Optical Fibre for Education and Research Networks in Eastern and Southern Africa

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Abstract

Africa is behind in the development towards the global knowledge society and the gap to the rest of the world is widening in some key areas. A major reason is that the markets for several essential resources are broken. The communication market is one, with several examples of this.

Markets basically have two types of actors: consumers and producers. Markets providing essential resources such as communication, energy and transport, are normally regulated to facilitate fair competition between providers, e.g. by balancing effects of scale, and to balance producer and consumer interests. Policy makers set policies and regulators translate them into operational procedures and enforcement mechanisms. A communication infrastructure is as essential for the development of society as transport, power, water and sanitation infrastructures. Although this fact is widely acknowledged, the policies and regulations controlling access to the available communication resources are not always designed accordingly.

In Africa, producers rule the communication markets even more than elsewhere. Consumers are weak and unorganized and pay several orders of magnitude more for communication than peers in other parts of the world. Policies are unclear and vary from closed to open in different countries. The regulatory frameworks are under-developed so that, even under reasonably open policies, the operational procedures and enforcement mechanisms are unclear. This introduces unnecessary business risks, and the consequences are devastating. This is particularly true for the most needed long term investments in infrastructure like cables. Any step forward to create a better balanced situation between operators, but also between them and the customers, is essential.

This report is concerned with a special group of consumers: tertiary level educational and research institutions. Universities and public research establishments are essential for development in all sectors of society and to all communities wanting to keep up with the development towards the global knowledge society. These institutions have a modest request: They need the same network connectivity as their peers on other continents to fulfil their basic duties. This implies a shift from Kbps to Gbps level solutions, use of optical fibre rather than satellite connections, and an inevitable change of the communication market.

Universities and research institutions are well suited to spearhead this market change, to the benefit of the whole society, bringing several strengths to the table: they are for public good, non-commercial, independent and rational; it is generally accepted that they deserve all support. They are also one of the few homogeneous and organised consumer groups. The Ubuntunet Alliance has been formed to organise the regional backbone for tertiary education and research, with backing from governments and from SARUA, Southern Africa Regional Universities Association representing all 45 public universities in the SADC region. SARUA clearly understands that ICT development must take place and fit within geo-political policy environments such as NEPAD and SADC. It is within this context that this study has been commissioned and taken on the challenge to make a change. The situation calls upon:

- Policy-makers and regulators, national and regional, to create and support the appropriate legislation, operational procedures and enforcement mechanisms to facilitate the necessary dynamic development.
- Universities and research institutions, and other user communities, to unite to pro-actively voice their demands and requirements of services, at least on a similar level as is today available for their peers on other continents
- Financial organisations and donors to step forward and cooperate with each other, in the spirit of the recent G8-declarations, and with these institutions, via SARUA and other regional efforts in Africa under the AAU umbrella, to work towards the vision in the best interest of the African communities
- ICT industry to strive for greater efficiency and to increase the social responsibility component in their operations to empower Africans to keep up with the global development and be competitive just because it also makes business sense for themselves

The goal is modest and realistic, if enough stakeholders cooperate: No later than 2008, universities and research institutions in Southern Africa will have access to broadband services and the global Internet on the same level as peers in the developed parts of the world, with a quality of service in the Gbps rather than Kbps range, and delays, variations and error rates as defined by normal properties of properly run terrestrial fibre networks.

The goal implies decisive reinforcement of the regulatory frameworks based on open access to essential resources to expose service providers to innovation from competitive pressure. The legal change includes liberalisation of right of way, access to fibre and the right to provide transmission and network services. The report describes how to demonstrate the feasibility of these concepts in the regional environment by supporting the deployment of National Research and Education Networks, and a regional backbone facilitating joint procurement of Internet connectivity and peering with global resources for education and research. The proposed infrastructure includes own deployed fibre, on and between nearby campuses, leased fibre from any fibre-owner, such as power utility companies nationally, and capacity purchased at the wholesale level in the EASSy submarine cable and its distribution loops to land locked countries.

1 Background

1.1 African communication infrastructure

Africa is the most underserved continent regarding communication infrastructure limiting the access to affordable voice, video and data services, other than broadcast services that can be provided to a large number of users via satellite. Since communication is a utility of the same importance to the development of society as power and transport, the limited access rapidly increases the digital divide between Africa and the developed world. A number of efforts are devoted to remedy this fact involving a broad spectrum of stakeholders with various objectives and strategies, including both public and private sector organisations.

The currently most successful efforts are those of the mobile telephone industry. Voice communication is clearly the most important and basic communication service, especially in countries with high illiteracy. For many reasons, mobile phone networks are expanding faster than traditional fixed networks and often and increasingly even replacing them, also with respect to performance and reliability. Mobility adds value to users and mobile networks are cheaper to deploy than traditional fixed wire-line networks, the latter a fact not recognized by many. Since rates are still kept higher, they are more profitable for the operators. Although there are still vast areas remaining to cover, the factors limiting the expansion rate are often practical business risk and governance-related, rather than anything else. An example of the first, cited in more than one SSA country, is the problem to clear equipment through customs fast enough to keep up with expansion plans. Uptake of service in urban areas is now reaching a point where there are no free channels parts of the day. This is a similar problem European carriers faced 6-8 years ago. The solution is the introduction of smaller cells demanding more equipment.

