FEAST: Feasibility Study for African – European Research and Education Network interconnection

Intermediate objective B. Analysis

Following on from the Information gathering phase of the project, the data that was provided was analysed and forms the basis of the following report. Due to the imminent arrival of several sea cables along the east coast of Africa it is proposed to concentrate on the countries that directly connect to these cables and a number of landlocked countries that have been identified as being ready to deploy national research and education networks and to capitalise on the extra capacity of the sea cables.

The Fact Finding phase of the FEAST Study identified that on about 10% of the 53 African Countries have NRENs which are operationally active and are connected to the global internet at an appropriate level. Of these, 20% have organised NRENs which could take on the functions of a Regional network, another 20% have some form of NREN activity but could not be considered as technically developed and 50% show little sign of activity or even awareness of the NREN activity or requirements. All of the reasonably ready NRENs are on the eastern side of Africa, from Sudan and Ethiopia in the North East, through the more central countries of Malawi, Zambia and Zimbabwe to Mozambique in the south. Egypt and South Africa have developed and active NRENs.

The existences of a regional network in the UbuntuNet Alliance is also a means of identifying countries that could make use to connectivity to the worlds' research and education networks. Reference documents from the Association of African Universities NREN Unit were used to augment the information from the other sources.

Two groups of countries are identified: the seaboard countries and the land locked countries:
> Seaboard Countries: Mozambique, Tanzania, Kenya, Djibouti, Sudan
> Landlocked Countries: Malawi, Rwanda, Uganda, Ethiopia

Activity B.1 Identification of alternative scenarios

a)   The likely demand for international connectivity

It is estimated that the research and education communities of the countries in question are currently subscribing to a total of about 250Mb of VSAT connectivity. This is largely distributed amongst the individual universities or research institutions in each country. Where existing NRENs have some form of organised and dedicated national network, there may be some consolidation of the national and international connectivity. Most of this connectivity is, however, used for what is known as "commodity internet" access, in other words access to generic information rather than specific research and academic services.

At present, all of the potential countries in Africa only have the commodity internet and cannot benefit from connectivity to the world Research and Education networks. Once they are connected to the R&E system, there will be a division of their traffic to encompass both areas. As the networks develop, there will be a rebalancing between the services and the usage of the R&E networks will grow as international collaborations increase.

Most European countries purchase connectivity to the commodity internet as well as to the R&E network. Commodity internet service can be purchased through a bulk deal such as DANTE World Service or can be done nationally as TENET in South Africa has done via the UbuntuNet router in London.

Depending on the configuration of the final network, it may be advantageous for the RREN to bulk purchase commodity internet service for the region. This should probably be locally obtained in Africa.

It is very likely that increased Internet access at much reduced costs will become available as soon as the submarine cable systems become active during Q2 and Q3 2009. This increase of available capacity at reduced price will lead to new dynamics in the commercial Internet markets across sub Saharan Africa. It is also likely that the new capacity will trigger the sub Saharan universities and research institutions to renegotiate their Internet capacities and move from the current VSAT capacity to submarine cable capacity. It is important to note that the planned project AfricaConnect will be focussed on the provision of connectivity to the world's R&E networks rather than the commercial internet. Special local arrangements will have to be made for access to the commodity internet. This could be provided via the local NREN, or the RREN. .

Based on the current 250Mb access rates, it is estimated that there would be an increase to about 2,5Gb over the 12 month period to June 2010, on the assumption that national NREN infrastructures will be implemented in this period. In the following two years, the capacity is likely to double each year, with 5Gb being required by June 2011 and 10Gb by June 2012.

Depending on the amount and types of research activity in the area, extra headroom capacity may be required for "bursty" type applications that required very high speeds, low latency networks but may only use this for relatively short periods. The availability of high capacity networks stimulates such projects which are unthinkable on normal commercial circuits.

b) The regulatory regime including a view as to whether it will be feasible to gain equal access to infrastructure

Based on the information gathered in D2A, it can be stated that most of the African countries that have been surveyed have advanced regulatory environments that will suit the rapid deployment and expansion of the respective NREN. Indeed, it could be said that the environment is much more favourable than that which was in place during the growth phase of the European NRENs in the 8s and 90s when there was often mistrust and hostility between the operators and the NRENs.

Relationships between the regulators and the NRENs appear to be at a very positive level as reported in the responses to the NREN questionnaire collected in the context of FEAST by TERENA.

The NREN survey has demonstrated that there is close collaboration between the national regulators and the NRENs in many countries. This is demonstrated by the regulators assigning low cost, or free, licences to the NRENs to allow them operate efficiently in their countries. In some cases, the regulators have documented the fact that the NREN does not require a licence and in others has provided for preferential access rates to VSAT services. The good relationship bodes well for the development of the networks and should prevent problems arising between the commercial operators and the academic networks in the future.

The following table shows the state of market in leased line liberalisation and the presence of an NREN license, where requited.

