digital multiplexing</td>
<td>A way of combining several digital signals into an aggregate bit stream.</td>
</tr>
<tr>
<td>Direct TV</td>
<td>Direct TV was launched in 1994 and was the pioneer of the satellite TV industry. In addition to offering access to hundreds of television stations, a Direct TV subscription offers two high-speed ways to access the Internet.</td>
</tr>
<tr>
<td>DTH</td>
<td>Direct to Home. Term used to refer to the satellite and broadcasting industries.</td>
</tr>
<tr>
<td>DVB</td>
<td>Digital Video Broadcasting</td>
</tr>
<tr>
<td>Gbps</td>
<td>Gigabits per second</td>
</tr>
<tr>
<td>Geostationary orbit</td>
<td>An orbit in which a satellite appears to remain in the same spot in the sky all the time. When a satellite is in geostationary orbit, it travels at exactly the same speed as the Earth is orbiting below it.</td>
</tr>
<tr>
<td>Term</td>
<td>Meaning</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ghz</td>
<td>Gigahertz—a unit of alternating current or electromagnetic wave frequency</td>
</tr>
<tr>
<td>GMPCS</td>
<td>General Mobile Personal Communication by Satellite</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technologies</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>ISP</td>
<td>Internet Service Provider</td>
</tr>
<tr>
<td>Kbps</td>
<td>Kilobits per second</td>
</tr>
<tr>
<td>Ka-band</td>
<td>A higher frequency than Ku-band, operating from 18 to 31 Ghz</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>Mbps</td>
<td>Megabits per second</td>
</tr>
<tr>
<td>Mhz</td>
<td>Megahertz</td>
</tr>
<tr>
<td>MySQL</td>
<td>An open source database server</td>
</tr>
<tr>
<td>PHP</td>
<td>An open source scripting language for the worldwide web</td>
</tr>
<tr>
<td>POP</td>
<td>Point of Presence. The point where a user can access a service provider.</td>
</tr>
<tr>
<td>PSTN</td>
<td>Public Switched Telephone Network</td>
</tr>
<tr>
<td>SDH</td>
<td>Synchronous Digital Hierarchy</td>
</tr>
<tr>
<td>Transponder</td>
<td>The portion of a satellite that transmits and receives radio signals in a prescribed frequency range, from ground stations or other satellites (transmitter/responders).</td>
</tr>
<tr>
<td>Turbo code</td>
<td>A relatively new forward-error correction technique. Turbo codes have been shown to manifest error-performance very close to what is theoretically possible.</td>
</tr>
<tr>
<td>VSAT</td>
<td>Very Small Aperture Terminal</td>
</tr>
<tr>
<td>Widebeam</td>
<td>Broad or wide transmission bundle of a satellite. Widebeam is used to reach the greatest geographic area possible, and thus the maximum number of viewer.</td>
</tr>
<tr>
<td>Wireless local loop</td>
<td>Wireless local loop (WLL) is a system that connects subscribers to the public switched telephone network (PSTN) using radio signals as a substitute for copper for all or part of the connection between the subscriber and the switch. This includes cordless access systems, proprietary fixed radio access, and fixed cellular systems.</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>Wireless Fidelity. A label for devices conforming to certain technical standards.</td>
</tr>
</tbody>
</table>
Acknowledgements

This report was made possible through the support of the foundations responsible for the Partnership for Higher Education in Africa: Carnegie Corporation of New York, The Ford Foundation, the John D. and Catherine T. MacArthur Foundation, and the Rockefeller Foundation. Our thanks are due to these foundations for making this study possible and for providing room to carry out this important assignment. The encouragement and input from program staff are also much appreciated.

The Committee also wishes to express its gratitude to Lisbeth Levey, Partnership facilitator. Our appreciation also goes to the United Nations Economic Commission for Africa (UNECA) for hosting the July 2002 meeting in Addis Ababa, at which the need to access increased bandwidth was a constant refrain.

We are grateful to the “Band-ITs Task Force (listed in Appendix 1) for a job well done in enabling us to complete this integrated report. Task force members were always cooperative and provided the necessary inputs to the terms of reference (TOR). We also thank the vice chancellors of the universities to which the “Band-Its” are affiliated for allowing them time to be of direct use to Africa.

Our special gratitude is extended to the Vice Chancellor of the University of Dar es Salaam (UDSM), Prof. Matthew Luhanga, for agreeing to host the Committee Secretariat and for his useful comments on both the Tanzania country report and this report as a whole.

Additionally, the Secretariat wishes to acknowledge the support of various members of UDSM staff, particularly the support of our principal assistant, Mr. Tobias Aloisi, which is much appreciated.

Lastly we wish to thank all the institutions and individuals who participated in this activity. Any shortfalls in the report remain the responsibility of the Secretariat and the Committee.

Prof. Beda Mutagahywa
Coordinator

Prof. Tolly S. A. Mbwette
Deputy Coordinator

University of Dar es Salaam
Dar es Salaam, Tanzania

October 2003
Executive Summary

The Importance of Bandwidth

ICT is a theme that the Partnership for Higher Education in Africa has identified as a crosscutting issue because it affects all aspects of university life. The Partnership pinpointed bandwidth for particular attention because of its importance to ICT planning and implementation. Broadly defined, bandwidth refers to the rate of data transfer, i.e., the capacity of the Internet connection being used. The greater the capacity, the more likely it is that downloads will be faster. Very often, however, bandwidth numbers represent theoretical or peak performance; bottlenecks, which slow down data transfer, can occur as a result of network overload and other factors.

None of the African universities with which the Partnership collaborates has sufficient bandwidth. It is expensive and, for the most part, Partnership universities purchase their bandwidth from middlemen rather than at the source. In a survey of universities receiving funding from Partnership foundations, we learned that costs range from $1,900 a month to $27,000, depending on the amount of bandwidth purchased (see Table 8). In general, bandwidth rates are at least ten times higher in Africa than they are in North America and Europe and can be up to 100 times more costly for broadband connections.

In order to maximize their bandwidth utilization, most universities in Africa, including those supported by Partnership foundations, employ an asymmetrical link bandwidth strategy called “thin up/fat down” on the principle that less bandwidth is required to send data to the Internet and more is necessary to receive large data, image, and text files. For that reason, bandwidth in this report’s tables is frequently expressed in two number divided by a slash (/). The first number is smaller and represents the bandwidth available to send data; the second number, which is larger, is the amount of bandwidth available to receive data.

The table below shows the total national bandwidth in Partnership countries and the international bandwidth available in bits per capita, measured in bits per second (Bps) for mid 2002—the most recent year for which this data is uniformly available.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total National Bandwidth</th>
<th>Bandwidth Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>398,512 Kbps</td>
<td>9.1 Bps</td>
</tr>
<tr>
<td>Mozambique</td>
<td>2,088 Kbps</td>
<td>1.2 Bps</td>
</tr>
<tr>
<td>Tanzania</td>
<td>12,000 Kbps</td>
<td>0.3 Bps</td>
</tr>
<tr>
<td>Uganda</td>
<td>9,250 Kbps</td>
<td>0.4 Bps</td>
</tr>
<tr>
<td>Nigeria</td>
<td>15,000 Kbps</td>
<td>0.1 Bps</td>
</tr>
<tr>
<td>Ghana</td>
<td>4,096 Kbps</td>
<td>0.2 Bps</td>
</tr>
</tbody>
</table>

Source: International Development Research Centre
http://www.idrc.ca/acacia/divide/
Table 2: Current bandwidth utilization in selected Partnership universities

<table>
<thead>
<tr>
<th>Institution</th>
<th>Bandwidth Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Dar es Salaam (Tanzania)</td>
<td>256 Kbps up/512 Kbps down</td>
</tr>
<tr>
<td>Makerere University (Uganda)</td>
<td>1.28 Mbps up/2.5 Mbps down</td>
</tr>
<tr>
<td>Eduardo Mondlane University (Mozambique)</td>
<td>384 Kbps up/1 Mbps down</td>
</tr>
<tr>
<td>Bayero University (Nigeria)</td>
<td>64 Kbps up/128 Kbps down</td>
</tr>
<tr>
<td>Obafemi Awolowo University (Nigeria)</td>
<td>128 Kbps up/256 Kbps down</td>
</tr>
<tr>
<td>University of Ibadan (Nigeria)</td>
<td>56 Kbps up/200 Kbps down</td>
</tr>
<tr>
<td>University of Jos (Nigeria)</td>
<td>64 Kbps up/128 Kbps down</td>
</tr>
<tr>
<td>University of Ghana (Ghana)</td>
<td>512 Kbps up/1024 Kbps down</td>
</tr>
</tbody>
</table>

Source: Bandwidth task force

What does bandwidth mean in an academic context?

- Fast access to JSTOR, a multidisciplinary online archive of academic journals, requires Internet connectivity of at least 1.5 Mbps data transfer capacity.
- More than 200 US universities are now using Internet2, a high speed, high capacity network that provides a minimum bandwidth speed of 2.4 Gbps and connections to international networks. If this were not fast enough, the network is now being upgraded to a capacity of 10Gbps.
- 2.4 Gbps is about 1,500 times the size of a typical US library T-1 Internet circuit.
- An Internet2 connection can transfer in one second what would take almost 30 minutes on a T-1 circuit.
- A student or researcher at New York University can download a 2 MB PDF formatted journal article in one minute in the middle of the day.
- At the University of the Western Cape Library in South Africa, an article of the same size would take five minutes at about 9 a.m., when network usage is slow. The University of the Witwatersrand library reported approximately the same speed at the same time.
- During peak hours at Makerere University (8 a.m.-9 p.m.), “you can go to have a cup of tea and a relaxed chat with your friends as the file downloads.”


Because of the centrality of bandwidth to university life, improving access to more and cheaper bandwidth, managing it efficiently, and using it appropriately for teaching, learning, and research came up in almost every discussion during the ICT workshop organized by the Partnership in Addis Ababa in July 2002. In Addis Ababa, conference participants unanimously agreed that bandwidth is a critical issue for African universities.

Bandwidth Study Rationale

The broadband study was organized at the request of the Partnership foundations in order to provide them with sufficient information to make appropriate recommendations to their presidents on whether it would be
appropriate to approach international satellite companies to request cheaper or free bandwidth for universities and institutions of higher learning in the six Partnership countries—Mozambique, South Africa, Uganda, Tanzania, Ghana, and Nigeria.

The study required information on and analysis of four interrelated questions:

- Which companies are selling bandwidth to Africa or would be able to do so;
- Which companies have spare bandwidth to donate or sell cheaply for use in African universities;
- Which companies might be amenable to an approach from the Partnership; and
- Whether the universities that the Partnership supports, using their existing or planned infrastructure, could tap access to more bandwidth.

These questions are complicated because economic, market, and regulatory conditions differ greatly in the six Partnership countries. In South Africa, the university network has been able to work with the government, the higher education sector, Telkom SA (the national telecommunications operator), and the donors, to create the Tertiary Education Network of South Africa [TENET (SA)]. In Uganda, there is a burgeoning local market and some competition, which is lowering bandwidth costs for everyone. In the remaining countries, universities primarily rely on VSAT systems. It is important to have a better understanding of conditions on the ground in the countries in which the Partnership is active to determine the feasibility and usefulness of intervention.

**Task Force Members**

The University of Dar es Salaam coordinated and led the study (see below), with significant input from ICT specialists and administrators in each of the Partnership countries. The complete list of Task Force members is as follows:

- **Mozambique** (Venancio Massingue, Vice Rector for Administration and Resources, Eduardo Mondlane University, and Francisco Mabilla, Deputy Director, Eduardo Mondlane University Computer Centre)
- **South Africa** (Derek Keats, Executive Director, Information and Communication Services, University of the Western Cape)
- **Uganda** (F.F. Tusubira, Director, Directorate for ICT Support, Makerere University, and Commissioner, Uganda Communications Commission)
- **Tanzania** (Beda Mutagahywa, Director of the University of Dar es Salaam Computer Centre, and Tolly Mbwette, Professor, Civil Engineering and the Built Environment, University of Dar es Salaam)
- **Ghana** (Mumuni Dakubu, Director, University of Ghana ICT Centre)
- **Nigeria** (Mamman Aminu Ibrahim, Deputy Director, Department of ICT, National Universities Commission)

In addition, two resource persons joined the team: Mike Jensen, a South African with expertise on the political economy and technology of bandwidth from an international perspective, and Aida Opoku-Mensah, the UN Economic Commission for Africa Team Leader for Promoting Information Technology for Development. Lisbeth Levey, Partnership Facilitator, served as an *ex officio* member.

**Terms of Reference**

The study terms of reference included two components—one for “In Africa,” which examined national and institutional issues, and one for “Outside Africa,” which identified and made recommendations concerning issues...
to bear in mind, satellite providers with an interest in Africa, and bandwidth projects relevant to Africa. Go to Appendix 2 for the full terms of reference; a summary is presented below, which reflects discussions in Dar es Salaam that called on African universities to take a proactive role in addressing bandwidth issues:

- Surveying national and institutional ICT capacity in Partnership countries
- Identifying telecommunications regulatory conditions, pricing, and marketing—both current and desired and the involvement of the universities
- Identifying bandwidth uses, management, current utilization, and future needs
- Designing ways to use bandwidth creatively
- Identifying human resource and training requirements;
- Determining whether internal university infrastructure is sufficient, including maximizing student access;
- Assessing the potential for collaboration with other African institutions
- Identifying bandwidth providers and funders of bandwidth projects that are relevant to Africa
- Making recommendations on the role of universities, governments and the partner foundations in obtaining increased bandwidth, managing it efficiently, and sustaining its availability

**Study Methodology**

The Task Force worked together through a discussion group moderated by the University of Dar es Salaam and met once in March 2003 at the University of Dar es Salaam. Each member of the group prepared a draft discussion paper for the Dar es Salaam meeting. These papers were revised and circulated following the meeting. This report is based on input from the email list, the Dar es Salaam meeting, the discussion papers, and a literature review of relevant ICT materials on the Web.

**Report Contents**

This report is organized according to the terms of reference outlined above, as follows:

- Chapter One: background information on ICT capacity and related information in each of the Partnership countries.
- Chapter Two: an assessment of ICT capacity and utilization in Partnership grantee university and, in some cases, the higher education sector nationally.
- Chapter Three: a description of five academic and research collaborative projects in Africa that require ICT—three of them would make heavy use of bandwidth if it were available, two of them are not bandwidth intensive. These projects are illustrative of the kinds of activities that can benefit from good Internet access and the pitfalls encountered when bandwidth is insufficient to meet project needs. They also demonstrate the uses to which ICT is being put right now.
- Chapter Four: “Out of Africa” questions
- Chapter Five: Recommendations

**Recommendations**

The original terms of reference, under which this study was set up, called on the Task Force “to provide the Partnership foundations with sufficient information to make appropriate recommendations to their presidents
on whether it would be appropriate to approach international satellite companies to request cheaper or free
bandwidth for universities in any of the six Partnership countries.” Upon investigation, the Task Force conclud-
ed that the task was not so simple and that a more elaborate strategy would be necessary. It is this strategy
that is outlined below, bearing in mind that reliance on satellites is not a long-term solution but rather a short-
to medium-term coping strategy.

**Using economies of scale to obtain more bandwidth**

“SAT3 goes from Lisbon down the west coast of Africa to South Africa. SAT3/WASC/SAFE (to include all its legs) was fi-
nanced and built by a consortium of 36 organizations...There is no fibre covering Africa’s east coast and few internal fibre
connections on the continent except in large cities.”

*Source: Russell Southwood, “The Balancing Act,” Issue 178*

Recommendations are broken into three broad, sometimes overlapping, categories. The first category, which
is laid out in detail in Chapter Five, presents our recommendations on how to obtain more bandwidth at lower
costs, with a focus on planning and financial issues as they pertain to obtaining economies of scale. This
category is based on the questions addressed in the “In Africa” and “Out of Africa” sections of this report. As
can be seen from chapters one-four, satellite bandwidth is expensive when compared to terrestrial alterna-
tives. Long-term strategies will clearly entail migrating to international fiber—when it becomes locally avail-
able. In the short term, however, this option is not viable in five of the Partnership countries for the reasons
laid out in Chapters One and Four. The Task Force therefore recommends a strategy that entails a collaborate
effort to obtain bandwidth. Acting together will improve the economies of scale to reduce the overall costs of
bandwidth and improve the negotiating capacity of participating institutions. Collaboration will require careful
planning. We propose the following steps to be taken by the Bandwidth Task Force:

- Establishing a detailed plan and costing for setting up a hub in Europe or North America to provide band-
  width to the Partnership universities, with the potential to scale up and include other institutions in the
  educational sector.
- Contacting potential stakeholders, in Partnership countries and internationally. (See 4.4 and 4.5 for a list
  of possible international collaborators and satellite providers.). This step would also involve developing a
  Request for Proposal (RFP) to be given to the satellite providers and collaborators, which would entail a
  clear business plan.
- Short-listing companies that have expressed an interest to offer access services to African educational
  and research institutions at fair and competitive rates.
- Selecting the winning satellite providers.
- Jointly seeking funding for implementation.

**What should the universities do?**

The second set of recommendations is intended for the universities themselves so that they will obtain maxi-
mum utilization of available and future bandwidth:

- Support the formulation of ICT policy and master plans for those without such plans because they provide
  a coordinated and prioritized action framework for introducing ICT services and systems
- Develop proper and adequate ICT infrastructure to ensure optimum utilization of bandwidth
- Train, employ and retain ICT personnel to operate, maintain, and manage ICT investments
• Prepare plans for end-user training including students and staff on the use of Internet efficiently
• Develop strategies for monitoring utilization of bandwidth and security enhancement
• Implement an ICT-mediated learning and teaching mode, including the adoption of virtual classrooms, online library access materials, etc.