Country	Market Officially Liberalised	Market State	NREN License Issued
Kenya	Fully	Competitive	Yes, License issued to NREN
Uganda	Fully	Competitive	None Required
Rwanda	Fully	De-facto Duopoly	May be required when NREN has infrastructure
Tanzania	Fully	Competitive	None Required
Malawi	Fully	De-facto Duopoly	Yes, License issued to NREN
Mozambique	Fully	Monopoly	None Required and confirmed in writing by Regulator
Ethiopia	No	State Incumbent	NREN working as state agency
Sudan	No	Private Incumbent	NREN working as state agency
Djibouti	No	State Incumbent	No NREN

c) The likely cost of hardware and network operations

Only when the RFI responses have been collected and analysed will a potential topology for a regional sub Saharan R&E network emerge. It seems, however, likely that there will be two or potentially three rings in the sub Saharan region that will interconnect with each other and to one or two GÉANT PoPs in Europe. Depending on the technology offered by the capacity suppliers routing and/or switching equipment will therefore be needed in the core PoPs of the sub Saharan R&E network. In addition to this routing and/or switching equipment, there will be a need for a certain amount of LAN equipment in these core PoPs to ensure the network operations.

The likely rings could be:
- North-Eastern: Sudan, Ethiopia, Djibouti
- Eastern: Kenya, Uganda, Rwanda, Burundi, Tanzania
- Southern: Mozambique, Malawi, South Africa, Zambia, Zimbabwe, Botswana, Namibia

The rings would overlap to some extent and provide internal redundant links.

In the past, the regional implementation projects in Latin America, the Mediterranean, Asia Pacific and South Asia have been able to obtain generous routing equipment donations from equipment providers.

In addition to the equipment in the core PoPs, there will be the need for smaller routing equipment in the respective NREN Access PoPs. In some cases, the NRENs will already have the relevant equipment available, but it should be considered to try and obtain a donation also for access equipment for NRENs that have not yet been able to obtain such equipment.

Should donations not be forthcoming, it is estimated that the cost of the equipment in each of the core PoPs of the sub Saharan regional R&E network would be in the range of approximately 300K Euros per core PoP (routing and LAN equipment, including interface cards). It has to be recognised that there will be a considerable amount of import duties to be paid for the equipment.

In addition to the pure cost of the equipment there would be costs associated to the installation and maintenance of the equipment. It is at this stage of the FEAST study not yet clear in how far the main equipment providers will be able to provide maintenance of equipment in the respective countries and how much this would be. It can be assumed, however, that there will be yearly maintenance costs of approximately 150K Euros.

It is our experience that a considerable additional cost is associated with the resilient electricity supplies needed in the PoPs.

At this stage of the FEAST study, it is assumed that both the Network Operations Centre (NOC) as well as the Network Engineering and Planning (NEP) tasks of the regional sub Saharan R&E network will be carried out by one or two of the more advanced sub Saharan NRENs or the UbuntuNet Alliance. If this is the case, the planned implementation project would need to fund the additional manpower needed to run the NOC and NEP functions. It is also likely that some monitoring equipment and software and also out of band access equipment will have to be purchased. It is therefore estimated that the yearly cost of an operational NOC and NEP function run by one of the sub Saharan partner NRENs will amount to approximately 175K Euro including minor equipment and software purchases.

Summary of Estimated Costs of PoPs an NOC & NEP	
Core Routing PoP (capital)	300K Euros
Core Routing PoP (maintenance per annum)	150K Euros
NOC & NEP running Costs (per annum)	175K Euros

Cost Allocation Model

The timing of the feasibility study and its subsequent implementation in Africa-Connect does not tie in well with the imminent deployment of the sea cables up the East coast of Africa. Some of the countries in the study have advanced national plans to connect their governmental and educational networks into the global internet community in the latter half of 2009. Some countries have national fibre plans that can be availed of by the respective NREN including connection to the sea cable and transit onwards to Europe.

The establishment of a firm cost sharing model at this stage is difficult due to these national programmes. It has been identified that some countries will be easy to reach whilst others will remain very difficult for some time to come. Any cost sharing model that is to be developed should be agile enough to take into account the great variability in national and cross-border fibre infrastructure as well as strategic plans of individual countries.

It is possible to outline the principles of a cost sharing plan that will allow for significant variations in national connectivity:

- Attempt to even out access cost difference between the various NRENs
- Equal access to international resources, based on shred costs
- At least 20% cash contribution by beneficiary countries, 80% being provided by EC
- Transition to a long tern sustainable model during the first three years of the project

There are a number of broad components to the costs of running a regional network in Africa, these are:

- Connectivity from the regional hub to GÉANT
- Connectivity from the regional hub to the national NRENs
- Equipment for the regional hub, routers, switches, servers etc
- On-going network management, either on an outsourced or on a staffed basis
- Project management at the start-up phase as well as in the production phase
- Project meetings with the partners
- Training and Human Resources Development

Generic NREN Requirements

An NREN should have a similar structure with a "Board of Directors" taking policy decisions and a Chief Executive and management team implementing these policies and working within budgetary guidelines set by the Board of Directors.

a) Full time CEO with business and technical skills

b) Administration/Finance Officer (at least half time in a small NREN)

c) Network Engineers (at least one in a small NREN)

d) Financial management system, network management system, bank accounts with international transfer possibility.

e) Secure physical offices, hosting facility

f) Appropriate electric power and back generator capacity for computers, network equipment and air conditioning services

g) Diverse physical network conduits to multiple suppliers

NREN Readiness

A number of criteria to determine the potential of an NREN to fulfil its national and international responsibilities have been determined, these include:

a) Organisation and Human Resources

b) Acceptable Use and Connection Policies

c) Interconnected Campus Networks of Member Institutions

d) Number Plan from AFRINIC

e) Lighthouse Demonstrators

Some general key points can be made regarding the requirements of the African NRENs, most of these apply to most countries, but of course there are exceptions:

1. Appointment of <u>Dedicated </u>Staff, CEO, CTO, CFO, engineers (see above)

2. <u>Active</u> support from the Government through one Ministry

3. <u>Active</u> support from the Telecom Regulator

4. <u>Active</u> support from the infrastructure providers, telecoms, electricity, railway, roads etc

5. Build strong relationships with the member institutions of the NREN to encourage cooperation and avoid fragmentation of the network resulting from independent network connections

6. Cooperation with neighbouring NRENs

7. Training plan for technical staff in the NREN

8. Training plan for the technical staff in the connected institutions

9. Formal agreement and publication of Acceptable Usage Policy

10. Formal agreement and publication of Connection Policy

11. The NREN <u>must</u> acquire an ASN number

12. The NREN <u>must</u> acquire public IP space for NREN operations

13. The NREN should become a Local Internet Registry (LIR) for the connected institutions and assist them in implementing the public IP address space

Analysis of NREN/RREN

1) **UbuntuNet Alliance**:

A formal organisation representing the countries of Eastern and Southern Africa that seeks to develop the networking facilities in and between its member countries. It is developing regional network along the models that exists around the world. The existence of such an organisation should make the creation of a physical regional network much easier.

Currently, DRC, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda and Zambia are formal members of the Alliance. Other countries in the region have cooperated with the Alliance and could be expected as potential members: Botswana, Burundi, Ethiopia, Lesotho, Namibia, Somalia, Swaziland and Zimbabwe.

Having a body that represents the region will strengthen its negotiating position with suppliers, both locally and internationally. It will also assist in the provision of capacity building project as it provides a central focus to a regional programme

2) Kenya: Kenya Education Network Trust (KENET)

Of all the countries that have been studied in the FEAST project, Kenya stands head and shoulders above the others in terms of its development. It is the only country with a substantive NREN which incorporates its own terrestrial network. It has dedicated NREN staff and occupies premises provided by a University. It is regarded as an "Established NREN" by the Association of African Universities NREN unit.

Compared with a European country of similar population (Spain), the staffing level is low at present, 8 compared with 28 in Spain. However, the NREN could be regarded as still in start-up mode as the fibre network is currently being deployed and coexists with copper 2Mb circuits and some distributed VSAT. International connectivity is by VSAT until the arrival of the sea cables later in 2009. Currently KENET peers, though its VSAT links, with the UbuntuNet Alliance router in London and has a total capacity of 266Mb VSAT.

KENET faces many challenges as it grows its network, these include the building of the downstream human capacity in its connected campus networks and institutions where there are low understandings of appropriate use of the network. As network capacity increases, the potential for abuse will grow and possible reputational damage to the institutions and to KENET will increase unless action is taken.

Structurally, KENET would appear to have the support of the member institutions over its 10 years of existence, however the migration from a totally VSAT network to a leased circuit national network with sea cable international connectivity may give rise to competitive issues within Kenya. The potential abundance of high-speed network capacity in the country may lead to apparently cheap offerings by local providers to the existing members of KENET. At this stage of development some users may not be able to differentiate between the existing commodity internet and the extra services provided on a Research and Education network.

KENET has an Acceptable Use Policy (AUP); this is published on their website along with security and other policies. An Autonomous System Number (ASN) and public IP address space has been assigned to KENET and is in operation.

3) Uganda: Research and Education Network for Uganda (RENU)

RENU is regarded as a "New NREN" by the Association of African Universities NREN unit which means that there is little infrastructure in place. RENU has been formally agreed by the Chancellors of the Universities in Uganda under a memorandum of understanding.

Due to the early stage of development of the NREN, it would not be appropriate to make any comparison to other developed NRENs in the world.

A Chief Executive and Chief Technical Officer have been appointed but both of these have senior full time jobs in their own respective universities.

RENU has an agreement with the Internet Educational Equal Access Foundation (IEEAF) in the USA and the IEEAF report that they have designed a backbone network for RENU and installed fibre between Kampala and Entebbe. The plans for completion of the RENU backbone are for implementation by June 2009.