In addition to the above recommendations, which are targeted at individual universities, it would also be appropriate to conceptualize and plan for interventions that would warrant collaboration among universities. Consortia to purchase bandwidth is one such instance, of course. Others include organizing joint training programs; sharing of expertise and experience in the areas of ICT planning, infrastructure, and management, for example; and collaboration in the development of innovative ICT teaching modules.

National-level ICT planning and implementation
Obtaining better bandwidth will require the active involvement of government. For this reason, Task Force members also articulated recommendations for Partnership countries. We believe that governments should:

• Have a workable National ICT Policy and Master Plan;
• Develop the national backbone to create cheap access to Internet for the education and research sectors (including libraries);
• Speed up the efforts to link the partner countries to Internet backbone through high capacity fiber optic cables;
• Monitor effective use of ICT services, infrastructure, and facilities within the universities, research, and educational institutions;
• Establish favorable tariffs for the education and research sectors in their respective countries;
• Assist the efforts of the universities and research institutions in their attempt to access bandwidth in terms of financial and policy frameworks;
• Provide room for negotiations with the international bandwidth operators in order to get cheaper and more bandwidth for research and educational institutions in each country.

Next steps for Partnership assistance
The recommendations outlined above and described more fully in Chapter Five represent an ambitious, although phased, agenda. At the outset, the Task Force requests assistance from the Partnership by providing the resources for a small secretariat to manage the start-up of activities pertaining to using economies of scale to obtain more bandwidth. This will involve: engaging in the short-term research required to carry out the steps delineated in the economies of scale section, carrying out outreach, and writing a business/work plan.

The University of Dar es Salaam proposes to continue to host the Secretariat, in coordination with the Partnership Facilitator. UDSM would hire a full-time assistant for the Secretariat. Members would include representation from the Bandwidth Task Force; one person experienced in bandwidth management and/or negotiations with regulatory agencies (perhaps from TENET (SA); one person conversant with technical issues; and one person to represent the telecommunications regulatory agencies in each of the six Partnership countries. UDSM believes the job could be done over a six-month period, at a budget in the range of $55,000.

Following the successful completion of this phase, satellite operators will need to be contacted to make them fully aware of the seriousness and scale of the project and of the need to provide discounted bandwidth. This would be the time to ask the presidents of the Partnership foundations to become active participants by assisting the Bandwidth Task Force in approaching the satellite operators. In addition, prior to implementation, it may also be necessary for the foundations to assist in lobbying national governments to waive license fees or import duties for equipment. The Task Force will collaborate with the Partnership
in determining the most appropriate nature of this assistance, which might involve help with developing negotiating tools and strategies rather than direct intervention by the foundations. It is also likely that support will be needed from the foundations for shared equipment and technical capacity building.

At the end of this start-up process, which we hope will be supported by the Partnership, the Task Force will have a detailed implementation work plan and budget to put in place the most appropriate economies of scale scenarios that are appropriate to our institutions. The ultimate goal is to create a viable model for establishing a broad educational backbone on the content. These first steps by the Partnership universities will set an example for other universities in Africa.

As a final note, although the authors have tried to write for a non-technical audience, portions of the report are, of necessity, technical in nature. It is important to remember that the technology of access is important because it is an important determinant of the price of access. Many African countries, including all of the Partnership countries except South Africa, rely on satellite-based access, easily the most expensive way of accessing the Internet backbone.
Background Information on Partnership Countries

1.1 An ICT Overview by Country

With the exception of South Africa, all of the Partnership countries have inadequate ICT infrastructure and low teledensity—averaging between 2 and 12 fixed line telephones per 1,000 people. (The number goes up when mobile phones are factored in). South Africa, however, has a far more sophisticated telecommunications infrastructure in the major urban areas. In addition, as will be seen from the discussion below, higher education institutions in South Africa benefit from an extensive Internet network. For these reasons, South Africa will be discussed in less detail—except in areas where South Africa can serve as a resource for countries elsewhere in the region.

Consistent data on expenditures for ICT by country are hard to obtain and methodologies differ. As a part of its e-readiness grant making, the World Bank-operated multi-donor grant program, infoDev, is funding Pyramid Research to develop "a set of indicators that provide a comparable measure of the communications infrastructure level, investments, revenues and traffic flows in 60 of the major developing and developed markets of the world."4 Indicators are updated annually and placed on the infoDev Web site. Although Pyramid Research does not have separate data for each of the Partnership countries, it does have data on information infrastructure expenditures in four of the six countries. This category includes investment costs for access (land and mobile lines), switching, and transmission. Pyramid Research plans to collect this and other data through 2010.

Table 3: Information infrastructure investment, 2002

<table>
<thead>
<tr>
<th>Country</th>
<th>Amount (US $millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>$38.81</td>
</tr>
<tr>
<td>Uganda</td>
<td>$21.21</td>
</tr>
<tr>
<td>South Africa</td>
<td>$1,068.59</td>
</tr>
<tr>
<td>Ghana</td>
<td>$44.19</td>
</tr>
</tbody>
</table>

The table below provides general ICT-related information for the six Partnership countries.

Table 4: General ICT information for Partnership countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Number of HEIs</th>
<th>Personal Computers per 1000 people</th>
<th>Number of ISPs</th>
<th>Number of Dial-up Subscribers</th>
<th>Number of Internet Users</th>
<th>International Internet Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>35 million</td>
<td>30+</td>
<td>3.3</td>
<td>23</td>
<td>30,000</td>
<td>300,000</td>
<td>12,000 Kbps</td>
</tr>
<tr>
<td>Uganda</td>
<td>24 million</td>
<td>15+</td>
<td>3.1</td>
<td>5</td>
<td>7,000</td>
<td>70,000</td>
<td>9,250 Kbps</td>
</tr>
<tr>
<td>Mozambique</td>
<td>18.1 million</td>
<td>12+</td>
<td>3.5</td>
<td>10</td>
<td>6,000</td>
<td>15,000</td>
<td>2,088 Kbps</td>
</tr>
<tr>
<td>South Africa</td>
<td>43.2 million</td>
<td>36</td>
<td>68.5</td>
<td>200+</td>
<td>650,000</td>
<td>1,950,000</td>
<td>398,512 Kbps</td>
</tr>
<tr>
<td>Nigeria</td>
<td>129.9 million</td>
<td>350+</td>
<td>6.8</td>
<td>38 (12 are active)</td>
<td>10,000</td>
<td>115,000</td>
<td>15,000 Kbps</td>
</tr>
<tr>
<td>Ghana</td>
<td>19.7 million</td>
<td>15+</td>
<td>3.3</td>
<td>8</td>
<td>20,000</td>
<td>200,000</td>
<td>4,096 Kbps</td>
</tr>
</tbody>
</table>

Source: Pyramid Research, *Global Information Structure*

---

Notes
1. The statistics in table 4 are gathered from a number of sources: data obtained by Task Force members, the Mike Jensen Internet site (http://www2.sn.apc.org/africa/), the African Information Society (AISI) website (http://wwwuneca.org/aisi/nici/Default.htm), and the African international Internet bandwidth site, which is maintained by Mike Jensen for the IDRC Acacia Project (http://wwwidrc.ca/acacia/divide).

2. Because of the large number of shared accounts, and the high use of public access services, it is difficult to measure the total numbers of Internet users. While the number of dialup subscriber accounts is readily available, these figures are only a partial indicator of the size of the Internet sector, and other factors should be taken into consideration. In the past, a general “rule of the thumb 3:1 ratio was used, but it is increasingly in question because it depends on the extent to which countries have cybercafes and heavy academic and corporate utilization of bandwidth. In any addition some subscribers have an institutional account and many mailboxes that use it. Makerere University, for example, has almost 4,000 users for its account. Therefore, in some countries the correct ratio would be 10:1 or higher. Thus, the table above includes both dial-up subscriptions and the best approximation of “number of users” that the country teams were able to determine.

3. Because providing information on the total number of users in Africa is difficult, many experts now look at utilization of “international Internet bandwidth” as a more reliable measure of Internet activity because it takes into account a wide range of possible use—from those who send a few emails a week to heavy Internet users. It is for this reason that we have included a column on “international Internet bandwidth” in the table above. It is extrapolated from the Acacia international bandwidth site, which uses data from mid-2002 and is referenced above. It is likely that the amounts of bandwidth used have gone up since then.

1.2 National Infrastructure, Planning, Telecommunication Regulatory Conditions, Pricing and Marketing

In general, the regulatory environment is intrinsically tied to the extent to which users have access to all forms of ICT. Restrictive policies and monopolies result in uncompetitive prices and poorly serviced bandwidth provision, all of which restrict universities from making appropriate use of technology. On the other hand, a liberalized ICT sector results in more competition and the possibility of lower prices.

Universities in all of the Partnership countries, except perhaps South Africa and Uganda, would have no difficulty obtaining licenses to use satellite bandwidth. In South Africa, only the three international gateway license holders are allowed to carry such traffic, and in Uganda there is currently a duopoly with only eight VSAT licenses operational. This duopoly will end in 2005, however, and is discussed in more detail below. In addition, it is possible that special dispensation could be obtained in both of these cases, given the political imperative, especially under the New Partnership for Africa’s Development (NEPAD).

Three Partnership countries have mounted their national ICT Strategic plans on the Web. They are:

Tanzania
http://www.ethinktank.tz.org/esecretariat/ArchiveDoc.htm

Uganda
http://www.undp.or.ug/ict.htm

Mozambique
http://www.infopol.gov.mz
1.2.1 Tanzania

The Tanzania Telecommunications Company, Ltd., which is now partially privatized, is the sole provider of fixed telephone lines in the country. The Tanzania Public Switched Telephone Network (PSTN) has a hybrid backbone network (digital and analogue), using fiber optic, microwave, and satellite-based links. More than 95 percent of the network is now digital. In addition to fixed-line service, there are four mobile-phone operators, with coverage in almost every part of Tanzania, especially the rural areas.

The Tanzania Communication Commission (TCC) regulates the country’s telecommunications industry, which is now partially liberalized with a variety of players and a high level of competition. Private networks in Tanzania include those for the Tanzania Peoples’ Defense Force (TPDF), the Tanzania Revenue Authority (TRA), the Tanzania Railways Corporation (TRC), and the Tanzania Electric Supply Company (TESC). To encourage utilization of ICT, the government has waived all taxes associated with the importation of personal computers.

In March 2003, the government adopted a national ICT policy, which identified education as a priority area, including the establishment of special “e-rates” for the education sector. ICT experts from the University of Dar es Salaam and other HEIs were actively engaged in drafting Tanzania’s ICT policy. The TCC and line ministries are responsible for implementation of “e-rates,” but they are not yet in place. As a result, HEIs must negotiate with Internet Service Providers (ISPs) and satellite providers, with no assurance that they will receive favorable rates.

1.2.2 Uganda

The Uganda Communication Commission (UCC) is responsible for regulating the telecommunications sector, and is responsive to stakeholders (consumers, service providers, and government) while remaining independent. There are two operators (called National Operators), MTN and Uganda Telecomm Ltd, which are licensed to compete fully in the provision of all telecommunication services in a duopoly environment. The duopoly will end in June 2005 when the Uganda Communication Commission plans to open up all services to full competition. There are also three cellular service providers that are licensed to compete throughout the country.

The demand for an ICT literate population has become acute, as has the demand for reducing the cost of bandwidth because costs are now so prohibitively high. Uganda’s policy provides for an environment in which any well-reasoned initiatives that will provide cheaper bandwidth to universities would be seriously considered. There is a high involvement of the academic community in areas pertaining to ICT, including the formulation of ICT policy.

Current regulations (through 2005) imply that any educational institution must work through one of the licensed service providers to access the Internet. These regulations, however, permit corporate entities with branches outside Uganda to establish their own independent VSATs. The same regulation is applied to embassies and NGOs. This implies an entry point for Uganda’s tertiary sector to establish a formal academic and research network without waiting until 2005.

1.2.3 Mozambique

The Mozambique telecommunications infrastructure consists of a national backbone, covering all provinces up to the district level. This network is a combination of different technologies—VSAT, wireless loop, copper cable, and, most recently, a 5 Gbps marine fiber optic cable along the coast, linking in a first phase the coastal cities of Maputo, Xai-Xai, Inhambane, Vilanculos, and Beira. In the next five years the project will reach Quelimane, Ancoche, Nacala, and Pemba; it will also include links to the hinterland cities of Chimoio, Tete, Nampula, Lichinga, and Cuamba. Within the main cities, telephone switches are linked via optical fiber networks; copper is used to connect users to the secondary network. There is only one mobile operator, but competition is anticipated as other companies join the market in the coming years.

The national telecommunications network infrastructure is managed and operated by Telecomunicações de Moçambique, E.P. (TDM) and owned entirely by the State. The Telecommunications Law of 1992 established
TDM as the monopoly service provider for basic services, switching, and transmission. Complementary and value-added services, however, as well as data communications are open to competition subject to licensing by the regulatory body, the Instituto Nacional das Comunicações de Moçambique (INCM), which was established in 1992. There is no restriction on resale to third parties of TDM circuits as long as they are not used for voice traffic. The government plans to privatize the telecommunications sector, but TDM continues to invest heavily in infrastructure modernization. The government justifies this position as a way of strengthening TDM in preparation for a competition in a liberalized market.

Mozambique approved a national ICT policy in December 2000 and an implementation strategy in June 2002, in which six priority areas were identified, among them education.

1.2.4 South Africa

The government Department of Communications is responsible for setting policy for the communications sector, working closely with the regulatory bodies, postal services, the national broadcaster, and the national telecommunications network operators. The regulatory framework was redefined in 1996 and vested authority in the South African Telecommunications Regulatory Authority (SATRA) to administer the sector. This body was then superseded by the Independent Communications Authority of South Africa (ICASA), which retains the objectives of SATRA and the Independent Broadcasting Authority (IBA), which had been formed in 1993 immediately prior to elections.

In 1997, the state-owned monopoly telecommunications operator, Telkom, was issued a license to provide public switched telecommunications services for a minimum of 25 years, including an exclusivity period of five years which ended May 7, 2002. A process to establish a second national operator (SNO) to provide public switched telecommunications services began in 2002, with the expectation that licenses would be issued in 2003 or early 2004. The solicitation of applications for the SNO licenses was not well received by prospective domestic and international telephone service providers, however. At the close of the SNO license application process only two bids from relatively unknown players had been received, and these were subsequently rejected by ICASA as being unsuitable. The Minister of Communications overruled this and formed a committee to decide on the issue.

In 2002 an international carrier of carriers license and multimedia license was issued to Sentech, the government provider of broadcasting signal distribution services. This allows Sentech to provide international connectivity to the other licensed telecommunications operators and to provide multimedia data services to end users using VSAT and WiFi.

The SAT-2 marine fiber optic cable connecting South Africa to Europe was established by Telkom in the 1980s, but is now fully utilized at 1 Gbps. As part of an upgrade and broader strategy to become a hub for Africa, Telkom invested approximately $85 million in the SAT-3/WASC/SAFE submarine cable system. The 28,800 km cable is a combination of two distinct projects, the South African/Far East (SAFE) cable, which connects Cape Town to India and Malaysia via Mauritius, and the SAT-3/West African Submarine Cable (WASC), which links Portugal to South Africa, with landing points in eight African countries along the way. Telkom has the right to approximately 20 percent of the combined capacity on the cable system, making it the largest capacity owner out of the 36 telecommunications operators that invested over $650 million in the project. (The SAT-3/WASC/SAFE submarine cable system is also discussed in Chapter Four.)

The rate of expansion of the Internet sector has slowed in South Africa following saturation among the early adopters and more wealthy sectors, who comprise about three million users. Further growth has also been hampered by the high cost of infrastructure, which is only available from the monopoly telecommunications provider, and the low levels of disposable income among the broad mass of the population. In contrast to the sluggish dial-up market, the growth in number of leased lines is significantly higher. The number reached more than 7,000 at the end of 2001, reflecting increasing demands for bandwidth among corporate users of the Internet.
After consolidation in the market reduced the number of ISPs, the number of ISPs has grown again, largely due to the rollout of a Virtual ISP service by Internet Solution and the continued heavy use of the equivalent service from Telkom, bringing the total to over two hundred. M-Web is the largest ISP with 240,000 subscribers as of 2002; Tiscali World Online is the second largest ISP, with 130,000 subscribers.

1.2.5 Nigeria

Nigeria does not have a national network backbone. The SAT-3/WASC submarine cable project, with a landing point in Bonny, has been completed to develop an international fiber link, to Lagos, but the lack of a national network backbone infrastructure means that more than 90 percent of the country is currently left out. Indeed, existing network projects in planning stages appear to assume that no national backbone will be available. In 2002, Nigeria added 1.3 million new mobile customers and reported the highest annual growth rate—369 percent—in the world.

Nigeria has been steadily opening up its communications sector to competition. It recently introduced a second national network operator (Globacom) to compete with the incumbent national fixed line operator Nitel. It has also issued about 25 Fixed Wireless Access licences and a number of other telecommunications operators licenses.

Largely because of the limited telephone infrastructure, Internet distribution is highly skewed towards the major cities – dialup infrastructure is available in the major urban centers of Lagos, Abia, Aba, Bauchi, Ibadan, Ile-Ife, Abuja, Benin City, Kano, Enugu, Kaduna, and Port Harcourt. Users in other urban centers have to make long distance calls to obtain access. Even in towns where ISPs have a point of presence, the number and quality of telephone lines available is a severe constraint. Obtaining a connection through Nitel’s aging network is often difficult and may require several trials before a connection with the ISP is achieved. As a result many ISPs serve their customers with WiFi links and many users have multiple dialup accounts to ensure reliability of access.