As would be the norm in a new NREN, there will be major challenges in acquiring suitably trained technical and managerial staff at appropriate levels to run the NREN at the appropriate level. However, there are opportunities for an NREN at this stage to profit from the experiences of other countries and to adopt modern techniques without the pain of having to develop new methods of working. There will be extensive requirements for capacity building in RENU and its member organisations.

Physically there is little evidence infrastructure on the ground in the NREN and sites are still connected to the internet by VSAT. Services provided by RENU appear to be emanating from constituent university premises. Plans will need to be put in place to replace the VSAT connections with fibre or copper connections with a consequential rebalancing in national/international connectivity costs.

Once the national infrastructure is in place, extra training will be required for engineers in all the connected institutions to ensure that appropriate controls are implemented and that the network behaviour etiquette are disseminated widely and are enforced.

At present there is no evidence of a published Acceptable Usage Policy or Connection policy, though it is reported that these are being developed. Similarly, no ASN or public IP space has been allocated, though applications have been made to AFRINIC for these.

4) Rwanda: Rwanda Education and Research Network (RwEdNet)

RwEdNet is regarded as a "New NREN" by the Association of African Universities NREN unit and is a very active member of the UbuntuNet Alliance. RwEdNet is working as a "project" and is supported by a board that comprises the Rectors of the universities and Higher Education institutions in Rwanda as well as several governmental agencies.

Despite the relatively immature level for formality in the NREN, the physical infrastructure comprises a number of institutions connected by fibre and an outsourced NOC at the Kigali institute of Science and Technology (KIST). An outsourcing model has been adopted for the NREN in an attempt to optimise services and minimise central functions. Plans are underway to recruit appropriate staff to the NREN in the period up to June 2009.

Rwanda is one of the countries on the African continent with a national ICT strategy and planning vigorously for using ICT as an engine for accelerated development. RwEdNet has to been seen as a key player in the delivery of this national ICT strategy. The national commitment translates to allocation of national connectivity that RwEdNet receives from the government.

As in other African countries being studied, there is a severe shortage of trained personnel on the ground and a vigorous capacity building programme is required to develop staff at the institutions who are either supporting RwEdNet or are members of the user community.

Rwanda has a programme to ensure that scarce satellite resources are not used for national traffic and has set up a national internet exchange point. This means that local Rwandan traffic stay in Rwanda. All RwEdNet international traffic is via VSAT at present. An ASN and public IP address space has been requested from AFRINIC but these assignments have not yet been made. The National University of Rwanda has an allocation of IP address space and an ASN that could be used by RwEdNet in the interim.

No Acceptable Usage Policy has been adopted or published yet, nor has a Connection Policy been adopted, though the standard UbuntuNet Alliance models are being considered.

The national ICT policies that the government espouses will enable the rapid deployment of any capacity that can be provided by the early deployment of high speed international networking once the issues of connecting a landlocked country that is two countries away from the sea cables (from a telecommunications point of view) are solved.

5) Tanzania: Tanzania Education and research Network (TERNET)

TERNET is regarded as a "New NREN" by the Association of African Universities NREN unit. TERNET has had a long developmental period in it formation but is now a registered trust which is supported by a large number of the Higher Educational institutions in Tanzania with more potential members in the community.

At the formal launch of TERNET in 2008, a wide range of ambitious plans were described, including the formation of a number of committees and groups to help the creation and management of the NREN. However there is little sign of any real progress in the deployment of a physical network in Tanzania.

Within Tanzania, there is some confusion as to the government department having overall responsibility for the NREN and Higher Education networking, this needs to be resolved so that there is one body that is championing the NREN at the highest level in government.

The physical size of the country provides some major challenges to the creation of an effective national network. There are about 19 Higher Education institutions in the region of Dar es Salaam and these could be interconnected on an existing fibre ring but there is a danger that this could be funded at the expense of the rest of the country.

All staff and financial support for the NREN is provided by the associated institutions on a voluntary and part time basis and this needs to be formalised before the NREN can start to provide effective services in the country.

No Acceptable Usage Policy has been published and some public IP address space has been sought by member institutions, no application to AFRINIC has been made by TERNET to date.

To date, there is little evidence of the NREN at a technical level; this is likely to give rise to major problems as the sea cables are deployed. There will be easy access to high bandwidth as the cables arrive in Dar es Salaam and there is enormous potential for a fragmentation of the education market by the number of commercial ISPs that will be providing services. Once high speed services arrive, there will be a large requirement for technical and managerial staff in the NREN and the educational institutions. A major educational programme will have to be initiated to ensure that the network is used in appropriate manner in the connected universities.