“Nigeria’s federal universities were established to serve as foci for national development, and often have to render services to their surrounding communities—including water, health, and library services. Unfortunately, Nigeria’s developmental objectives and projects have tended to ignore universities entirely. For example, instead of using them to launch well-funded national programs, such as rural Internet access and telephony, public awareness campaigns, and training and research on ICTs, the present IT policy for Nigeria seeks to establish at least six new IT institutions from scratch rather than facilitate the development of IT competence in any of the 300+ higher education and research institutions in the country. This tradition is such that the country now has more government-owned research institutes and special agencies than universities, colleges, and polytechnics, all competing basically for the same increasingly scarce funding and staff resources.”

Aminu Ibrahim

Neither the Nigerian telecommunications policy document nor the national policy for information technology has a chapter on education. The two policy documents have already been approved by the Federal Executive Council. The National Communications Commission (NCC) and the Nigerian Information Technology Development Agency (NITDA) have begun implementation, although legislation is still pending in the National Assembly. The telecommunications policy being implemented by the NCC is more favorable to the tertiary education sector than is the NTIDA document, perhaps because the telecommunications policy was subjected to wider consultations, beginning with a legislative public hearing in 1999. In the case of the information technology policy, such wide consultations have not taken place. Nigerian universities and higher education institutions appear helpless on many fronts. They are often not aware of policies and regulations that are detrimental to their interests or whom to approach and what to request. This situation places Nigerian universities at a seri-
ous disadvantage in their efforts to implement ICT efficiently, for telecommunications policies will impact on
their ability to make intelligent decisions concerning Internet and other technologies.

1.2.6 Ghana

Ghana’s existing infrastructure inventory includes Voltacom’s fiber optic network, Ghana Telecom’s digital
microwave Synchronous Digital Hierarchy (SDH) multiplexer backbone, the Accra metro fiber SDH network,
the Kuntunse satellite teleport, the West African Submarine Cable (SAT3), and the GNPC (Connexsat) satellite
network. Ghana Telecommunications paid US$24 Million as its contribution towards SAT-3/WASC. Installation
and acceptance tests were completed in early 2002. (The same is true for Nigeria; see above.)

The National Communications Authority (NCA), which was established in 1996, is the regulatory body with the
responsibility for creating transparent mechanisms for the regulation of the telecommunications sector and
the promotion of a stable operating environment for all participants. The telecommunications sector is partially
privatized. Ghana was one of the first countries in Africa to license a second network operator to compete with
the incumbent government telecommunications provider; however, it has not performed as well as expected.

Ghana has a national ICT policy, and the government has established two sub-committees—one for communi-
cations infrastructure and one for management structure—to examine how best to implement the principles
laid out in the policy document. Each committee is also mandated to formulate an enabling policy and regula-
tory legal framework pertinent to its mission. The work of the communications infrastructure sub-committee is
the one of relevance to Partnership efforts in securing affordable bandwidth.

Table 5: Summary of national fiber optic backbone in Partnership countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>The Tanzania Public Switched Telephone Network (PSTN) has a hybrid backbone network (digital and analogue), using fiber optic, microwave, and satellite-based links. More than 95 percent of the network is now digital. In addition to fixed-line service, there are four mobile-phone operators, with coverage in almost every part of Tanzania, especially the rural areas.</td>
</tr>
<tr>
<td>Uganda</td>
<td>An internal fiber backbone already extends to the major centers of Kampala, Entebbe, and Jinja. Kampala has two backbone networks owned by MTN and UTL that link to all major buildings and centers in the city. An Internet exchange point operated by the ISP Association is operational. Specific expansion plans by the service providers outside the main centers is strategic information that they cannot easily release at this time. The more critical issues of linkage within East Africa and linkage to the international backbone are under discussion among the private service providers and within the East African Community. This project, however, has been in the works for some time, and it is hard to give a timetable for implementation. Privatization of the telecommunications sector in Kenya will have a major impact on deliberations.</td>
</tr>
<tr>
<td>Mozambique</td>
<td>The Mozambique telecommunications infrastructure consists of a national backbone, covering all provinces down to the district level. Additional locations will be reached in the next five years—Quelimane, Angoche, Nacala, Pemba, Chimoio, Tete, Nampula, Lichinga, and Cuamba.</td>
</tr>
</tbody>
</table>
South Africa

Although fixed-line teledensity is relatively high for South Africa, at over 10 percent, there are profound differences in the telecommunications infrastructure between rural and urban areas. South Africa has an extensive national telecommunications network, with first-world infrastructure in the commercial centers, but this contrasts with very low penetration of services in rural and remote areas. To counter this inequality, part of Telkom’s license conditions required a network roll out for the installation of about 1.7 million lines in under serviced areas. A large proportion of these lines were subsequently disconnected, however because of non-payment.

Ghana

Ghana does not yet have a national backbone. Its existing infrastructure inventory includes Voltacom’s fiber optic network, Ghana Telecom’s digital microwave Synchronous Digital Hierarchy (SDH) multiplexer backbone, the Accra metro fiber SDH network, the Kuntunse satellite teleport, the West African Submarine Cable (SAT3), and the GNPC (Connexsat) satellite network.

Nigeria

Nigeria’s does not have a fiber optic backbone. There is a high-capacity marine fiber optic cable to link Lagos, Wary, Bonny, and Port Harcourt. The same fiber has been extended from Port Harcourt to Enugu and Calabar through Aba. Another fiber optic link was recently completed between Enugu and Abuja. In addition, optic fiber networks have been installed in Lagos, Ibadan, Enugu, Kaduna, and Abuja.

1.2.7 Teledensity

The table below provides data on teledensity in each of the Partnership countries. We have used the numbers given in the 2003 United Nations Development Program Human Development Index because they are the latest most uniform and reliable figures that we could obtain. (UNDP derived these statistics from the International Telecommunication Union.)

The number of mobile phones being used in Africa is greater than the number of fixed lines and those numbers can only go up as people flock to cell phones when they cannot get conventional telephones at home. It is important to remember, however, that neither the standard fixed nor mobile lines have any impact on meaningful Internet usage in Africa because of the high cost of calls and bandwidth issues. Heavy users, such as academic institutions and large organizations, use dedicated leased lines (wired or wireless) or VSATs. The real significance lies in the number of lines and growth rates as an indicator of sector dynamism. It is also possible that the high capacity GSM microwave systems that mobile operators use could also be utilized to link African universities nationally in countries where fiber optic lines are not in place and internationally in countries that have a landing point for one of the submarine cables. This scenario is only realistic in countries where mobile operators have built up their own backbone infrastructure and have spare bandwidth and where the regulatory framework permits such a relationship.

Table 6: Teledensity in Partnership countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Fixed Lines per 1000 people</th>
<th>Mobile Lines per 1000 people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>4</td>
<td>1.3</td>
</tr>
<tr>
<td>Uganda</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Mozambique</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>South Africa</td>
<td>111</td>
<td>242</td>
</tr>
<tr>
<td>Nigeria</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Ghana</td>
<td>12</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: Human Development Index 2003 (data from 2001)
1.3 ICT Training in Partnership Countries

At the Addis Ababa ICT workshop and then at the Bandwidth Task Force meeting in Dar es Salaam, ICT training was identified as an important variable for the sustainability of ICT development in Partnership countries. Appropriate training is critical, for it means that bandwidth, which is an expensive resource, can be used efficiently. Even so, everything comes back to bandwidth—better access to bandwidth can facilitate Web-based technical training, for example.

The recognition of ICT as a major tool for development in Africa has created many avenues for training ICT personnel, but more needs to be done. Sufficient and sustainable human-resource development to sustain the use of bandwidth in the education and research sectors is essential. This includes technical training and also ICT management and policy training. If African universities are to have the capacity to make their voices heard in the policy and regulatory environment, they must have the tools with which to do so.

The discussion below describes and assesses ICT training available in all of the Partnership countries. South Africa is also included because of the potential of taking advantage of training opportunities offered there on an individual or a regional basis.

1.3.1 Tanzania

In Tanzania, course restructuring was carried out in the public universities to include ICT applications in each degree program. The University of Dar es Salaam now offers various ICT programs, including degrees, postgraduate diplomas, and a master’s in computer science and ICT-related subjects. There are more than 20 private and public institutions offering ICT certificates, diplomas, and advanced diplomas in Tanzania. The University of Dar es Salaam also hosts the African Virtual University Learning Center (AVU-LC) that collaborates with the Royal Melbourne Technology Institute in Australia in providing a virtual distance learning program in computer science leading to a certificate, diploma, or degree. The University Computing Center Ltd., which is solely owned by the University of Dar es Salaam, serves as a regional center for the Cisco Networking and Programming Academy, and has a mandate to issue licenses to other institutions.

1.3.2 Uganda

Because the high cost of establishing ICT-related programs, not all the universities offer in-depth ICT training (including electrical engineering and computer science), and those that do face acute shortages of staff and training resources. Makerere University is the only one to offer a degree program through the doctoral level. Approximately 320 students are in electrical engineering, 700 in computer science, and more than 500 are taking computer science in combination with other subjects. Seven universities offer a bachelor’s degree in computer science. Many of the universities in this category are in the process of establishing local academies for training to become a Cisco Certified Network Associate (CCNA), and will thus be positioned to become part of the higher Cisco Certified Network Professional (CCNP) Academy roll out.

There are also some institutions in Uganda that offer training at technician level, a cadre that is critically lacking in Uganda. While Kyambogo University oversees several technical colleges, Uganda Institute of Information and Communication Technology (UICT, formerly UCI), run by the Uganda Communications Commission, has the most focused approach to ICT training. It is not surprising that it is now a CCNA Regional Academy, overseeing the rollout of this program in universities and technical institutions. Makerere University, on the other hand, is establishing a Regional CCNP academy with the first intake planned for August 2003.

1.3.3 Mozambique

The ICT sector in Mozambique is one of the most competitive sectors in the national market, thanks to the business opportunities brought about by external investments. The country requires ICT professionals in every sector, but the private sector has been able to hire and retain a higher proportion of ICT personnel because salaries there are so much higher. There are very few ICT-dedicated institutes in Mozambique. The existing universities teach informatics and telecommunications-related subjects but only one university has introduced a
master’s degree in computer sciences. The informal ICT sector is still embryonic. There are isolated instances of basic computer training and hardware repair. In addition, plans are underway to establish the Mozambique ICT Institute, which will have three components namely, research and learning, a technology incubator, and a science park. Eduardo Mondlane University developed the concept, conducted a feasibility study, and is now involved in the initial implementation stages.

1.3.4 Ghana

In Ghana, the University of Ghana (UG), Kwame Nkrumah University of Science and Technology (KNUST), the University of Cape Coast (UCC), and Ashesi University offer degree courses in computer sciences. In addition, UG, KNUST, and UCC offer a variety of ICT-related programs through the African Virtual University. In the private sector, there are nearly 15 institutions that offer various courses in computer science and ICT at certificate and diploma levels.

1.3.5 Nigeria

A recent article in CYBERSCHUULNEWS (040403-87) indicated that to sustain development of the telecommunications market, Nigeria requires 2,600 telecommunications engineers. There are probably that many unemployed graduates, but the article also indicated that only 6 percent out of 400 tested could be employed without extensive re-training.

During the International Conference on Human Capital Development & Global Opportunities in the ICT Industry, held from May 14-16, 2001 in Abuja, Professor Munzali Jibril (then the Executive Secretary, National Universities Commission), alerted Nigerian universities and other HEIs to the fact that they were not producing enough ICT technical staff to meet even their own requirements, much less the needs of the nation. According to his report (“On Meeting the Challenges of Providing Nigeria’s Human Capital Needs for ICT”), although 30 Nigerian universities (17 federal and 13 state universities) offer computer science, their total graduate output in 1999/2000 was only 3,789: 1,889 in mathematics and computer science and 1,900 in electrical engineering/electronics. Similarly, in the 45 Nigerian polytechnic institutions, only 7.7 percent (8,873 students) of the total enrollment had majored in the relevant ICT subjects. Even if every one of these students went to work in the tertiary sector after graduation, the number is not great enough to meet its needs. More recently, the Federal Ministry of Education (“Current Policies and New Directions of Government on University Education”, March 2003) estimated that Nigeria presently has 3,451 skilled ICT staff against 8,350 required in the next 5 years, with a human resource deficit of 4,899. The basis for the estimates, however, was not given; the report should be interpreted taking into consideration the assessments described above.

Perhaps of even greater concern, however, is the quality of human-resource output from Nigerian Heist, given their lack of adequate teaching laboratories and the level of facilities’ deterioration in general (including the libraries). These factors, combined with a failure to revise technical curricula to take into consideration recent ICT developments, has trapped and frozen course offerings and computer centers in the era of mainframe and data-crunching equipment.

1.3.6 South Africa

South Africa is in a category by itself. While training needs are still vast, it has a significant “first world” higher education, research, and polytechnic sector, augmented by many private sector offerings, ranging from foreign private universities and large commercial training schools to small business and informal training facilities and even some government-sponsored ICT literacy programs in rural areas.

Almost every university and technikon offers degree courses in the relevant subjects. There are also numerous private-sector courses at various levels. The University of South Africa (UNISA) also has an ICT program as part of its distance education service, which has over 100,000 registered students, many of whom are outside of South Africa. Through agreements with host institutions, UNISA maintains examination centers in 17 African countries, including Mozambique and Tanzania. ICT is also an important component of a
partnership between the major South African distance and continuing education institutions—UNISA, Vista University and Technikon SA—called the Confederation of Open Learning Institutions in South Africa (COLISA).

In addition, TENET now manages the DITCHE program (Development of IT Capacity in Higher Education) to develop IT capacity in higher education institutions in South Africa. In 2002, DITCHE organized a very successful “Techie Event,” under the auspices of the National Research Foundation, to pass on IT services experience and expertise and to encourage human networking among IT support staff. DITCHE is now planning to host a symposium on bandwidth management strategies, a topic of keen interest to ICT directors elsewhere on the continent. Finally, South Africa is taking the lead in developing a number of regional initiatives, some of which already involve other Partnership countries. These include the establishment and facilitation of National Educational and Research Networks (NRENs), and a number of collaborative programs already being implemented—SeaweedAfrica, the International Ocean Institute Virtual University, and a new master’s program in telecoms and ICT policy and regulation. These latter activities are described in more detail in Chapter Three of this report.
ICT and Internet in Partnership Countries

With the exception perhaps of South Africa, higher education institutions on the continent import ICT from developed countries. Most governments permit the importation of ICT equipment at little or no charge as part of their policy to combat poverty and promote education. For reasons well known to the reader, African HEIs suffer from poor ICT infrastructure. Only a few universities with subsidies from donors and the government have a reasonably well-developed infrastructure (campus backbone and LANs), but all of them confront the problem of too few computers. The ability to access available bandwidth is also facilitated or impeded by the number of computers available to university users. None of the universities have nearly enough computers to go around. The universities that fall within the Partnership aegis estimate that they should increase the number of computers at their institutions by more than 500 percent in the coming three to five years. Makerere University has 1,800 computers, but a population of more than 30,000 students.

Table 7: Number of networked computers in Partnership universities

<table>
<thead>
<tr>
<th>University</th>
<th>Number of Networked Computers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Dar es Salaam</td>
<td>2,100</td>
<td></td>
</tr>
<tr>
<td>Makerere University</td>
<td>1,800</td>
<td>Makerere University expects to have about 8,000 networked computers for 45,000 students in five years. (The target is actually 10,000)</td>
</tr>
<tr>
<td>Eduardo Mondlane University</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>University of Ghana</td>
<td>450</td>
<td>The university expects that the number of networked computers will be about 1,500-2,000 in four-five years.</td>
</tr>
<tr>
<td>Bayero University</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Obafemi Awolowo University</td>
<td>1,250</td>
<td></td>
</tr>
<tr>
<td>University of Ibadan</td>
<td>650</td>
<td></td>
</tr>
<tr>
<td>University of Jos</td>
<td>360</td>
<td></td>
</tr>
</tbody>
</table>

The ICT capacity of private institutions depends on the fees that they charge and the priority they give to ICT. In Mozambique, for example, the Higher Polytechnic and University Institute (ISPU) and the Higher Institute of Sciences and Technology of Mozambique (ISCTEM) have excellent ICT facilities, although much of the teaching staff moonlight from their positions at Eduardo Mondlane University. In Ghana, Ashesi University, which has benefited from Microsoft funding, also has an excellent ICT infrastructure for its small campus in Accra.

Because of the infrastructure problems described in Chapter One, all of the Partnership universities, with the exception of those in South Africa and Uganda, rely on their own VSATs or links to private ISPs for their connectivity to the Internet. In turn, these ISPs use VSATs. At the moment, South Africa is the only one of the six Partnership countries that does not require a VSAT at some point along the way. Although the Sat3/West African Submarine Cable/South Africa Far East (WASC/SAFE) now lands in Nigeria and Ghana, it is not yet feasible to consider it as an option for these two countries. Although there are plans for an East Africa link (Uganda/Kenya/Tanzania) and Mozambique, using satellite and terrestrial facilities, it will take at least two or three years for implementation.

The sections below address ICT infrastructure, Internet, bandwidth, and related issues within the universities receiving support from any of the Partnership foundations.
2.1 ICT Infrastructure and Planning

Universities supported by the Partnership in three countries also have ICT information on their Web sites:

University of Dar es Salaam
http://www.udsm.ac.tz/ict_udsm/ict_milimani.html

Makerere University
http://www.makerere.ac.ug/makict/

Eduardo Mondlane University
http://www.uem.mz/ictproj/ictarec/index.htm

2.1.1 Tanzania

With a fiber optic backbone on the main campus and its two college campuses that connects all of the main buildings, the University of Dar es Salaam has, by far, the most well-established infrastructure of all of the tertiary-level institutions in Tanzania. Each academic building and some of the halls of residence are connected to local area networks. Plans are also underway to connect some of the university staff houses to the main backbone through a wireless link. The university has about 2,000 computers, of which more than 90 percent are connected to the Internet. UDSM also benefits from its University Computing Center, Ltd. (UCC), which offers ICT services, including maintenance, to the entire university community. Sokoine University also has a computer center, but the remaining institutions rely on academic staff that are also ICT specialists to coordinate ICT-related activities.