6) Malawi: Malawi Research and Education Network (MAREN)

Malawi is regarded as an "Established NREN" the Association of African Universities NREN unit, however there is little evidence of much activity by the NREN. MAREN has range of enthusiastic volunteer staff who have built an impressive network in Malawi with few resources. The network has been constructed in a similar manner to some of the early networks in Europe, using equipment, data connections and human resources that have been built by the energetic work of the people interested in developing the network and the services.

MAREN is well developed, working in cooperation with a variety of state and commercial organisations to build and sustain the NREN for the national development of the people of Malawi and as a tool for the implementation of a national development strategy. There is active cooperation of the electricity company and the incumbent telecom operator to provide special communications facilities to the NREN. This level of cooperation has not been displayed in many of the other countries surveyed

At a national level, MAREN has the support of the relevant ministries, regulators and telecoms and infrastructure suppliers. The regulator has arranged for cheap licensing of the VSAT links and the electricity company has donated a pair of fibres to interconnect two sites in Blantyre and Zomba. Plans are underway to create and connect to a Malawian internet exchange point.

While there is an enthusiastic volunteer staff in MAREN, the budget for the operation of the network is very low. Funding sources need to be established to appoint full time staff to the network, CEO, CTO and CFO, as well as to provide appropriate hardware to support the network links in a professional manner.

No Acceptable Usage Policy has been published and no application far been made to AFRINIC for an ASN or public IP address space. Both of these issues need to be resolved in the short term and would be a major stumbling block to the implementation of a high speed network connected to a sea cable unless resolved.

The volunteer staff deployed will provide a good base for the NREN, but must be augmented and supported by full time trained personnel, so there is a great requirement for the education and development of support staff in the NREN and in the connected institutions. The use of volunteer staff can be a great breeding ground for the recruitment of full time staff and should be encouraged by the provision of equipment and training.

There are extra challenges for international connectivity as Malawi is a landlocked country and any data transmission must traverse another country to connect to own of the sea cables. Traditionally such cross border connections have been more expensive and difficult to implement, both physically and politically. There are encouraging signs that both the major telecoms and electricity companies of Mozambique and Malawi may be considering connecting their fibre networks. This could give MAREN access to the sea cables.

7) Mozambique: Mozambique Research and Education Network (MoRENet)

MoRENet is the planned nationwide data network that will interconnect Academic and Research institutions in Mozambique and is regarded as a "New NREN" by the Association of African Universities NREN unit.

MoRENet currently operates under the auspices of the Ministry of Science and Technology, the project is part of the Mozambique ICT Policy Implementation Strategy. It is planned that the NREN will migrate to an independent legal entity during 2009. Clearly there is a tight and a good arrangement between central government and the NREN.

While the telecoms market is liberalised, there is in practice one state owned provider, given that there is a high degree of support by the state for the NREN, this monopolistic market may be an advantage in the early implementation of the plans to interconnect all of the institutions in the country.

The initial topology of MoRENet will consist of about 20 nodes, 10 in the pilot, representing all the Universities and Research centres located around the country. Institutions comprise many disciplines including the social sciences and engineering.

A phase 1 network based on wireless links is operational in Maputo. Discussions are under way about a second phase to establish a fibre based Metropolitan Area Network connecting all major institutions in Maputo.

It is interesting to note that in the NREN Survey, MoRENet reports a 99% availability of electricity service which superior to any other country surveyed and may be an indicator of the infrastructure available. However the quality of the power supplied is poor and regulators are need for most equipment.

Like most other African NRENs, there is a severe shortage of skilled and trained staff in the NREN and in the connected institutions and a large training programme needs to be undertaken to develop the skills required to capitalise on the high speed connections to the research facilities around the world.

A draft Acceptable Usage Policy exists but has not yet been published. No connection policy exists yet. No allocation of an ASN or public IP address space has been made to MoRENet, though these have been applied for and MoRENet expects to act as a Local Internet Registry for the academic community in Mozambique.

8) Ethiopia: Ethiopian Educational & Research Network (EthERNet)

Regarded as a "NRENs in Development" by the of African Universities NREN unit, EthERNet is not a member of the Alliance but is associated with the Alliance as an Observer.

The Ethiopian E-Government project is an ambitious programme to spread the use of ICT throughout the lives of the people across the country. This includes programmes for the various levels of education, including the EthERNet project at third level. Currently there are some 9 universities connected at E1 speed with another 13 due to be connected soon. A second phase project, EthERNet-II is in the planning stage.

A standardised setup for the connection of each university has been designed which includes the physical structure of the data centre as well as hardware, software and services. This model could well be used in other NRENs in Africa.

The telecoms market has not been liberalised and all services are provided by the state owned incumbent operator who is aggressively rolling out fibre across the country. Access to the sea cables can be made through Djibouti and there is some potential for a cross border connection to Kenya in the South, which might allow for the creation of a Northern data ring.

9) Sudan: Sudanese Universities Information Network (SUIN)

SUIN is regarded as a "New NREN" by the Association of African Universities NREN unit and is a full member of the UbuntuNet Alliance.