UDSM and Sokoine University are the only ones with their own VSATs. The remaining tertiary-sector institutions, both public and private, rely on wireless links or leased lines to an ISP. Currently no joint efforts are in place to negotiate with bandwidth suppliers and ISPs, although the University of Dar es Salaam is leading efforts to form the Tanzania Educational Network–TENET (T) – that would negotiate with suppliers for cheaper and more plentiful bandwidth. To date, 15 institutions have signed the TENET (T) Memorandum of Understanding (MOU), and there is room for additional educational and research institutions to join. TENET (T) is in the process of registering as a non-governmental, non-profit organization.

UDSM is also the only institution in Tanzania with an ICT policy and master plan. (Hurbert Kairuki Medical University received a grant from the Ford Foundation in 2002 to write an ICT policy.) As a result, with the exception of UDSM, Tanzania’s HEIs are hard put to articulate the amount of bandwidth available and needed for different applications, such as for the library, teaching and learning, research, and administration. Bandwidth requirements and availability vary greatly in the different institutions. Available bandwidth ranges from 128/64 Kbps to 10 Mbps.

2.1.2 Uganda

Makerere University, which is a publicly owned university, has better ICT infrastructure and facilities than the remaining HEIs in Uganda. The network backbone of the university is single-mode optical fiber covering four campuses. Redundancy is built into the network. Although ICT implementation started only three years ago, it has been able to roll out systems and services in a more coordinated fashion because it also developed an ICT strategic plan. As stated above, procuring more computers remains an ever-present challenge. Makerere University opted not to purchase a VSAT, preferring to rely on a leased line to a commercial ISP in Kampala.

---

5 Most of the Partnership universities employ an asymmetrical link—“thin up/fat down”—bandwidth strategy on the principle that less bandwidth is required to send data to the Internet and more to receive large data, image, and text files.
Although it would appear that a VSAT would significantly reduce link costs, the university found through an open tendering process that included a VSAT that a leased line was the most cost-effective option for any institution in Uganda working at less than 2 Mbps downlink capacity. The link is provided by the two national operators: MTN (256/512Kbps) and UTL (1,024 Mbps Mbps/2 Mbps). It is worth noting that Makerere University is now Uganda Telecomm’s biggest corporate client for Internet bandwidth.

At the outset of the Makerere University ICT implementation, there was no campus-wide ICT support center. With the master plan in place and funding available, the university created the Directorate for ICT Support, which has now built up the core competencies necessary for information resource management. Specialized human resource capacity, however, remains a challenge.

In September 2002 the Forum of Vice-Chancellors of Uganda agreed in principle to set up an institutional and infrastructure framework network, the Uganda Universities Network (UniNet). This will establish the national network for delivery of Internet through a network linking higher education and tertiary education institutions in Uganda.

2.1.3 Mozambique

In 1995, with a link to South Africa from Eduardo Mondlane University, Mozambique became the second country in sub-Saharan Africa outside of South Africa to have full Internet connectivity. Eduardo Mondlane University has remained inextricably tied to the development of Internet in Mozambique since then. UEM operates an 11 Mbps wireless metropolitan area backbone, which interconnects all faculties and university services located outside the main campus. Five student residence halls also have computer rooms linked to the backbone. All faculties have their own LANs, most of which have one or more computer labs for students and lecturers. The university computer center hosts and manages the university’s VSAT and provides ICT services to the university. UEM was the first of the Partnership universities to write and implement an ICT strategic plan. In the early days, both UDSM and Makerere University were able to benefit from UEM’s experience. Compared to UEM, Mozambique’s other public universities have very poor ICT facilities and infrastructure and no ICT strategic plan. They rely on dial-up or cable TV networks for their Internet connection; they are also hampered by a paucity of technical staff, instead of relying on an outsourcing approach.

2.1.4 Ghana

ICT development in Ghanaian universities started in the mid 90’s, but growth has been slow and difficult for a number of reasons:

- Ghana’s poor infrastructure and no clearly defined national ICT policy framework
- Slowness in the deregulation of the telecommunications sector, which resulted in a lack of private sector participation
- Tardiness on the part of the universities themselves in realizing the potential of ICT (with the exception of the libraries, which were frequently at the forefront of ICT developments, such as utilization of email and CD-ROM)
- Financial constraints

The situation is beginning to change, but Ghana and also Nigeria (see below) lag behind the other Partnership countries. Of Ghana’s five public universities, only the University of Ghana (UG) has an ICT strategic plan; Kwame Nkrumah University of Science and Technology (KNUST) and the University of Education Winneba (UEW) are in the final stages of developing one. Both UG and KNUST also have computer centers. UG has a campus fiber backbone with four access points on it. KNUST, the University of Cape Coast, and UEW have local area networks of one kind or another. The University of Development Studies has the weakest infrastructure of all, with only a few LANs in the administration building.

---

6 Zambia was the first country, with a link through the University of Zambia
Until 2002, Ghana’s public universities (with the exception of UDS) shared bandwidth for Internet connectivity through a Research Education Network (REN). REN failed for a number of reasons—among them poor infrastructure at the universities; problems with the wide area network; poor communication between the University of Ghana, where the hub was located, and the universities; and inadequate bandwidth. Internet access is now handled independently at each university, either through VSAT or links to ISPs, although the Committee of Vice-chancellors and Principals plans to reconstitute REN with a new mandate and clear terms of reference.

### 2.1.5 Nigeria

The most recent university system ICT survey was conducted by the NUC’s Nigerian Universities Network (NUNet) project committee in August 2000, which involved 19 out of 30 Federal institutions. It revealed that:

- Of 294,946 staff and students, only 6,832 (2 per cent) had network accounts and access;
- The 19 institutions with almost 300,000 primary target users had only 2,861 functional computers, of which only 1,066 were connected to a LAN;
- Throughout the 19 institutions studied, only 466 staff had access to direct telephone lines in their offices, while only 95 staff had direct telephone lines in their homes.

Real-time Internet connectivity, via VSAT or radio-link to an ISP, presently exists in Nigeria at the NUC secretariat, Abuja; ten federal universities (located at Ife, Jos, Calabar, Sokoto, Benin, Abeokuta, Uyo,Nsukka, Ibadan, and Yola); two state universities (Delta State University and the Ambrose Alli University); and one private university (Pan-African University).

Although many individual staff members have email accounts, only 44 universities have registered domain names and only 15 of them are actually active. The University of Jos and Obafemi Awolowo University have VSATs. The remaining Partnership universities—the University of Ibadan, the University of Port Harcourt, Ahmadu Bello University, and Bayero University have dial-up access or a wireless link, as is the case at Ibadan, to local ISPs. However, there is notable work at Ibadan and Ahmadu Bello to implement real-time access.

There are currently at least eight different educational networking projects in Nigeria, at various levels of conception, planning, and implementation. There is very little interaction or collaboration among them. Only three federal universities (Obafemi Awolowo, Jos, and Usmanu Danfodiyo University Sokoto) have adequate local area networks, although the University of Ibadan is now developing a network and several universities are thinking about one.. Jos has a fiber optic backbone on two of its five campuses, three of the campuses are now linked to one another. Ife’s network is largely based on wireless and cable technology, and the university has identified the need for a fiber optic backbone. Covenant University, which is private, has a radio communication link between its two campuses.

Two of the Partnership universities (Jos and Obafemi Awolowo) are able to manage and monitor utilization, but they are not satisfied with their methods of managing and monitoring effective use of bandwidth. In the case of Obafemi Awolowo University, restrictions on concurrent users was identified as responsibility for reducing the university’s ability to provide effective Internet services for research purposes.

### 2.2 Current Bandwidth Utilization and Future Requirements

The table below, which was compiled from Task Force reports, provides data for all of the universities currently supported by the Partnership foundations, with the exception of Nigeria because information on Ahmadu Bello and Port Harcourt was not provided at the time of this report.

Monthly cost per Kbps is an estimate because bandwidth prices are generally negotiated per package (64 Kbps, 128 Kbps, 256 Kbps, etc.) by combining uplink and downlink capacity, and not necessarily by single Kbps. For that reason, UEM did not provide Kbps per month costs.
Increased enrolments, new ways of using ICT for teaching, learning, research, and management will all require more bandwidth and cheaper ways to access it in the coming years. Task Force members estimate that approximately 80 percent of the bandwidth will be used for learning and teaching purposes, but the University of Dar es Salaam, which uses Allot Net Enforcer and Cache Enforcer, is the only Partnership university that currently has the capacity to monitor and allocate bandwidth utilization in its various academic units, faculties, and research institutions. UDSM estimates that about 40 percent of its current bandwidth is used for teaching, 30 percent goes to the library and research, and 30 percent for communications. (Makerere University and the University of Ghana also have the capacity to monitor and allocate bandwidth utilization.)

It has proven very difficult for the Task Force universities to determine how much bandwidth is required to meet current and future needs because they have never had nearly enough to go around. Following considerable email debate, we came up with the following rule of thumb method for accessing current research information:

- We used computers as our unit of measurement because access to the Internet and bandwidth is facilitated or impeded by the number of available computers.
- Computers are in heavy use in the African universities included in this investigation—for Internet, word processing, data processing, etc.
- Ideally, the average user would like to spend an hour at a time identifying, downloading, and printing or saving journal articles. Thus, each computer can handle about 10 people a day.

---

7 Negotiations are underway for an upgrade at UEM: 512 Kbps/2.048 Mbps at a total cost of $9,576.
• We then determined that the average journal article in PDF format ranges from 500 KB to 2 MB, and decided that the average user would want to download about 10 MB a day—recognizing that patterns vary over the course of the year.

• We also restricted ourselves to journal articles that must be downloaded from remote servers rather than materials that can be downloaded and stored on a university intranet. We decided to concentrate on journal articles because we can report bandwidth needs more reliably for them than for anything else. Using bandwidth for video conferencing, exchanging research data, and other forms of academic utilization will necessitate more robust bandwidth access, of course.

This is the formula that we used:

\[
10 \text{ MB/day} \times 8 \text{ bits} \times 10 \text{ people} \times \text{number of computers} \div \text{seconds/10 hours} = \text{number of Mbps}
\]

Table 9: Bandwidth requirements for accessing research information

<table>
<thead>
<tr>
<th>Number of Networked Computers</th>
<th>Amount of Bandwidth Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 computers</td>
<td>11 Mbps</td>
</tr>
<tr>
<td>1,000 computers</td>
<td>22 Mbps</td>
</tr>
<tr>
<td>1,500 computers</td>
<td>33 Mbps</td>
</tr>
<tr>
<td>2,000 computers</td>
<td>44 Mbps</td>
</tr>
<tr>
<td>2,500 computers</td>
<td>55 Mbps</td>
</tr>
<tr>
<td>3,000 computers</td>
<td>66 Mbps</td>
</tr>
</tbody>
</table>

If one compares these numbers with those in Table 7, which contains information on the number of networked computers in each of the Partnership universities, every one of them (with the exception of Jos and Bayero) could make use of an 11 Mbps connection today—just to access current journal literature.

Recognizing that this is a conservative estimate because we were unable to take into consideration additional applications that require bandwidth because of insufficient experience with them, we tried to determine what university systems outside of Africa require and came up with an interesting study on the creation of an Australian Research and Education Network (AREN) that was published in 2002. The table below indicates how much bandwidth the Australian Academic Research Network estimated it would need by number of computers and staff. Although the ratio of computers to users is far lower than is the case in most African universities, the table provides us with information on how much bandwidth could be used under ideal circumstances.

Table 10: AREN notional bandwidth targets based on campus characteristics

<table>
<thead>
<tr>
<th>Networked Computers</th>
<th>Research Staff and Students</th>
<th>Research Intensity</th>
<th>Minimum Target Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100</td>
<td>Low</td>
<td>Out of scope</td>
<td></td>
</tr>
<tr>
<td>100+</td>
<td>&lt;200</td>
<td>Small</td>
<td>10+ Mbps</td>
</tr>
<tr>
<td>500+</td>
<td>200+</td>
<td>Medium</td>
<td>100+ Mbps</td>
</tr>
<tr>
<td>2,000+</td>
<td>400+</td>
<td>Very high</td>
<td>1+ Gbps</td>
</tr>
</tbody>
</table>
How many networked computers do Partnership universities currently have and what are the projections? The numbers range from a low of about 400 networked computers at the University of Ghana and the University of Jos to a high of 2,000 computers at the University of Dar es Salaam and Makerere University. Obafemi Awolowo University has 1,200 computers. Even by the most conservative estimate (Table 10 above), none of the universities has nearly enough bandwidth to meet information access needs.

2.3 Creating and Nurturing a Bandwidth Culture

Managing bandwidth to get the most out of what you have is just as crucial as determining minimum and ideal bandwidth requirements. Spam, viruses, using Internet for entertainment purposes, and reliance on out-of-country Internet email accounts, such as Yahoo and Hotmail, all make heavy use of bandwidth and clog the pipe. Yahoo and Hotmail may be useful, but it is far more efficient to require university users to open university email accounts. For that reason, Makerere University now blocks international online email during daytime peak hours. In addition, Web caching could be used more intensively. Clearly any solution to the bandwidth problem must also require participating institutions for managing it effectively. Steps to manage bandwidth are therefore included in Task Force recommendations.

2.4 The High Cost of Bandwidth

As is apparent from Table 8 above, the cost of bandwidth to African universities is exorbitant in comparison to the cost in the United States, where the current cost for a full T1 (1544 Kbps) Internet connection is about $450 a month for a three-year contract (which is what Makerere has). Makerere University is paying over $20,000 a month for less bandwidth. If one factors in the much higher per capita income in the US and the budgets available to US universities, the price paid by Makerere and other African institutions is that much higher. In general, consumers in Europe and North America pay $100 a month for more bandwidth than African universities get for $10,000 a month. The extent to which governments have a monopoly on telecommunications is another factor, for this sector represents a significant source of much needed revenue to them.

The reasons for this include the following:

- Lack of competitively provided international and national broadband infrastructure. Even monopoly provided infrastructure is limited in availability, and many countries do not have international fiber optic links to the international backbones.
- Poor or weak negotiation skills on the part of universities with Internet service providers and/or satellite companies.
- No power of joint negotiation. In Europe, there are national research and education networks for the tertiary and research sectors, as well as a pan-European multi-gigabit research network, called Géant. US universities benefit from NSFNET, a high speed hierarchical “network of networks,” funded by the National Science Foundation. These large networks are able to negotiate for cheaper bandwidth from a much more advantageous position than any one institution working alone. As an old union slogan goes: “There is power in numbers.” Further exacerbating an already bleak picture, many African countries are billed twice over—they must pay for both ends of the international link—whereas in other regions of the world ISPs only pay for one end. The reason for this is complicated: the cost of traffic is only shared between the top tier, i.e., larger providers. If you are a small ISP, which is the case in most African countries, you must pay for access to the top-tier transit backbones and the telecommunications link to get to the upstream Internet connection point. Therefore, the whole cost of carrying the traffic from the rest of the Internet is borne entirely by the African ISPs and not shared with sender ISPs.

2.5 National Academic and Research Networks in Africa

Of all the Partnership countries, South Africa provides the best workable joint connectivity for higher education institutions. The country’s first educational and research network, UNINET, was established in 1987 with seed funding from the Foundation for Research and Development. UNINET served the country’s tertiary sector until its responsibilities were taken over by the TENET (SA) in 2001. The planning for the creation of TENET (SA), its implementation, and its negotiating strategy with Telkom is an interesting model for consideration by the Partnership.

The planning process for creating TENET (SA) built on UNINET’s strengths and learned from its weaknesses. Vice-chancellors, senior academic administrators, including librarians, assumed ownership of the TENET concept from the outset.

Donors assisted grantee universities in establishing a strong and knowledgeable team to negotiate better rates with the national telecommunications operator, Telkom. The universities were able to explain to Telkom that they stood the risk of losing further donor support if bandwidth did not improve because the donors would only provide bandwidth-intensive resources if they could be used. Through the university consortium’s education of Telkom, it came to understand that favorable treatment for higher education was in South Africa’s best interest. Although the negotiations required a considerable time investment, Telkom and the universities now have a good working relationship.

Learning from the TENET (SA) experience

- The TENET (SA) concept was recognized nationally by the entire tertiary structure.
- An independent coordinating committee was established that was respected nationally by the higher education sector, the government, and the donor community.
- TENET had to demonstrate that higher education served South Africa’s developmental goals in order to obtain preferential IP pricing from Telkom and the regulatory authority.
- For their part, the universities had to demonstrate their willingness to establish, maintain, and sustain appropriate IP connectivity.

TENET (SA) is a non-profit company that acts as an agent for the higher education sector by negotiating a single set of pricing packages and collecting the money to pay Telkom. TENET is not a network manager, rather it is responsible for negotiating and managing contracts with Telkom. In this way, it is radically different from its predecessor, UNINET, which maintained the networks for the National Research Foundation (NRD), which signed the contracts with Telkom for the circuits.

The consortium is basically a discounted customer on the country’s commercial optic fiber backbone. HEI customers pay below-commercial rates for committed bandwidth (Committed Information Rate—CIR). They are also allowed to use bandwidth above their Permitted Information Rate (PIR) to a cap—if it is available. In effect, TENET (SA) customers are permitted to burst into the bandwidth that other customers are paying for but not using any particular point in time. The existence of TENET (SA) network means that connectivity among South African HEIs is more affordable than it would be at full commercial rates, and the costs of collaboration among institutions is kept low because traffic does not have to move outside the TENET (SA) network. This TENET (SA) model could be adapted to apply to satellite providers, who also may have bandwidth that is paid for but not used at any point in time. It cannot be re-sold at commercial rates because it must be available on demand to the paying customers.

The South African government has been invited by the EU to connect to Géant, and an initiative to determine the feasibility of doing so is underway, coordinated by the Department of Science and Technology (DST). TENET (SA) is heavily involved in the process, and there are reasonable expectations that during 2004 South
Africa will establish a NREN that meets the criteria for connection to Géant. If this happens, the connection will probably be via the SAT3 submarine cable.

### 2.6 ICT Training, Recruitment, and Retention of Staff

ICT infrastructure and bandwidth must go hand in hand with human-resource capacity and development strategies. Although most Partnership universities have a pool of ICT personnel, training new staff, skills development for current staff, and staff retention are critical issues. As one way of dealing with the problem of staff retention problems, Makerere University plans for staff non-retention, i.e., retaining staff long enough for them to pass on their skills to others. End-user training is also essential.

A World Bank consultancy report in 2000 identified a number of training needs for Nigerian universities, that may well hold true for other universities within the Partnership constituency. They are outlined below.\(^9\)

**Table 11: Types of ICT training required by Nigerian universities**

<table>
<thead>
<tr>
<th>Training Need</th>
<th>Description</th>
</tr>
</thead>
</table>
| Internet connectivity issues  | • Technologies, traffic management and security  
• Service providers  
• Terrestrial microwave planning, including transmission path analysis  
• RF frequency planning, antenna and 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 for aerials and buried lines |
| Intranet connectivity issues  | • Local area networks  
• Wide area networks  
• Network architecture (hubs, routers, structured cable facilities, computers, power and power conditioning systems)  
• Network software (Windows NT, Unix, Novell, Linux, etc.)  
• Network services  
• Management, security, and local content  
• PC hardware configurations, including troubleshooting and maintenance  
• A wide variety of applications software |
| Professional training for academic staff | • Sponsorship for higher levels of ICT training |

The recruitment of ICT personnel is primarily carried out, using normal university recruitment policies, and usually comes from the pool of students who graduate from the university’s own ICT-related courses. They serve as system administrators, computer specialists, programmers, etc. Public universities find themselves hard put to compete with the private sector, however, because salaries are lower than what ICT specialists can earn in the open market. The practice at UDSM, Makerere, and UEM is to attempt to make up for low salaries by providing technical staff with as much extra training as possible and ICT-related consultancy assignments to supplement their income. Staff appreciate any possibility for professional development and like the challenges associated with consultancies. University staff also receive housing allowances and medical

---

services, which are not always offered by the private sector. Nevertheless, more needs to be done to train, retool, and retain technical staff. Retention rates are still low, which necessitates a time-consuming process of recruiting and orienting new staff. If Partnership universities are not assured of sufficiently well-trained technical staff, the heavy investments in ICT infrastructure will come to nought.
Regional ICT Collaboration in Africa

The development of ICT utilization has facilitated the establishment of virtual partnerships in all sectors on the continent, including higher education. The availability of adequate bandwidth and peering within Africa would strengthen the efforts underway and facilitate the creation of new initiatives. Strong virtual programs based in African universities and targeted at Africa as well as at the global market for higher education would foster the use of local content and demonstrate the potential of South-North collaboration in teaching and learning. Unlike programs brought in from outside, virtual collaboration from within Africa can only strengthen the participating institutions, help build institutional confidence, and contribute to the development of higher education in Africa.

There are three umbrella areas under which such collaborations can happen:

- Development and delivery of collaborative teaching-and-learning programs;
- Development of collaborative research initiatives; and
- Development and sharing of learning content.

The sections below describe five regional projects that require ICT. Three of them were require heavy use of bandwidth and two of them can work more easily around bandwidth problems, but would obviously benefit from having more available. These examples demonstrate what can be done as well as the fact that ICT is already being used for teaching, training, and research, even if conditions are not ideal.

We recognize that there are many more active partnerships on the continent; the five below were selected as illustrations.

3.1 The NetTel@Africa experience

NetTel@Africa\(^{10}\) provides a prime example of the use of bandwidth to enable networking or alliance-building to create a high-quality degree program, reinforced by direct connections with US academic institutions and resource partners. NetTel@Africa is a collaborative master’s program in ICT policy and regulation developed for the Telecommunications Regulatory Association of Southern Africa (TRASA) by a collaborative effort of seven African and three US universities, together with other partners from the ITU, FCC, and CTO among others. The NetTel@Africa master’s program consists of ten course modules and a thesis or equivalent. A postgraduate diploma will be possible after one year of full time or equivalent study, and a master’s degree after two years. Most of the courses will be offered via distance learning over the Internet, with supplementary materials on CD-ROM and content mirrors. Pilot courses are now being offered, with the full program expected to commence at the beginning of 2004.

The universities developing content modules and that will offer the program include: the University of Botswana, The University of Zambia, the University of Dar Es Salaam, the University of the Witwatersrand, the University of South Africa, the University of Fort Hare, Makerere University, and the University of the Western Cape, which provides and hosts the open source learning platform. In addition to these universities, the African Advanced Level Telecommunications Institute (AFRALTI) based in Nairobi, Kenya, is also participating—both in developing a module and in offering the program.

Problems encountered as a result of lack of bandwidth and peering prevented the training program from proceeding as planned for those institutions located outside of South Africa. In anticipation of such problems, the mobile training team carried a laptop that was configured as a server, so the training was able to proceed without connection an online site, but without the benefits of interaction with the support group at UWC. It is

significant that not only was bandwidth insufficient to allow for real-time training to occur in Botswana, Kenya, Zambia, and Tanzania, but there were also problems in South Africa—at UWC and at the University of the Witwatersrand. The reasons for the problems in South Africa will be investigated, because the universities there all use TENET (SA), which supplies sufficient bandwidth to support training requirements.

### 3.2 The SeaweedAfrica Experience

SeaweedAfrica ([http://www.seaweedafrica.org](http://www.seaweedafrica.org)) is a project to expand AlgaeBase ([http://www.algaebase.org](http://www.algaebase.org)), a biodiversity database of seaweed information, to include ecological, commercial and technology data from the whole of Africa. It is a three-year project funded by the European Union under the INCO-DEV section of the Fifth Framework Programme. The project brings together marine scientists from nine countries spread throughout Europe, Africa and South America, most of whom are biologists with a strong focus on biodiversity.

In Africa, SeaweedAfrica scientists are based in Kenya, Tanzania, Mozambique, South Africa, and Namibia. Over the three-year life of the project, ecological, commercial and technological information on seaweeds and their uses internationally will be researched and added to AlgaeBase and made available via the internet both through the main AlgaeBase site and through the SeaweedAfrica site.

Observations at KMFRI in Kenya show very sluggish response times, with the site sometimes accessible but mostly not. Data entry from Kenya, as well as the other sites in Africa outside South Africa, is impossible most of the time, with the result that alternative means of getting data onto the site have to be explored. Namibia is an exception to this pattern, where response times are typically well within acceptable limits. In contrast, access from most of the sites in Europe is within the acceptable limits; data can be entered on the live site.

### 3.3 African Virtual Open Initiatives and Resources

The African Virtual Open Initiatives and Resources (AVOIR) project was developed as a result of contacts made and discussions held during the Partnership meeting in Ethiopia, as well as subsequent email and face-to-face interactions and interactions with the US Agency for International Development (USAID), which made a small grant to UWC to develop a concept document and larger funding proposal.

The idea behind AVOIR is to create a network of open source developers in higher education institutions in Africa, as well as a network of developers of learning content, who are creating content according to open content licensing arrangements. The project is still in the very early stages of development, but so far response from around 40 African universities has been very positive and supportive.

The funds are being used to create a small pilot network with developers at the University of Dar es Salaam. They will work initially on the learning management system, Knowledge Environment for Web-based Learning (KEWL), which was initiated at UWC, as the basis for establishing the interaction around an open source project and for developing procedures for operation as a network across national boundaries and the “Great Bandwidth Divide.” One of the outcomes will be a version of KEWL that is truly cross-platform and open source using MySQL and PHP.

### 3.4 Network for Analytical and Bioassay Services in Africa

The Network for Analytical and Bioassay Services in Africa (NABSA) is a network of voluntary non-profit laboratories, primarily working in Botswana, Ethiopia, Kenya, and Tanzania. NABSA is headquartered at the University of Botswana in Gaborone, where it has a Nuclear Magnetic Resonance (NMR) unit with two spectrometers, one operating at 300 Mhz and the second one at 600 Mhz. NABSA assists African scientists by providing analytical and bioassay services. Until recently all of the resulting analyses were then returned by mail.

NABSA would prefer to return the raw data, however, so that the scientists themselves can analyze them, a particularly useful task for students. Electronic transmission of data from Gaborone calls for additional
computerization (hardware and software), training, and robust bandwidth. To that end, the University of Dar es Salaam received equipment and training in 2002. Researchers in Tanzania can now send their samples to Botswana, where they are analyzed, but the raw NMR data is returned to Dar, so that researchers and students can transform and process the data from their own samples. A similar workstation will be set up in Cameroon in 2003, with training in Botswana. The NABSA coordinator estimates that the desktop computer and peripheral equipment costs less than $10,000, the NMR software $25,000, and training $2,500.

### 3.5 African Virtual University

The African Virtual University (AVU) is a first-of-its-kind interactive-instructional telecommunications network established to serve the countries of Africa. The objective of the AVU is to build capacity and support economic development by leveraging the power of modern telecommunications technology to provide world-class quality education and training programs to students and professionals in Africa. With over 20 learning centers in 17 African countries, AVU is based in Nairobi, Kenya.

By 2007 AVU aims to be a reputable, independent African organization contributing to the continent’s capacity-building efforts, harnessing the power of Information Communication and Technology (ICT) to expand access to quality, and affordable education at tertiary level throughout Africa. In its vision, AVU seeks to be:

- An organization recognized for quality academic services throughout the world;
- An organization “for the people”, providing equitable access to affordable, quality education at tertiary level;
- The organization within Africa that provides access to high-quality educational resources of global standards including learning programs, a digital library, and an online portal;
- The network hub of Higher Education institutions in Africa;
- A recognized center of excellence for academic programs originating from African universities.

The above information was obtained from the AVU website [http://www.avu.org](http://www.avu.org). However, AVU is undergoing changes in management and direction, and is exploring ways to improve bandwidth access for its constituent learning centers.
Out of Africa Supply Issues

4.1 African Fiber and Satellite Telecommunication Structure

4.1.1 Regional Fiber

Currently, six submarine cables provide international fiber connectivity to Africa. All remaining international bandwidth is provided by satellite. These cables are Sat-2, SEAMEWE (South East Asia – Middle East – Western Europe) II and III, FLAG (Fiber optic Link Around the Globe), Atlantis II and SAFE/WASC/SAT-3. These cables also connect South Africa to Portugal via Sat-2. To all intents and purposes, the capacity on SAT-2 is fully used.

The Sat-3/ WASC/SAFE project is split into two segments: Sat-3/WASC, which runs from South Africa to Portugal with landing points in Angola, Gabon, Cameroon, Nigeria, Benin, Ghana, Côte d’Ivoire,Senegal, Canary Islands, and Spain, and SAFE which runs from South Africa to Malaysia and India via Mauritius and Reunion. In both cases, the fiber has already been laid, and the cables have been ‘lit’ in most countries. The other cables provide international links for Algeria, Djibouti, Egypt, Morocco, Senegal, Tunisia, and also the Canary Islands and Cape Verde. With the link between WASC/SAT-3 and Atlantis-2 in Senegal, it is now possible to transit traffic between Africa, Latin America and Asia without needing to go through Europe or North America.

“SAT3 goes from Lisbon down the west coast of Africa to South Africa. SAT3/WASC/SAFE (to include all its legs) was financed and built by a consortium of 36 organizations...There is no fiber covering Africa’s east coast and few internal fiber connections on the continent except in large cities.”


Sat-3/WASC has an ultimate capacity of 120 Gbps. It currently has a capacity of 20 Gbps, but because this is already fully subscribed, it is in the process of being upgraded to 40 Gbps—a capacity that was planned to become available in mid-2003. The cable itself is a part of a consortium comprising 35 operators, including a number of African carriers where there are landing points. Each of these carriers owns capacity on the cable, based on a pro rata scale, depending on their respective level of investment. In addition, there is a pool of unused capacity that these operators do not require in the immediate future. Capacity in this pool can then be used by one of the owners, or by another operator. The cable owners are Angola Telecom, AT&T, Belabor S.A., BT Global Network Services, Cable& Wireless Global Networks, Cameroon Telecommunications, China Telecom, Cumshaw Telecom, Cote d’Ivoire Telecom, Cyprus Telecommunications Authority, Deutsche Telecom, France Telecom, Ghana Telecommunications, Global One Communications, Itissalat Al Maghrib, Korea Telecom, KPN Royal Dutch Telecom, Marconi Portugal, Mauritius Telecom, MCI WorldCom International, Nigerian
More Bandwidth at Lower Cost: An Investigation for the Partnership for Higher Education in Africa

Telecommunications, OPT Benin, OPT Gabon, Reach, Singapore Telecommunications, Société Nationale des Télécommunications du Sénégal, Sprint Communications, Swisscom, Telecommunications Italia, Telecommunications Namibia, Telefónica de Espana, Teleglobe USA, Telkom Malaysia Berhad, Telkom SA, Communications Authority of Thailand, and Videsh Sanchar Nigam India. Non-owners can therefore get capacity one of two ways:

- They can do so from the national carrier in the country that is an owner of the cable. A prerequisite for direct access is that such operators are licensed to carry international traffic, so typically mobile operators will be able to have direct access but not ISPs, which would just lease more capacity from the carrier (which in turn has greater international bandwidth).
- Operators can buy directly from the pool and therefore bypass that carrier, through an Indefeasible Right of Use (IRU) from the cable’s network administrator—which is Telkom. However, the national carrier has first right of refusal. Moreover, in order to allow carriers to recover their investment into the cable, they enjoy exclusivity for the first five years. This could mean that operators would be forced to buy capacity from the incumbent carrier, which could therefore charge whatever price it likes. But in order to protect the buyer, carriers cannot charge more than the pool price.

As this bandwidth has not been subject to competitive pricing, and regulatory positions on access to the cable are still fluid in some countries, it is unclear how tariffs will change in the near-to-midterm. However, given that most of the Partnership universities do not have access to international fiber (even in countries where it lands, due to the poor national infrastructure), satellite access is likely to be the dominant medium in the short-medium term for all except South Africa.

### 4.1.2 Potential for using the regional cables

<table>
<thead>
<tr>
<th>What would a national fiber network cost?</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to an estimate produced for Connectivity Africa, an IDRC project, a generic IP fiber network of about 6,000 kilometers would cost approximately $38 million.</td>
</tr>
<tr>
<td>Source: Mike Jensen</td>
</tr>
</tbody>
</table>

A number of donors are looking into potential projects—among them DfID, IFC, and the EU—and investigatory work is underway. Mike Jensen is involved in two of the three studies.

In all likelihood, largely market forces will drive the potential for additional countries to link to any of the existing submarine cables. Heavy infrastructure investments and a favorable licensing regime are the two prerequisites. National fiber infrastructure improvements may take three-four years in some of the Partnership countries, but it is difficult to generalize. In Mozambique, UEM will link to East African fiber as soon as it becomes available, and is already receiving traffic over the national TDM cable to Beira. Uganda will need to wait for the East African fiber, as will Tanzania. Ghana and Nigeria already have access to SAT-3/WASC, but have infrastructure and pricing problems. For this reason, we are recommending a short-term strategy of investigating other ways to obtain more bandwidth at lower costs.

### 4.1.3 Satellite operators and vendors

The major operators of satellites over Africa are: Anatolia (Kalitel), Europestar, Eutelsat, Intelsat, Lockheed Martin, New Skies, Thaicom, and PanAmSat. These operators’ fleets of satellites have overlapping footprints in both C-band and Ku-band, which between them cover every inch of the continent. Some operators are also repositioning existing satellites in their fleet over the region to provide additional coverage in high demand areas such as West Africa, and new satellites are also planned. Most of the satellites have footprints, which
also cover Europe or North America, allowing upstream traffic to flow at low cost onto the major Internet backbones. For this reason, as most off-continent traffic from the universities is to Europe or North America, it is more efficient to connect there directly via the satellite, than to land in Africa at one of the other VSAT hubs in South Africa or those planned along the other countries linked by the SAT-3 cable. This is because users in Africa landing in South Africa would still have to pay for the expensive link along 6,000 kms of the SAT-3 back to the US/European backbone for most of their traffic.

Economies of scale in VSAT networks combined with the broadcast nature of satellite (radio) communications means that costs in these systems are very sensitive to the number of users. Generally 200 sites are needed to justify the establishment of a dedicated hub, however the number also depends greatly on the extent of shared traffic. If extensive use of shared caches, broadcast and multicast applications such as CBT videos, videoconferencing or audio for education and team-based research are used, this can substantially increase the overall cost effectiveness of a common platform.

The Ku-band satellite footprints recently provided by some of the operators have reduced terminal equipment prices significantly, although the systems available are mainly oriented toward more thin-route SOHO and small cybercafe applications where quality of service is less important. For multi-megabit connections C-band is generally preferred. Investing extra in larger high-grade VSAT equipment usually pays off in lower bandwidth costs due to the increased efficiency of operation. However this can add $15,000-$20,000 per site to the initial equipment cost.