Sudan, being a very large country, has some special challenges for the deployment of NREN facilities. Quite apart from important political problems in the south, the scale of the country and the availability of skilled staff is going to require enormous efforts to implement a suitable network to live up to the objectives of the Ministry of Higher Education.

The NREN project appears to be appropriately staffed and has delivered connectivity to about a quarter of the universities in Sudan at speeds of 128Kb or above using Frame Relay techniques on terrestrial cables. Plans are underway to connect the other institutions and to upgrade the speed of the network. Appropriate public IP address space is in use in the connected universities but no ASN has yet been assigned to the NREN.

Currently, international connectivity uses a central VSAT connection but this could be converted to make use of one of the sea cables at Port Sudan. The national telecom provider has fibre across the country which could eventually be used to interconnect Egypt, Ethiopia and Kenya whilst building a resilient network in the region.

10) Djibouti: Université de Djibouti

The sea cables enter the Red Sea near Djibouti; whilst there is no established NREN in Djibouti it should be possible to connect the university as a single member NREN. The "Université de Djibouti" currently has a network connection and uses properly assigned IP address space.

Djibouti would be a key component in connecting Ethiopia to the network as a connection from the sea to Ethiopia would have to pass through there.

11) South Africa: Tertiary Education Network (TENET)

TENET is the de-facto NREN in South Africa and would be considered. Internationally, as a developed NREN with appropriate staff, equipment and facilities. It has a cable connection to the UbuntuNet router in London and has negotiated extra capacity on the new East coast cable link.

TENET is a leading member of the UbuntuNet Alliance and has provided technical support for the other countries. It is likely that South Africa could be an interconnection point for some other countries in the southern region.

Independently from TENET, the Ministry of Science and Technology has set up and provided funding for a new national research and education network in South Africa called SANReN. The Meraka Institute was tasked with the planning and deployment of this network and is now working with TENET on this process.

Whilst South Africa cannot be a beneficiary of the current project, there are terrestrial links from South Africa to neighbouring countries that can be utilised in building the regional network. The expertise that has been built up in TENET may be applicable in other countries and their experiences can be used in the capacity building programmes that are envisaged.

1   Demographic Information

INTERNET USERS AND POPULATION STATISTICS FOR AFRICA						
AFRICA REGION	Population (2008 Est.)	Pop. % in World	Internet Users, Latest Data	Penetration (% Population)	% Users in World	Use Growth (2000-2008)
Total for Africa	955,206,348	14.3 %	51,065,630	5.3 %	3.5 %	1,031.2 %
Rest of World	5,720,913,940	85.7 %	1,412,566,731	24.7 %	96.5 %	296.3 %
WORLD TOTAL	6,676,120,288	100.0 %	1,463,632,361	21.9 %	100.0 %	305.5 %
NOTES: (1) Internet Usage and Population Statistics for Africa are for June 30, 2008. (2) CLICK on each region for detailed data for individual regions. For help and definitions see the site surfing guide. (3) Population numbers are based on figures from the U.S. Census Bureau. (4) The Internet usage numbers come mainly from data published by Nielsen//NetRatings , ITU , local NICs and other local sources. (5) Data from this table may be cited, giving the due credit and establishing an active link back to Internetworldstats.com. Copyright © 2008, Miniwatts Marketing Group. All rights reserved.						

2   Internet Usage in Africa

INTERNET USAGE STATISTICS FOR AFRICA			
AFRICA	Population (2008 Est.)	Internet Users Latest Data	Penetration (% Population)
Ethiopia	82,544,838	291,000	0.4 %
Kenya	37,953,838	3,000,000	7.9 %
Malawi	13,931,831	139,500	1.0 %
Mozambique	21,284,701	200,000	0.9 %
Namibia	2,088,669	100,100	4.8 %
Rwanda	10,186,063	150,000	1.5 %
South Africa	43,786,115	4,590,000	10.5 %
Sudan	40,218,455	1,500,000	3.7 %
Tanzania	40,213,162	400,000	1.0 %
Uganda	31,367,972	2,000,000	6.4 %
Zambia	11,669,534	500,000	4.3 %
Zimbabwe	12,382,920	1,351,000	10.9 %
TOTAL AFRICA	955,206,348	51,065,630	5.3 %
WORLD TOTAL	6,676,120,288	1,463,632,361	21.9 %

There are some great disparities in the level of internet penetration between the African countries and between Africa and the rest of the world. The African figure of 5.3% compares badly with the World figure of 21.9% and shows the potential for the provision of extra services in Africa.

Within the countries being considered by the FEAST project there are great variances in general penetration which is also possibly reflected in the use of the internet in the Academic sector.

Whilst the creation and implementation of Academic and Research networking will not dramatically increase the overall internet penetration immediately, it will increase the level of demand and potentially seed the level of rollout by the commercial providers. Clearly, the implementation of high speed networking by the academic community will increase the overall levels of use of the internet in the relevant countries.