In establishing a multi-site VSAT facility, a fraction of, or a whole transponder is normally leased from the satellite operator, which usually provides either 36Mhz or 54Mhz of radio spectrum. As a rule of thumb for conversion to data bandwidth, 1Hz is equivalent to 1Kbps. That is, a 36 Mhz transponder should provide about 36 Mbps of bandwidth (new coding schemes are being tested which could provide up to 3 Kbps per 1Hz, however these are proprietary and largely untested systems as yet). As an indication of raw satellite bandwidth costs, a whole 54 Mhz Ku-band transponder on New Sky’s NSS7 costs about $150K/month, i.e about $2.8/Kbps, or $2800/month for a 1 Mbps link. Monthly costs for satellite bandwidth can also be reduced considerably by signing longer-term contracts, perhaps of three years’ duration. To this must be added the cost of upstream Internet access and the capital installation and maintenance costs of the hub, which can come to about $1m in the first year.

4.2 Comparison of International Bandwidth Supplies

There are usually four alternate sources of international bandwidth available in Africa— a) a direct VSAT/satellite link to a hub in Europe or North America, b) a link to a local VSAT/satellite hub, c) a direct link via international marine fiber cable to a hub in Europe or North America, d) a link to a shared local hub connected to international fiber. While access to international fiber cable is not available to all of the partnership universities (see below), these four options can be considered along a continuum from highest cost to lowest cost. However this pattern of pricing only applies to open competitive markets, in many cases monopoly ownership of the international fiber, in Africa means it may be priced it at 5-10 times the cost of equivalent competitively provided satellite bandwidth. And even in countries without access to fiber, satellite connectivity and Internet access is also often not fully competitive, or is burdened with high license fees.

Currently, Partnership universities, excluding those in South Africa, obtain their bandwidth independently from a variety of local or international satellite-based ISPs. Variations in the local market and choice of suppliers are reflected in the range in prices the universities pay for bandwidth—for example, Makerere pays $27K/month for 2.5Mbps/1.28 Kbps (in/out) and Eduardo Mondlane pays $10K/month for 1Mbps/384Kbps while the University of Ghana pays $10K/month for 1Mbps/512Kbps. Adding inbound to outbound bandwidth for each university and dividing this into the monthly payments reveals that Ghana is paying the least for its bandwidth at $6.60 per Kbps a month, while Jos pays the most at $20.80 per Kbps. Clearly some universities should be able to obtain somewhat better market prices for bandwidth. Caveats to this statement include:
• Quality of service and international versus local bandwidth availability must be taken into account along with pricing.
• Prices are heavily influenced by service levels, including penalties when service agreements are not achieved.

Putting the bandwidth figures together indicates that collectively, the Partner universities outside South Africa are paying over $55,000 a month for 2 Mbps outbound and 4 Mbps inbound bandwidth. While these figures are about 100 times more expensive than equivalent prices in North America or Europe, as the table below shows, they are not greatly above the best market-related satellite rates currently available in Africa. If the universities were paying the satellite operators wholesale transponder rates for space segment alone, prices would probably amount to about one-quarter to one-third of current best satellite Internet access costs. This assumes that the costs of setting up and managing the hub are not included, and that upstream Internet costs are born by a larger academic network such as Géant. The rates for DSL links are also shown in the table below to provide an indication of what pricing can be expected in more competitive markets with access to international fiber. With the exception of the ADSL providers, all of them have coverage in the six Partnership countries.

Table 12: Comparison between two-way service charges for African Internet operators

<table>
<thead>
<tr>
<th>Operator</th>
<th>C-band or Ku-band</th>
<th>Hardware</th>
<th>Monthly bandwidth costs (US$)</th>
<th>Uplink</th>
<th>Dowlink 64 Kbps</th>
<th>128 Kbps</th>
<th>256 Kbps</th>
<th>512 Kbps</th>
<th>1024 Kbps</th>
<th>2048 Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telcom SA</td>
<td>ADSL</td>
<td>$263-$314</td>
<td>256 Kbps</td>
<td>$86.50</td>
<td>$101.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonatel</td>
<td>ADSL</td>
<td>$77 $116</td>
<td>128 Kbps 128 Kbps</td>
<td>$51.50</td>
<td>$100.30</td>
<td>$386.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AST</td>
<td>C</td>
<td>$13,950</td>
<td>64 Kbps 128 Kbps 256 Kbps 384 Kbps</td>
<td>$552</td>
<td>$822</td>
<td>$1,370</td>
<td>$1024</td>
<td>$5,241</td>
<td>$9,883</td>
<td></td>
</tr>
<tr>
<td>Bentley Telcom</td>
<td>Ku</td>
<td>$1,850</td>
<td>128 Kbps (30:1) 128 Kbps (20:1) 128 Kbps (10:1)</td>
<td>$143</td>
<td>$190</td>
<td>$275</td>
<td>$485</td>
<td>$860</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bizarnet (Limited Service) (Unlimited service)</td>
<td></td>
<td>$5,200</td>
<td>76.8 Kbps</td>
<td>$213 (£180)</td>
<td>$272 (£230)</td>
<td>$532 (£450)</td>
<td>$674 (£570)</td>
<td>$923 (£780)</td>
<td>$1,633 (£1,380)</td>
<td>$982 (£830)</td>
</tr>
<tr>
<td>Geolink</td>
<td>C</td>
<td>$6,750+VAT +$500 shipment</td>
<td>128 Kbps</td>
<td>$935 (£790)</td>
<td>$1,656 (£1,400)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilat Alldean</td>
<td>C</td>
<td>$5,877 (£3,600)</td>
<td>73.6 Kbps</td>
<td>$569 (£349)</td>
<td>$814 (£499)</td>
<td>$1,141 (£699)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IVS Africa</td>
<td>Ku</td>
<td>$4,800+ $500 connection fee</td>
<td>64 Kbps 128 Kbps</td>
<td>$626</td>
<td>$926</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link Sat</td>
<td>Ku</td>
<td>$1,995+ costs</td>
<td>32 Kbps 64 Kbps 128 Kbps 256 Kbps</td>
<td>$995</td>
<td>$1,990</td>
<td>$3,648</td>
<td>$6,256</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3 Satellite Licensing and Regulatory Considerations

As can be seen from Chapter One, particularly section 1.2, the considerations above provide an indication of potential for satellite bandwidth, but actual uptake can be influenced by the rate at which national regulatory reform takes place in some countries, and in those where conditions remain restrictive, on the choice of the local partners for the project.

At this point regulatory issues vary tremendously within countries but in general are restrictive, if unclear. At the one end of the scale there are countries like Mozambique and Malawi, in which it is a relatively simple matter to obtain a VSAT license, to the other extreme where use of VSAT for public services is only allowed by the monopoly telecommunications operator, such as in South Africa and many others. However there is an increasing recognition by African regulators that the availability of VSATs and other satellite-based communications is instrumental in creating jobs, attracting foreign investment, and improving foreign trade. Recognition of these benefits is manifested by several recent policy breakthroughs, including:

- **GMPCS-MoU:** The ITU continues to gain global support for the Memorandum of Understanding for GMPCS-MoU. The agreement is designed to reduce or eliminate the burdensome licensing, customs, and type approval requirements associated with the use of mobile and fixed satellite terminals, such as VSATs. African signatories include Botswana, Burundi, Cameroon, Chad, Eritrea, Gabon, Ghana, Kenya, Madagascar, Malawi, Mauritius, Namibia, Sierra Leone, South Africa, Tanzania, Tunisia, Uganda, and Zimbabwe. Others are expected to follow.

- **WTO:** The World Trade Organization’s Telecommunications Trade Agreement formally entered into force and with it more than 50 countries are committed to varying levels of expanded market access for foreign suppliers of satellite services. In Africa, among the first to sign this agreement were Cote d’Ivoire, Ghana, Mauritius, Senegal, and South Africa.

- **The Tampere Convention:** More than 30 nations recently signed an international legally-binding instrument facilitating the immediate provision of VSAT and other telecommunications services for disaster recovery. Called the “Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations”, the treaty is significant because it provides for the reduction or removal of regulatory barriers. Further, it offers an opportunity for telecommunications companies and administrations to negotiate an arrangement whereby the disaster-recovery system can also be used as a permanent network for the provision of additional services.

Several African nations were among the first to sign the treaty in June 1998, among them, Benin, Burundi, Gabon, Ghana, Kenya, Liberia, Mali, Mauritania, Niger, the Republic of the Congo, and Sudan.

Having said this, there are two additional factors to take into account. First, even in countries where licenses are easily obtainable, the license fees are usually priced for corporate VSAT networks with much greater operating costs and this can be a significant additional burden on resources. However, African governments are increasingly seeing Internet access as a priority area and it has been possible to negotiate exemption for VSAT services especially for public sector use, such as in education and health. Development agencies working in these areas have been able to obtain special permission to install VSATs in some countries, such as the World Bank’s schools networking program, which has installed VSAT equipment for schools in Uganda and Senegal; the ITU’s African telemedicine project; the Multilateral Initiative on Malaria; and SchoolNet Namibia. In addition, to reduce the cost barriers created by import taxes, regulators have granted tax concessions for import of VSAT equipment for the public sector, such as has been obtained from the Ugandan government for the World Bank’s schools networking project.

As the availability of the satellite services become more widely known in countries that restrict the number of license holders or limit the use of private VSAT, it is expected that local pressure from ISPs and potential customers will build up and assist in the process of regulatory change. Support for capacity building and awareness raising at national and regional levels for these changes is already receiving attention from development agencies as part of the efforts around the Dot.Force initiative, such as USAID, DFID, the EU and CTO.
For the purposes of the Partnership universities, the independent use of satellite is only likely to pose some problem in South Africa and Uganda where existing national license holders are the sole franchisees for their own VSAT services. However, due to the public sector nature and wide political support for improving the use ofICTs and education within the NEPAD context, a special exemption from these countries would be likely to be forthcoming. The Partnership universities in the other countries may also have to apply for exemption from VSAT license fees. In the unlikely event of difficulties, support from the Partnership could assist in the process.

4.4 Discounted satellite bandwidth and collaborative projects for Africa

In order to feed into the development of a strategy for collaboratively obtaining cheaper bandwidth, existing efforts in this area have been identified. Some of the projects outlined below are not directly concerned with Africa but could have an impact on the continent or provide useful examples/lessons. Details of the international bandwidth operators mentioned below are outlined later.

4.4.1 Liberty Foundation / Panamsat

In probably the most mature and largest non-profit satellite project in Africa, satellite operator Panamsat has donated a full transponder for education to the South African Liberty Insurance Group’s Liberty Foundation. The facility is available for a year, after which bandwidth charges will take effect, at nominal rates. Five TV channels will be operational within a year (two are already running), and the remainder of the bandwidth can be used for two-way Internet. The Universities of the Western Cape, Natal, and the University of Capetown are involved in the project. Panamsat has invested about $2 million in the project so far. The transponder is currently on the Southern African PAS-7 satellite footprint but could easily move to the sub-Saharan footprint of PAS 10 if the right project presents itself. Panamsat has been keen to support projects of this kind but believes management is the key issue and has so far not found the capacity to manage a complex project of this nature. However Liberty put together a non-profit company called Mindset, which met the requirements, and Panamsat believes this could be either used as the vehicle or it could be replicated for supporting broader educational access across the continent. The Foundation has invested its own money in the project initially and since then USAID, the Mandela Foundation and others have also contributed. Equipment vendors are also interested in donating platforms for the project. The head of Liberty Foundation is Hilton Applebaum (+27-11-408-2914).

4.4.2 World Bank Uganda Schools Connectivity Project

The World Bank’s World Links for Development (WORLD) project supported the purchase of VSAT connectivity for schools in Uganda. By bulk-buying bandwidth on behalf of a number of schools and subsidizing the initial cost of the equipment and bandwidth, the project has made Internet access more sustainable for these schools which are also providing access services for the broader community in order to offset costs. Unfortunately the satellite bandwidth provider recently indicated that it can no longer sustain provision of service at the current low rates. In addition, following its initial five-year pilot stage, World Links for Development became an independent NGO. Its executive director is Hans Hoyer (hoyer@world-links.org).

4.4.3 ITU IP Connectivity in Laces Project

The ITU has been discussing for some time a project to support access to VSAT Internet in Laces, which is expected to take place initially in Uganda and Nepal. Contact: Claudia Sarrocco (claudia.sarrocco@itu.int).

4.4.4 Kalitel

Kalitel is a Turkish operator with a satellite that has C Band coverage of all Central and North Africa. Due to brief seasonal interruptions (4 hours at night for a few days a year) its commercial value is limited and it is offering, at cost, bandwidth to worthy organizations in Africa. Any non-profit or socially conscious commercial customers may apply. Contact: Hugh Miracle, VP – Anatolia Kalinet, (hmiracle@worldnet.att.net).
4.4.5 African Virtual University (AVU)

The AVU operates over 20 learning centers in Africa, providing distance education using video/audio conferencing and interactive access. It has engaged German company Detecon to propose the best solution for its ongoing bandwidth requirements. (Joyce.vandeGarde@detcom.com)

4.4.6 SHARE/Intelsat

In 1985, the International Satellite Organization (Intelsat) and the International Institute of Communications established the Satellites in Health and Rural Education (SHARE) project to establish teleconference links between Nairobi and Kampala. As well, the project provided a teleconference link between those two East African cities, Memorial University (Newfoundland, Canada) and through its bridging facilities, to other medical schools, thereby broadening the base of Canadian expertise that could be made available to Kampala. With the collaboration of Teleglobe Canada, Post Telegraphs of Kenya and Uganda, and Intelsat, a four-wire dedicated system was established with Nairobi and Kampala. Funding, in part, for this project came from the Toronto Hospital for Sick Children’s Foundation. Satellite facilities were made available free of charge by Intelsat and its signatories. The system was used for teaching sessions, administrative meetings, the transmission of EEGs, and a variety of other applications.

4.4.7 Intelsat/Americas

Intelsat’s “Distance Education and Training Network of the Americas” pilot program was announced in 1996 aiming to donate free satellite time to educational and medical institutions in North, Central and South America for one year, with charges for the bandwidth in subsequent years.

4.4.8 Teleglobe/China Research Network

Teleglobe is providing Internet connectivity to Qinghua University in Beijing as part of China’s research network. The link consists of earth station and backhaul circuit connectivity services by China Telecommunications to Tsinghua University; space segment via China Telecommunications and Teleglobe jointly leased INTELSAT space segment capacity; and corresponding earth station and backhaul capacity to the Globiinet access node in North America. Teleglobe also provides a Quality of Service (QOS) operating system, enabling higher priority traffic to flow ahead of other network traffic during periods of congestion. Teleglobe also provides backbone services for CANET*2, Canada’s national academic network; NORDUnet, the academic backbone network of the Nordic region; Federal Centre RUNNET, Russia’s academic backbone network; SINGAREN, Singapore’s national academic network; SuperJANET, the backbone network of UKERNA, the United Kingdom Educational and Research Association; SURFnet, the Netherlands’ academic backbone network; and Ten-34, the European community’s academic backbone network. (http://www.gi.teleglobe.net)

4.4.9 Clarke Institute Global Trust Fund for Tele-education

This proposal aims to mobilize financial resources and underutilized broad (Internet 2 level) bandwidth on both satellite transponders and fiber optic cables for use by tele-education and telehealth projects in qualifying developing countries. A credible, reliable, and competent structure aims to be established to administer the allocation of both the financial resources (which can be used to purchase bandwidth), as well as the in-kind donations of underused bandwidth that would be solicited from owners. This activity is being coordinated through Glosas and the Global University System. The proposal will use international organizations including INTIELSAT, UNESCO, ITU, WHO, and the World Bank Group to operate the project with active participation by working groups. International institutions with the relevant mandates (ITU, UNESCO, and WHO) are being asked to convene the working groups that will set policy on qualifying countries for GSTF resources. These working groups would include representatives of other interested organizations, such as foundations, other NGOs, private companies involved in telecommunications, other private companies interested in tele-education and telehealth, bilateral aid agencies, regional development banks, etc. (http://www.clarkinstitute.com/gfund.html)
4.4.10 University of the South Pacific Network (USPNet)

USPNet is a closed satellite communication network used exclusively by the USP for its distance education program. It utilizes some bandwidth of the C-band global beam transponder of Intelsat 702 satellite. The network consists of 12 earth stations, each of which is located at each USP Campus or USP Center. These 12 earth stations are classified into three categories, i.e. hub station, mini-hub station or remote station. The hub station is located at the headquarters of the USP in Laucala Campus in Suva, Fiji. A mini-hub station is located at Alafua Campus of the USP in Apia, Samoa, and another mini-hub station is located at Emalus Campus of the USP in Port Vila, Vanuatu. Nine remote stations are located at the USP Centers in the rest of the member nations. (http://www.usp.ac.fj)

4.4.11 Models for the Partnership

The initiatives above, including those that are not directed at Africa, such as USPNet and the China Research Network, provide an indication of the range of potential strategies that the Partnership universities could use to reduce the costs of satellite bandwidth. The above in particular highlights three areas:

- Obtaining donations of bandwidth from the satellite provider, as in the case of Liberty Foundation
- Increasing the economies of scale for bandwidth purchase, as in the case of the AVU
- Sharing the cost of network infrastructure and management, as in the case of USPNet.

4.5 Satellite operators and providers in Africa

4.5.1 Intelsat

Intelsat (International Telecommunications Satellite Organization) operates the largest satellite network, in Africa, supplying international bandwidth to most of the African national public telephone operators (PTOs), as well private links, broadcasting and domestic services for many countries. Aside from the provision of voice circuits, Intelsat also has a range of high bandwidth Internet and multimedia services bundled into the cost of a satellite circuit. (http://www.intelsat.int)

Intelsat circuits range in size from 64 Kbps up to the 155 Mbps service. There are substantial discounts for long-term contracts, which can be up to 15 years. If a private agency obtains permission to operate an Intelsat link, then the signatory PTO must also approve the application and it or the regulator usually adds a mark-up on the cost of the bandwidth. In the case of South Africa it is about 30 per cent; in Democratic Republic of the Congo the PTO charges about 5 per cent.

4.5.2 PanAmSat

Panamsat was the first large private sector satellite system operator, launching its PAS-1 satellite in 1988 into geostationary orbit over the Atlantic Ocean. Since then it has launched a number of additional satellites, now comprising a fleet of 10 satellites which provides global coverage reaching about 98 percent of the world’s population. Although television/video and radio broadcasting accounts for most of PanAmSat’s revenues worldwide and in Africa, it also provides data and voice services to businesses in areas where the regulatory climate allows it. In particular, SpotBytes, its packaged Internet and space segment service, has proved popular among African ISPs in countries where private VSAT is not restricted.

The first of Panamsat’s African offerings were PAS-3 and PAS-4 providing C-Band coverage to most of Europe and Africa except for the extreme west of the continent (Gambia, Senegal, Mauritania, Guinea Bissau, Guinea and Sierra Leone are excluded). The satellite also provides a Ku-Band spot beam aimed at South Africa but also covering the southern parts of Namibia, Botswana, Lesotho, Mozambique, Swaziland, Zambia and Zimbabwe). Last year PAS-10 was launched with a high powered Ku-band beam covering the whole of sub-Saharan Africa as well as parts of Europe, Asia, and the Middle East.
4.5.5 Eutelsat

Paris-based Eutelsat provides a wide range of satellite services via its fleet primarily focused on Europe and North Africa, but increasingly including Ku band coverage in the rest of Africa and the Middle East.

Eutelsat recently announced it has signed a contract with Astrium Space Industries for the delivery of a new satellite called W3A. This new 50-transponder spacecraft is aimed at the market in Europe for multimedia services, and to reinforce its expansion path into Africa. W3A will provide a pan-European footprint similar to the one provided by W3; coverage, although optimized for Europe, will include Turkey, Iran, Saudi Arabia, and Ethiopia. Content currently delivered by the steerable spot beam on W3 will provide capacity for additional services and coverage of sub-Saharan Africa through Ku-band transponders, which will be optimized for two-way satellite broadband access and business-to-business networks within Africa. Connectivity between Europe and Africa will be possible using Ka-band frequencies for communications to and from Europe and Ku-band frequencies for communications to and from Africa. (http://www.eutelsat.com)

4.5.6 Loral Space & Communications

Loral Space & Communications is a telecommunications company that concentrates primarily on satellite manufacturing and satellite-based services, including transponder leasing and value-added services, domestic and international corporate data networks, global wireless telephony, broadband data transmission and content services, Internet services, and international direct-to-home satellite services. The Loral Global Alliance, which will soon include Stellat, is currently comprised of Loral Skynet, Satélites Mexicanos S.A. de C.V. (Satmex), Loral Skynet do Brasil, and Europe*Star, forming a network of satellite operating companies that provide global satellite solutions. EuropeStar is the Loral Space operator with African coverage (see below). (http://www.eutelsat.com)
4.5.7 Europe*Star

Europe*Star has recently launched a satellite with African Ku-band coverage. It is a joint venture between Alcatel and Loral as part of the LoralGlobal Alliance. Europe*Star and France Telecommunications recently finalized their agreement to establish a new joint venture to provide fixed satellite services across Europe, Africa, and the Middle East. The new company, called “Stellat”, has already committed to the construction of a new high-powered communications satellite, called “Stellat 5,” which was launched in 2002 into the 5° West longitude orbital slot. Stellat has contracted with Alcatel Space for the construction of the new satellite based on the Spacebus 3000 B3 platform. Stellat 5 will be equipped with 45 transponders: 35 Ku-band and 10 C-band. (http://www.europestar.com)

It will provide a Ku-band Superbeam for DTH video and high-speed Internet services across Europe and Northern Africa, while the Ku-band widebeam will extend Internet and video distribution to Eastern Europe and the Middle East, supplemented by a steerable beam. The C-band hemi-beam will cover Africa and Europe. Both C-band and Ku-band will include connections across the Atlantic and will be capable of linking the eastern seaboard of the U.S. and South America with Europe, the Middle East, and Africa.

The company currently offers fixed satellite services from its Europe*Star 1 and Europe*Star B satellites, serving customers across their five coverage regions: Europe, Southern Africa, the Middle East, the Indian subcontinent, and South East Asia, and includes digital transponder capacity for full-time, part-time, and occasional use requirements.

4.5.8 Alcatel Space

An affiliate of Alcatel (51%) and Thomson-CSF (49%), Alcatel Space generated a 1999 turnover of 9.3 billion francs (1.4 billion Euros) and employs 5,500 people. Alcatel Space has partners around the world, subsidiaries throughout Europe and is a prime contractor, operator, investor, or service provider—in a majority of ongoing space programs for telecommunications, navigation, optical and radar observation, meteorology, and sciences. Alcatel Spacecom, a subsidiary of Alcatel Space, groups together the activities and interests relating to investments and operations in systems and satellites. This subsidiary is responsible for several programs and projects of this nature, including, among others, SkyBridge, Cyberstar (multimedia); Euteltracs (positioning and fleet management); Europe*Star, Eurasiasat, Rascom, Bolivarsat, AirTV (telecommunications and broadcasting). (http://www.alcatwl.com/space)

4.5.9 Verestar/Interpacket (USA)

The growing Verestar group has recently absorbed three of the larger satellite bandwidth providers active in Africa - American Tower Corporation (ATC), Interpacket and US Electrodynamics Inc (USEI). ATC had in fact recently acquired USEI before being itself taken over by Verestar. These operations have provided data and Internet bandwidth for companies and ISPs in Africa since the mid ‘90s. California-based Interpacket had been aggressively signing up ISPs in Africa with its C-band based Espresso service which is available on both PanAmSat and Intelsat satellites, providing both simplex (half-duplex) and duplex solutions from 256 Kbps upwards. It is not known if Verestar plans a Ku-band offering yet. (http://www.verestar.com)

4.5.10 Tiscsat

Tiscsat is a European-based reseller of a low-cost VSAT based two-way Internet service making use of Eutelsat Ku-band satellite coverage over Europe and North Africa. The service costs about $2000 for the VSAT terminal and $400/month for a 64 Kbps out and 400 Kbps incoming service. (http://www.tiscat.com)

4.5.11 African Sky Communications

African Sky is a Canadian public company listed on the Canadian Venture Exchange. The company focuses on providing communications services throughout Eastern and Southern Africa. Initially through a joint venture with a South African company it has obtained the right to provide VSAT communication services in South Africa. In addition the company has an agreement with the Common Market for Eastern and Southern Africa
(COMESA) to implement and operate a communication networks in its 21 member states. ([http://www.africanskys.com](http://www.africanskys.com))

4.5.12  Hughes Network Systems (HNS)

HNS is a manufacturer of VSAT products for delivery of interactive data, voice, facsimile, and multimedia services. HNS has a close relationship with Telkom SA and is projected to support 90 percent of Telkom South Africa’s VSAT requirements. Under a recent contract it is estimated that HNS will supply up to 14,000 terminals to serve the country’s metropolitan and rural areas. With this four-year agreement, HNS will support Telkom SA in the delivery of its SpaceStream VSAT service. The contract also includes sales and marketing support from HNS and maintenance for ten previously installed HNS satellite hub earth stations.

HNS is the leading supplier of VSAT network equipment in Africa with more than fifteen African operators utilizing HNS hubs and HNS equipment deployed in all but three of the African countries. The SpaceStream VSAT service provides networks to market segments such as financial services, retail, and manufacturing, and government services such as air traffic control, police, and election monitoring. ([http://www.hns.com](http://www.hns.com))

The networks run a variety of applications from email, Point-of-Sale, ATM, voice, and telex to newer multimedia, business television, and e-learning applications. Telkom SA has already signed with a major financial institution, the Amalgamated Bank of South Africa, as its first customer for a deployment of over 700 remote terminals for automatic banking machines.

4.5.13  Titan

Titan is a diversified US-based telecommunications and other electronic equipment and services provider with a variety of interests in Africa. In 1999 Titan Corp entered into an agreement with Telecel International, one of the largest wireless communications service providers in Africa, to create a joint venture that will provide satellite-based telecommunications services in Africa utilizing Titan’s patented Xpress Connection VSAT technology. The agreement calls for the new joint venture to provide rural telephony service in each market where Telecel owns a cellular license. Deployment of pilot projects in underserved regions of two West African countries, Ghana and Central African Republic (CAR), has begun. Ultimately, the joint venture plans to offer service in at least eleven additional African countries. The technology features prepaid payphone services and Internet access as well as wireless local loop integration so that local entrepreneurs can have a long-term viable business. ([http://www.titan.com](http://www.titan.com))

4.5.14  RASCOM

The Regional African Satellite Communications Organisation (RASCOM) project was established in 1992 by an intergovernmental treaty now signed by 44 countries, RASCOM was originally formed to pool and optimize satellite capacity leased from Intelsat, and to help maximize the discounts by buying transponder space in bulk. A second phase is to see the launch of a dedicated satellite for the region; a build-operate-transfer (BOT) partnership was formed to launch RASCOM Star, but although this was due to be operational by 2003, it has yet to get off the ground.

South Africa is interested in launching its own regional satellite. This alternative was a key factor in Telco’s decision not to invest in the RASCOM project, which needed the biggest carrier on the continent to help underwrite the cost. Instead, South Africa is believed to be looking at two alternative proposals: SACOMSAT (South Africa Communications Satellite) and SADC-1, a sub-regional project jointly owned by the 14 members of the Southern Africa Development Community (SADC) region. Nigeria, too, has had ambitions to launch its own satellite and has looked at the idea of its own space program.
Recommendations

As can be seen from the previous chapters, an overall project to obtain more bandwidth at lower cost for Partnership universities and by extension to other educational institutions on the continent involves three interrelated components:

- Improving international connectivity at sustainable rates through economies of scale;
- Efficient management and appropriate utilization of bandwidth at the institutional level; and
- Coordination between African educational institutions and their respective budgets.

The sections below lay out what we believe is the most appropriate scenario to achieve the objectives delineated in the Partnership’s terms of reference for this investigation.

5.1 Options for Improved International Connectivity at Sustainable Rates

As can be seen from the earlier section, satellite bandwidth is expensive when compared to terrestrial alternatives, and the long-term strategy will clearly be to move over to international fiber when it becomes locally available. Thus an initial and continuing action point for each country will be to participate in efforts to encourage the establishment of competitively provided national and international infrastructure. In some countries—where fiber is locally available (i.e. the SAT-3/WASC cable, which lands in Nigeria, Ghana and South Africa), the universities could lobby the national monopoly operators—Nitel, Ghana Telcom and Telkom—for access to the cable at competitive tariffs. In South Africa the call-center industry successfully lobbied for competitively priced access, with support from the Department of Trade and Industry.

In the short-term, although each university could ‘shop around’ and perhaps obtain slightly better satellite bandwidth pricing individually, or even negotiate individual discounts with satellite providers, a more collaborative effort to obtaining bandwidth will, at a minimum, improve the economies of scale to reduce the overall costs of bandwidth. At the same time acting together as a group will improve the negotiating capacity of the institutions to obtain better prices and also make providing discounted bandwidth more attractive to satellite operators and service providers looking to minimize administrative costs in such arrangements. Finally, if the universities all use the same remote satellite gateway, the main advantage of satellite connectivity can be exploited, namely being able to broadcast the same data to multiple sites for the same cost as sending it to one site.

However establishing such a facility will only be able to lower the costs of bandwidth significantly if there are substantially more sites than the existing Partnership universities to share the cost of the service. Because of the economies of scale in Internet and telecommunications bandwidth provisioning, along with the reduced technical resources needed and to spread costs of equipment, shared access via a common national VSAT or satellite-based international gateway for all local educational institutions is desirable. This suggests a second scenario/action point – support should be given to the development of a shared national educational infrastructure linking to the international educational gateway and to local Internet exchange/peering points (IXs). In this respect, the Partnership universities would be setting an example and spearheading an effort to establish a broader educational backbone on the continent.

At the same time, to find enough additional sites to attain critical mass, collaboration could take place with the other similar projects on the continent aiming to address the bandwidth issue for the educational sector. These are:

- The Liberty Foundation Panamas educational bandwidth sponsorship. As described above, this is the only large-scale project in this area. Collaboration with the Partnership would improve the reach of both projects.
• The African Virtual University, housed at many of the Partnership universities and at over 20 other sites in Africa, would add a substantial and common user-base to a collaborative project.

• The Open Society Institute (OSI) Southern Africa is planning to support VSAT access for a number of university sites in Southern Africa as part of its EIFL program.

• Connectivity Africa, the new multi-million dollar Canadian program administered by the IDRC and UNECA, aims to improve international connectivity on the continent.

• USAID has programs to support the academic sector in Africa improve its connectivity.

• The UK Department for International Development (DfID) is responsible for an ambitious research program called Catalysing Access to ICTs in Africa (CATIA), some components of which are directly relevant to the bandwidth initiative.

The aim of collaboration would be to link with other similar institutions within the footprint that are more likely as a group to benefit from the shared broadcast facility of the satellite bandwidth. This would ultimately restrict it to the higher institutions of learning and training on the continent. While those on local terrestrial fiber connections may not initially choose to become part of the VSAT network, ultimately as intra-university traffic grows, it may become cost effective for them to join, especially as this also addresses the need for redundancy and reliability by providing an alternate link – breakages in marine cable can take days if not weeks to fix.

The hub for the network should be placed within the footprint and closest to the ultimate destination for the bulk of the traffic. This rules out placing the hub in Africa, as the cost of the marine fiber to bring most of the traffic back to Europe and North America is unnecessary since the satellites can land the traffic directly into these backbones. The landing location could be decided according to a combination of which routes have the lowest bandwidth costs (or operators willing to provide sponsored bandwidth) and which organizations have an interest in providing local gateway management. Ideally this would be at one of the national academic networks in North America or Europe falling under the relevant satellite footprints. The European academic network, Géant, would be a possible option for the Partnership project. It has already indicated its interest in supporting connectivity for South Africa’s National Research and Education Network.

The use of a common satellite provider for connectivity also allows for the possibility for the satellite operator to easily donate bandwidth to a large number of institutions at the same time. This could take place in two ways. The operator can either simply provide the bandwidth free or discounted for a certain period, and/or it can provide ‘burstable’ additional bandwidth for temporary needs at no extra cost when it is available.

The nature of the telecommunications trucking industry/technology is that each satellite or fiber has a fixed capacity (although recent developments have increased the potential capacity of existing fiber to some extent), which the operator aims to use to the full for the maximum length of time the satellite or fiber is operational. The operator attempts to presell as much bandwidth as possible before the satellite is even launched or the fiber is installed and will adjust pricing according to demand and available capacity on its network or fleet as a whole.

This naturally produces a wide variety of discounting mechanisms for most efficiently using the available capacity, which also takes into account the type of use to which the bandwidth will be put, including volume-based discounting, contract-length discounting, pre-emptive and non-preemptive pricing, and Indefeasible Right of Use (IRU) supply arrangements. In this context, the definition of ‘surplus capacity’ is not easy. However at the same time, the promotional and social responsibility goals of the telecommunications operators has meant that discounted or free bandwidth has been made available for special purposes such as education. This is more easily provided for shorter, immediate-term periods when the operator has a better idea of unused capacity. Similarly because there is likely to be overcapacity at the beginning of the life of a satellite or when a fiber link is first installed, it is more possible that special arrangements may be made for some of this initial capacity. Finally, it is also possible that local telecommunications operators have undertaken long-term contracts with upstream suppliers for amounts of bandwidth that they are not currently using.
In conclusion, the proposed strategy is to ask the Partnership to support the establishment of a satellite hub to provide lowest possible cost bandwidth to HEIs. This would involve the following steps:

- Establishing a more detailed plan and costing for setting up a hub in Europe or North America to provide bandwidth to the Partnership universities with the potential to scale up to a few hundred institutions. This would involve identifying the national academic network or other agency willing to host the hub management facility in North America or Europe. The South African academic and research network, TENET, may also be able to assist in providing upstream bandwidth; however, the extra costs of backhauling most of the data to Europe and North America over SAT-3 are likely to increase costs over a solution in which traffic is landed directly in Europe or North America. Nevertheless, TENET is likely to benefit from participation in the network for African university traffic.

- Contacting the potential stakeholders in the network to identify those interested in supporting the strategy proposed—the Partnership universities, the international hub management, the Liberty Foundation partners, the AVU and member sites, and the Open Source Initiative (OSI) and partner universities. This would identify available resources and establish a working committee to develop an RFP to be given to all the major satellite operators in Africa asking them for their best sponsored prices and options for additional discounted burstable bandwidth for the project (along with proposals for network design). The RFPs would need to include a clear business plan for the proposed ongoing management of the operation and indications of support from the proposed hub manager and the Foundations. Feedback from the satellite operators during the course of this study has indicated that great importance is attached to the quality of the management of the operation, so this should be clearly established before contacting the satellite operators.

- Proposing the winning bid to the stakeholders who would agree to use the facility and define the resources they are able to commit to the project.