At present, most internet services are provided using satellite technology which is both expensive and slow. Some advanced services are not available via satellite and facilities that are used in the rest of the world are practically unavailable in Africa.

2009 will see the installation of several fibre optic cables on the East coast of Africa; these high-speed cables will improve the speed of access by many orders of magnitude and will go a long way to redressing the imbalance in penetration on the continent.

3   Economic and Geographic Indicators for potential FEAST countries

Country	Domain	GDP (PPP) per capita int $	Ranking of GDP (PPP) per capita	Land area (square km)	Population Density per square km.	Population from Table 1	Mobile Penetration 2008
Burundi	.bi	400	227	25,649	338.84	8,691,005	4.6%
Congo, Dem. Rep.	.cd	300	228	2,267,599	29.33	66,514,506	8.3%
Ethopia	.et	800	219	1,119,683	73.72	82,544,838	16.0%
Kenya	.ke	1,800	188	569,251	66.67	37,953,838	24.2%
Malawi	.mw	800	218	94,079	148.09	13,931,831	4.6%
Mozambique	.mz	900	214	784,089	27.15	21,284,701	13.5%
Namibia	.na	5,500	136	825,418	2.53	2,088,669	31.6%
Rwanda	.rw	900	216	24,949	408.28	10,186,063	5.0%
South Africa	.za	10,400	104	1,219,912	35.89	43,786,115	84.2%
Sudan	.sd	2,200	183	2,376,001	16.93	40,218,455	14.9%
Tanzania	.tz	1,400	202	886,039	45.39	40,213,162	16.3%
Uganda	.ug	1,100	211	199,710	157.07	31,367,972	10.0%
Zambia	.zm	1,500	200	740,724	15.75	11,669,534	15.2%
Zimbabwe	.zw	200	229	386,669	32.02	12,382,920	67.1%

The economic and geographic indicators above highlight some of the problems facing the implementation of high speed academic networking in the region. The countries are physically very large, with high populations but have, in general, very low levels of economic activity.

The GDP work ranking is a scale of 1 to 229, with Liechtenstein as number 1 and Zimbabwe as number 229. Most of the countries being considered are near the bottom of the ranking order. Clearly, South Africa and Kenya stand out in terms of the GDP ranking.

One area where Africa has taken a lead is in the use of mobile phones where there are a range of innovative services that have been developed to address the special requirements of the African environment. These include health, finance and agriculture.

An example of the mobile innovation is the facility for people to transfer money via SMS messages which is widely used in some countries and replaces the use of banks. It is likely that these sorts of activities will increase in the future and will put more demands on the mobile services and handsets. As internet services are implemented across the countries, more sophisticated financial, health and agricultural activities will be possible and will probably replace the use of the mobile telephone networks.

4   FEAST NREN Activity Status

Country	NREN Location		Questionnaire Completed	NREN	Status	Ownership, legal status	website	AFRINIC Member
Congo, Dem. Rep.	.cd	Kinchasa			active			
Ethiopia	.et							no
Kenya	.ke	Nairobi	Y	Kenya Education Network Trust (KENET)	active	Legal entity, owned by trustees	www.kenet.or.ke	no
Malawi	.mw	Zomba	Y	Malawi Research and Education Network (MAREN)	active	Legal entity, owned by trustee	www.malico.mw/maren	no
Mozambique	.mz	Maputo	Y	Mozambique Research and Education Network (MoRENet)	active	To be created in July 2009	www.morenet.mct.gov.mz	no
Namibia	.na	Windhoek	Y	Namibia Research and Education Network (NAMREN)	active	To be created in March 2009	www.unam.na	no
Rwanda	.rw	Kigali	Y	Rwanda Education and Research Network (RwEdNet)	active	Not legal entity, to be owned by institutional members	www.rwednet.ac.rw	no
South Africa	.za				active			yes
Sudan	.sd	Khartoum	Y	Sudanese Universities Information Network (SUIN)	active	Not legal entity, owned by Ministry	www.suvl.edu.sd	no
Tanzania	.tz	Dar es Salaam						no
Uganda	.ug	Kampala	Y	Research and Education Network of Uganda (RENU)	active	Legal entity, owned by members	www.renu.ac.ug	no
Zambia	.zm	Lusaka	Y	Zambia Research and Education Network (ZAMREN)	active	Legal Entity		no
Zimbabwe	.zw	Harare						no

Relative to other countries in Europe or around the world, there is a low level of NREN activity which demonstrates the urgent requirement for capacity building in order to advance the development of the NRENs.

Much of the work required is organisational; the creation of good autonomous NRENs under a clearly defined legal framework should be pursued vigorously. Many countries have already defined their structural framework, but seem to get stuck in actually progressing to the creation of the organisation or company.

International activity in the internet community is low as shown by the countries interest in becoming active members of AFRINIC and taking on the role of Local Internet Registries for the Research and Academic communities.