- The Partnership could initially support the initiative by providing the resources for a small secretariat to manage the start-up of the project, engage the research, and carry out the outreach. Following the successful completion of this phase, the satellite operators would need to be contacted to make them fully aware of the seriousness and scale of the project and of the need to provide discounted bandwidth. Prior to implementation stage it may also be necessary for the Foundations to assist in lobbying some of the national governments to waive license fees or import duties for the equipment. At this point, it might also be desirable to convene a conference to bring together the vice-chancellors, service providers, regulatory bodies, and the donor community to work on blanket exemptions or e-rates for the educational community. This would permit the academic communities to develop a special relationship with the vendors and regulators. At implementation stage it is likely that support will be needed from the Foundations for shared equipment and technical capacity building.

5.2 Recommendations for Partnership Universities

The Bandwidth Task Force recommends the following to the partner universities:

- To prepare ICT policy and master plans for those without such plans;
- To develop proper and adequate ICT infrastructure to ensure optimum utilization of bandwidth;
- To train and retain adequate ICT personnel to operate, maintain, and manage ICT investments;
- To prepare plans for end-user training, including students and staff, on the use of Internet;
- To develop strategies for monitoring utilization of bandwidth and security enhancement;
- To implement ICT-mediated learning and teaching, including the adoption of virtual classrooms, online library access, etc.

In addition to the above recommendations, which are targeted at individual universities, it would also be appropriate to conceptualize and plan for interventions that would warrant collaboration among universities. Consortia to purchase bandwidth is one such instance, of course. Others include organizing joint training pro-
grams; sharing of expertise and experience in the areas of ICT planning, infrastructure, and management, for example; and collaboration in the development of innovative ICT teaching modules.

5.3 The Role of Partnership Countries

The partnership countries have the following roles in assisting the enhancement of cheaper and more bandwidth access to the institutions:

- To have a workable national ICT policy and master plan;
- To develop the national backbone and to create cheap access to Internet for universities;
- To speed up efforts to link Partner countries to the Internet backbone through high capacity fiber optic cable;
- To monitor effective use of ICT services, infrastructure, and facilities within universities, and research and educational institutions;
- To establish favorable tariffs for the educational and research sectors;
- To assist universities and research institutions in their efforts to access bandwidth through appropriate financial and policy frameworks;
- To provide room for negotiations with international bandwidth operators in order to obtain cheaper and more bandwidth for research and educational institutions.

5.4 Items for Partnership consideration

The recommendations described above represent an ambitious, although phased, agenda. At the outset, the Task Force requests assistance from the Partnership by providing the resources for a small secretariat to manage the start-up of activities pertaining to using economies of scale to obtain more bandwidth. This will involve: engaging in the short-term research required to carry out the steps delineated in the economies of scale section, carrying out outreach, and writing a business/work plan.

The University of Dar es Salaam proposes to continue to host the secretariat, in coordination with the Partnership Facilitator. UDSM would hire a full-time assistant for the secretariat. Members would include representation from the Bandwidth Task Force; one person experienced in bandwidth management and/or negotiations with regulatory agencies (perhaps from TENET (SA); one person conversant with technical issues; and one person to represent the telecommunications regulatory agencies in each of the six Partnership countries. UDSM believes the job could be done over a six-month period, with a budget in the range of $55,000.

Following the successful completion of this phase, satellite operators will need to be directly involved to make them fully aware of the seriousness and scale of the project, and the need to provide discounted bandwidth. This would be the time to ask the presidents of the Partnership foundations to become active participants by assisting the Bandwidth Task Force in approaching the satellite operators in negotiations. In addition, prior to implementation, it may also be necessary for the foundations to assist in lobbying national governments to waive license fees or import duties for equipment. The Task Force will collaborate with the Partnership in determining the most appropriate nature of this assistance, which might involve help with developing negotiating tools and strategies rather than direct intervention by the foundations. It is also likely that support will be needed from the foundations for shared equipment and technical capacity building.

At the end of this start-up process, which we hope will be supported by the Partnership, the Task Force will have a detailed implementation work plan and budget to put in place the most appropriate economies of scale scenarios that are appropriate to our institutions. The ultimate goal is to create a viable model for establishing a broad educational backbone on the content. These first steps by the Partnership universities will set an example for other universities in Africa.

The table below delineates a number of overall responsibilities, primarily at the institutional and governmental level. In some instances, Partnership assistance would facilitate some of the required actions and is indicated accordingly.
### Table 13: Division of responsibilities

<table>
<thead>
<tr>
<th>Action</th>
<th>Parties to Take Action</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilize Internet efficiently</td>
<td>Universities</td>
<td>Partnership could provide capacity-building support: necessary equipment and software, and assistance in negotiating on copyright issues.</td>
</tr>
<tr>
<td>Remove policy or regulatory barriers</td>
<td>Universities to position themselves for relevance and policy influence; to work with governments and regulators to identify and remove barriers; to package negotiations in socio-economic context of human development.</td>
<td>Partnership could help by offering support to bandwidth initiatives—subject to removal of barriers where they exist.</td>
</tr>
<tr>
<td>Improve human-resource retention</td>
<td>Universities to implement strategies that admit and accept human-resource mobility; to focus on senior undergraduates and fresh graduates The Partnership could support capacity-building through attachments and scholarships</td>
<td>The challenge of international skills migration must be looked at: bonding agreements for limited amounts of time, for example 1-2 years.</td>
</tr>
<tr>
<td>Practice technical ingenuity</td>
<td>Universities to work together to share experiences The Partnership to provide short-term on-site training and to support equipment procurement.</td>
<td></td>
</tr>
<tr>
<td>Plan for sustainability</td>
<td>Universities to follow the principle of implementing only what is sustainable and to depend on internal resources for sustainability; universities to negotiate as a block with major carriers</td>
<td>External funding is necessary at the outset, including support for extra capacity, provided that it is only in the short term—with agreed modalities for building internal funding. The Partnership could contact large providers on behalf of the universities, as outlined above.</td>
</tr>
<tr>
<td>Work with government</td>
<td>Universities to involve themselves actively in national policy and strategy setting. No one else will issue an invitation to the table. Universities must go for their places.</td>
<td></td>
</tr>
<tr>
<td>Form consortia</td>
<td>This already exists in all but name, except in Mozambique and Nigeria. Universities should formalize this through an MOU.</td>
<td></td>
</tr>
<tr>
<td>The long-term solution of optical fiber access</td>
<td>Universities to influence internal strategies. Partnership could approach multilateral donors.</td>
<td>Long-term sustainability and availability of cheap bandwidth will only come when African universities can transfer to the internal optical fiber Internet backbone.</td>
</tr>
</tbody>
</table>

---

*More Bandwidth at Lower Cost: An Investigation for the Partnership for Higher Education in Africa*  
*Page 41*
Appendix 1
Bandwidth Task Force Members

Eduardo Mondlane University
http://www.uem.mz
Venancio Massingue, Vice Rector for Administration and Resources
Eduardo Mondlane University
CP 257
Maputo, Mozambique
Telephone: +258-1-307271
Email: carlotta@nambu.uem.mz

Francisco Mabila, Deputy Director
Informatics Centre
Eduardo Mondlane University
CP 257
Maputo, Mozambique
Telephone: +258-1-492601
Email: mabila@uem.mz

Makerere University
http://www.makerere.ac.ug
F.F. Tusubira, Director
Directorate for ICT Support
Flat B5 Lincoln Flats
Makerere University Main Campus
Kampala, Uganda
Telephone: +256-41-531343 and +256-41-531437
Email: tusu@dicts.mak.ac.ug

National Universities Commission (Nigeria)
http://www.nuc.edu.ng/
Mamman Aminu Ibrahim, Head, Networking and Communications
Department of Information and Communications Technology
National Universities Commission
PMB 237
Maitama District
Abuja, Nigeria
Telephone: +234-9-4135401
Email: ibrahim@nuc.edu.ng and aminu@widernet.org

University of Dar es Salaam
http://www.udsm.ac.tz
Tolly Mbwette, Professor of Environmental Engineering
Prospective College of Engineering and Technology
Faculty of Civil Engineering and the Built Environment
University of Dar es Salaam
PO Box 35131
Dar es Salaam, Tanzania
Telephone: +255-22-2410365
Email: mbwette@wrep.udsm.ac.tz and tsmbwette@yahoo.com
Beda Mutagahywa, Director
University Computing Centre
University of Dar es Salaam
PO Box 35062
Dar es Salaam, Tanzania
Telephone: +255-22-2410645 and +255-22-2410690
Email: bmutag@udsm.ac.tz

University of Ghana
http://www.ug.edu.gh
Mumuni Dakubu, Director, University ICT Centre
University of Ghana
Chemistry Department
Accra, Ghana
Telephone: +233-021-508099 and +233-021-502262
Email: mdakubu@ug.edu.gh

University of the Western Cape
http://www.uwc.ac.za
Derek Keats
Executive Director, Information and Communication Services
University of the Western Cape, P. Bag X17
Bellville, South Africa
Telephone: +27-21-959 2304
Email: dleats@uwc.ac.za

Resource Persons
Mike Jensen
PO Box 101
Port St. Johns
Eastern Cape, South Africa
Telephone: +27-47-564-1351
Mobile: +27-83-541-6185
Email: mike@sn.apc.org Website: http://www2.sn.apc.org/africa/

Aida Opoku-Mensah
Team Leader
Promoting Information Technology for Development
Development Information Services Division
United Nations Economic Commission for Africa
PO Box 3001
Addis Ababa, Ethiopia
Telephone: +251-1-511167
Email: apoku-mensah@uneca.org Website: http://www.uneca.org

Ex Officio
Lisbeth A. Levey, Facilitator
Partnership for Higher Education in Africa
New York University Steinhardt School of Education
239 Greene Street, Room 317
New York, New York 10003, USA
Telephone: +1-212-998-5514
Email: lal9@nyu.edu Website: http://www.foundation-partnership.org
Appendix 2

Bandwidth Study Terms of Reference

Objective: this bandwidth activity will provide the Partnership foundations with sufficient information to make appropriate recommendations to their presidents on whether it would be appropriate to approach international satellite companies to request cheaper or free bandwidth for universities in any of the six Partnership countries.

Background: ICT is a theme that the Partnership for Higher Education in Africa has identified as a cross-cutting issue. It affects all aspects of university life. None of the African universities with which the Partnership collaborates has sufficient bandwidth. It is expensive and, for the most part, Partnership universities purchase their bandwidth from middlemen rather than at source. In a survey of universities receiving funding from Partnership foundations, we learned that costs range from $4,500 a month to $12,000, depending on the amount of bandwidth purchased. In general, bandwidth rates are usually far higher in Africa than they are in North America and Europe.

In Addis Ababa, conference participants agreed that bandwidth is a critical issue for African universities. Without better bandwidth, there can be no meaningful utilization of ICT for teaching, learning, research, or management.

The activity proposed below is designed to respond to the interest of the Partnership presidents in assisting to leverage additional bandwidth for the universities that the Partnership supports in Africa by directly approaching one or more satellite companies. If the presidents are to use their influence in a productive way, they need to have sufficient information on four issues:

• Which companies are selling bandwidth to Africa or would be able to do so;
• Which companies have spare bandwidth to donate or sell cheaply for use in African universities;
• Which companies might be amenable to an approach from the Partnership; and
• Whether the universities that the Partnership supports, using their existing or planned infrastructure, could tap access to more bandwidth.

These questions are complicated by the fact that economic, market, and regulatory conditions differ in the six Partnership countries. In South Africa, the university network has been able to work with the government, the higher education sector, TelKom, and the donors to create TENET. In Uganda, there appears to be a burgeoning local market and competition, which is lowering bandwidth costs for everyone. In the remaining countries, universities primarily rely on VSAT systems. It is important to have a better understanding of conditions on the ground in the countries in which the Partnership is active to determine the feasibility and usefulness of intervention.

Assignment: The objective of this activity is to ascertain whether there is a useful role for the Partnership, particularly the foundation presidents, in leveraging cheaper bandwidth from the satellite companies. At this time, no further Partnership action is envisaged.

In July 2002, the Partnership organized a conference in Addis Ababa on identifying key issues regarding ICT use by African universities. The University of Dar es Salaam volunteered to be responsible for coordinating a follow-up bandwidth activity and for hosting a secretariat. The group will take responsibility for the investigation outlined here.
Terms of reference include:

**In Africa:**
- Identifying the ways in which telecommunications regulatory conditions, pricing, and marketing impact on the higher education community. Highlighting the kinds of policy and regulatory frameworks that must be in place to ensure that the universities can take advantage of any offers made by the satellite companies.
- Assessing how much bandwidth is being used now, how much bandwidth will be required in one year, how much in five years. Projecting to the extent possible bandwidth requirements and what activities bandwidth might be used for. (For example: How much library needs; teaching and research applications)
- Estimating the types and magnitude of human resource requirements to manage bandwidth and maintain increased use.
- Identifying how universities might sustain the use of bandwidth. (Can they use the promise of free or cheaper bandwidth to leverage more cooperation within the universities and outside of the universities—within the educational sector, with the government, etc.?)
- Determining the types of training that will be necessary—technical, managerial, and for academic applications. (Are appropriate mechanisms within the university already in place? If not, what needs to be done?)
- Assessing the sufficiency of current university infrastructure to support increased bandwidth. (The campus backbone, local area networks, computers, etc.)
- Assessing the potential for collaboration between universities within and across countries to create national or regional economies of scale for reducing bandwidth costs and increasing opportunities to share material.

**Outside Africa:**
- Assembling material on ICT status in the relevant Partnership countries, which will complement the work carried out by the university representatives to the Bandwidth Task Force.
- Identifying the satellite providers that have surplus bandwidth that could be donated or sold more cheaply to the Partnership countries and universities.
- Determining whether any satellite providers have a history of free or discounted bandwidth and, if so, how these contracts were negotiated.
- Making recommendations on how best to approach the satellite companies, including identifying the key points of leverage and the decision makers within the bandwidth companies with whom the Presidents might interact.

Some of this material already exists in print and on the Web. Mike Jensen, a well-known ICT consultant, who maintains the most up-to-date Web site on ICT in Africa, recently completed a case study of Ethiopia for the ITU, which is a model for the kind of assessments required. ITU also commissioned a similar study for Uganda in 2001. Both studies are on the ITU home page: [http://www.itu.int/osg/spu](http://www.itu.int/osg/spu).

In addition, UNECA’s Africa Information Society Initiative has country information for each Partnership country, although entries are of uneven quality. These entries can be found at: [http://www.uneca.org/disd/ict](http://www.uneca.org/disd/ict). Finally, UNECA collaborated with UNESCO and UNDP in convening an ad-hoc experts meeting in Nairobi in 2001. Several of the papers prepared for this conference are relevant, including one on ICT for higher education in Ghana and one that examined lessons from Asia and their relevance for Africa.

**Methods:** The investigation will begin on 1 February 2003 and conclude on 31 July 2003. Implementation involves the following components:

Creation of a small committee, with representation from each of the Partnership countries:
Tanzania: Beda Mutagahywa, Director of the University of Dar es Salaam Computer Centre, and Tolly Mbwette,
Professor, Civil Engineering and the Built Environment, University of Dar es Salaam
Ghana: Mumuni Dakubu, Director, University of Ghana ICT Centre
Mozambique: Venancio Massingue, Deputy Rector, Eduardo Mondlane University
Nigeria: Mamman Ibrahim Aminu, Director, University ICT Activities, National Universities Commission
South Africa: Derek Keats, Executive Director, Information and Communication Services, University of the Western Cape
Uganda: F.F. Tusubira, Director, Directorate for ICT Support, Makerere University

Each of these individuals was previously selected for the Task Force at the Addis Ababa meeting in July 2002.
In addition, Aida Opoku-Mensah, who is UNECA's Team Leader for Promoting Information Technology for Development, and Mike Jensen, will be added to the committee as resource people. Jensen will concentrate on the political economy and technology of bandwidth from an international perspective.

Lisbeth Levey, Partnership Facilitator, will also be appointed, as an ex officio member.

The University of Dar es Salaam will establish an email list in February 2003 to begin delineating the parameters and specific terms of reference for country/university surveys.

The University of Dar es Salaam will host a meeting in Dar es Salaam in March 2003. Each member of the group will come to the Dar meeting with a draft document for discussion.

Following the March meeting, committee members will return to their institutions to continue to work on their assignments. Draft documents will be circulated for review using the email list. Each member’s report should be finalized by early May.

The University of Dar es Salaam will draft a report to the Partnership following receipt of every member’s final report. This report will be ready for review by the team in mid May. At this point, the group might be widened to include one or two experts in the United States. Possibilities include Nancy Hafkin, formerly of UNECA and now an independent consultant, Jonathan Peizer, Open Society Initiative, Tom Nygren, Mellon Foundation, and Ernest Wilson, University of Maryland.

If this investigation provides sufficient basis for consideration of an intervention strategy by the Partnership, there would be a second meeting in New York in June 2003. This gathering would focus specifically on appropriate interventions by Partnership presidents and officers. Up to four members of the investigative team from Africa, including Mike Jensen, would attend the New York meeting. One or more outside specialists outside Africa would be invited to the New York meeting as well.

The final report, which will be a collaborative effort of the entire team and coordinated by the University of Dar es Salaam, will be written and sent to the Partnership in July 2003.

**Recipient:** Service Contract with the University of Dar es Salaam

**Research Team:** Tolly Mbwette and Mutagahywa will serve as principal investigators. The team experts listed above will assist them.

**Travel:** There will be travel within Africa to the Dar es Salaam meeting by Massingue, Keats, Tusubira, Dakhubu, Aminu, and Opoku-Mensah and possibly one trip to New York for four members of the Africa team and one or more local experts, as described above.

**Output:**
- Report and recommendations to the Partnership about the feasibility of interventions that would result in more bandwidth at a lower cost.
- A set of considerations and suggestions for universities wishing to utilize increased bandwidth effectively.
Appendix 3

Papers Submitted by Task Force Members

Ghana

Mozambique

Nigeria

South Africa

Tanzania

Uganda

Out of Africa