5 FEAST NREN Funding

	et	ke	mw	mz	rw	za	sd	tz	ug	zm	zw
funding											
Principal funding		Users 88%	Government 10%	Government 11%	Government 83%		Government 100%		Government 80%	Government 38%	
other funding sources		Government 7.2%, Other 4.8%	FRENIA 90%	Donor 89%	IDRC, FRENIA 12% Users 5%				Users 20%	FRENIA 42%	
2008 expenditure (Euros) for:											
National connectivity		86%	20%	40%	5%						
International connectivity			Inst		60%						
Equipment			30%	20%	10%				12%		
Network & operations (staff)		10%	40%	10%	15%				20%		
Total 2008 expenditure on above items											
Total Budget (Current Year)		733,014	19,674	555,555	230,769		390,000		5,856	3,026	
Total Budget (Next Year)		1,591,821	60,000	787,400	800,000		724,000		8,784	5,043	
Projected user income for 2008											
Projected Govt funding for 2008											
Source of funding for FEAST participation											

In line with what is seen in other NRENs, there is a range of funding models in the various FEAST countries. This would also reflect the state of development of the NRENs.

As most countries are using satellite connectivity for their internet services and as this connectivity is usually attributed directly to the institutions, the true spend may not actually be known in some cases.

When fibre based services arrive, there will be a transfer of costs from the satellite services to a combination of international costs and national connectivity costs. This will happen on a phased basis as the national networks are implemented.

6   FEAST NREN Staffing

staffing	et	ke	mw	mz	na	rw	za	sd	tz	ug	zm	zw
No. of full-time employees		8		3.5		2		10				
No. of part-time employees			0.8		0.3					2		
No. of contractors												

Staffing in the NRENs, unsurprisingly, appears to track the economic development of the country*.*

7   FEAST User Organisations in Country

user community	et	ke	mw	mz	na	rw	za	sd	tz	ug	zm	zw
# Universities in country		39	6	26	3	10		80		28		
# Universities connected		10	2	6	0	4		30		7		
% Universities connected		26%	33%		0%			38%		25%		
# Inst Further Ed in country		12	24	0	5	10						
# Inst Further Ed connected		5	0			6						
% Inst Further Ed connected		42%	0%									
# Research institutes in country		6	16	140	1	4		10		3		
# Research institutes connected		1	4	2		0				2		
% Research institutes connected		17%	25%					0%		67%		
# Primary Schools connected			0	0		n						
# Secondary Schools connected			0	0		n						
# others (libraries, hospitals) connected			2			y						
# National Government Offices						n		15				
# Government Institutes/Offices connected		5										
# Commercil Research Institutes		0			n	n						
End users - Other												
End users - Total												
Acceptable Use Policy		Yes	Not Published	Not Published		Not Published	Yes	No		No		
Connection Policy		Yes	Not Published	Not Published		Not Published	Yes	No		No		

The range of users supported by the NRENs is similar to other NRENs around the world; however it is not clear that suitable Acceptable Use and connection policies have actually been published. This would appear to require some help in actually getting this done as it could be a show stopper in implementing any future network.

8   FEAST NOC Capabilities

user community	et	ke	mw	mz	rw	za	sd	tz	ug	zm	zw
NOC in Place		Yes	No	Yes	Yes		Yes	No	Yes		
Hours of operation		07:00-21:00*5 08:00-16:30*2		8x5							
Staff											
Management tools used											
Security tools used											
Points of Presence in country		3		2	1					3 planned	
Reliability of mains power		70%	70%	99%	80%			90%		70%	
Backup generator capacity				40 KWH	100 KWH						
Maximum time for generator		2Hours		8 Hours	30 Hours						
Sq M for POP		50		15							
Expansion capabilities		20%		70%							
Public IP Addresses Allocated		41.204.160.0/19			In Prog.			In Prog	In Prog.	In Prog.	
AS Number Assigned		36914	No		In Prog.			In Prog	In Prog.		
Managing Local Internet Registry		Yes									

The low level of actual IP address capacity or the presence of ASN allocations indicates a problem somewhere and will be a major obstacle to the implementation of a national network. Possibly some help is required in the NRENs in applying for these numbers as well as pressure on AFRINIC in the allocation of the numbers to the NRENs

9 FEAST NREN Capacity and Traffic

	et	ke	mw	mz	rw	za	sd	tz	ug	zm	zw
capacity & traffic											
International Commodity capacity	VSAT	95	5.12	16.19	18	10Gb to Géant	50	VSAT	37.9	8.83	VSAT
Member access capacity											
Upgrade plans for international capacity											
Nat'l backbone /			1Gbps/ 20Mbps								
access capacity plans						10Gb to Géant					
Capacity requirement for FEAST											
2007 total traffic across the network (TB)			0.02								
Intern'l incoming traffic in 2007 (TB)		13.155	0.02								
Intern'l outgoing traffic in 2007 (TB)		13.722	0.00								
% to commercial internet		98%	90%								
International link congestion											
backbone network congestion											
Metro network congestion											
Access link congestion											