The situation is more critical regarding broadband data services. Mobile phone access networks have so far only provided expensive narrow-band data services, as an addition to their main product, voice calls, and the corresponding African trunk networks are mostly using microwave link backbones dimensioned for these needs. They are not designed to support broadband networks similar to what is being deployed elsewhere. Using satellite in Africa is much more expensive than in the developed world, due to the lack of alternatives that can create competition. The availability of fibre is improving but is still limited. In some countries there is fibre available that cannot be used due to legal constraints. At the same time, the fibre capacity that can be used is often even more expensive than using satellites, with the argument that the better quality of services motivates a higher price. The main obstacles seem to be due to the policy and regulatory environments created by the telecommunication and competition legislation in the different countries. Operators are in this environment either very profitable, like most GSM operators, inefficient or inept, as are a few PTTs, or they are using the unnatural monopolistic advantage to offset political risk and associated financial costs such as the prohibitive local interest rates.

To contribute to the process towards a broadband infrastructure in Africa, a user perspective is introduced and a case is made based on academic networking that is now severely hampered by the lack of affordable broadband capacity in Africa. The policy and regulatory framework developed would, however, not concern an exclusive network for universities, but serve as a spearhead. Academic networking is easy to start with, since it constitutes the use of an indisputably public good, is critical for overall economic development also in the private sector, and is driven by the increased cadre of business leaders and entrepreneurs that emerge from the university system. Universities provide a significant customer base that can contribute to making a fibre infrastructure sustainable and under-gird the private sector use on top of this. TENET, the national research and education network in South Africa with 22 academic institutions as members, did initially provide a substantial part of the Telkom Internet-traffic on the SAT3 cable.

The tasks of universities include research, education and community service. It is widely understood that universities play a central role in the capacity building necessary to develop society. In a recent workshop organised by the World Bank Institute in Johannesburg, several Ministers of Science and Technology from African countries and representatives from industry emphasised the importance of communication to develop the universities. In his key note presentation at the Annual meeting of the Association of African Universities (AAU) in Cape Town in February 2005, the South African president Thabo Mbeki talked about the importance of supporting the capacity building in Africa by facilitating transborder education between African countries.

Ultimately, a Pan African Research and Education Network connecting African universities to each other and to the rest of the world would not only make universities more productive, but also provide a substantial traffic volume and demonstrate the feasibility of sustainable business models for other sectors of society.

1.2 Education and Connectivity as Public Goods

African higher education systems have seen some renewal and regeneration in recent years following slow down and crises over the last two decades. There is a growing recognition of the role of higher education in social and economic development, democratic empowerment and competitiveness and as means of accumulating and sharing knowledge. In spite of structural constraints higher education institutions in Africa have continued to train new generations of citizens in science, engineering, medicine and technology. Universities are increasingly called upon to play a leading role in developing a multidisciplinary education and research to solve sustainable development problems in the region.

Moreover, rapid advancements in the development of information and communication technologies and the increasing complexities of the global scientific practices have resulted in a huge demand for quality training and continuous professional development. One of the key challenges facing African countries is maintaining a high-level of competence to respond to the rapid globalization of knowledge and to deliver services that meet development challenges of the public. Universities are required to meet global academic standards, inculcate universal academic values; at the same time they have to respond to the peculiar demands and needs of their societies.

Reforms are underway in many African universities to achieve these goals, but very slowly. Higher education reform spans many issues including creating efficient management and governance systems, modernization of curricula, increasing the relevance of teaching and learning to developmental goals and putting quality assurances accreditation systems in place. The application of information and communication technologies is continually featuring in the academic reform process; ICTs are now regarded as an important tool for speeding up the reform process. ICT has brought along new kinds of institutions such as the African Virtual University; it has also created new possibilities for the conduct of distance and open learning. It has brought access to e-content, setting African Universities at par with their western counterparts and reversing the stagnation experienced by university libraries.

The progress indicates that African universities will continue to play the key role in sustainable development, particularly in finding solutions to specific challenges facing the continent. Because of these multiple developmental roles they should be considered a public good. Since equitable access to scientific knowledge requires advanced ICT applications and affordable access to a networking infrastructure to advance learning, teaching and scientific research, universities and connectivity should both be regarded a public good.

1.3 Background of the study

The study behind this report on Optical Fibre for Education and Research Networks in Eastern and Southern Africa goes back to 2002 when the existence of a private high capacity transmission link over optical fibre in the power line between Maputo and Johannesburg was discovered. The link is owned by a power utility company. It turned out not be possible to use it for public communication purposes due to the closed policy and regulatory environment in South Africa, while data communication is open in Mozambique, including transborder communication. Despite meetings of the ministers of science and technology in the two countries and positive declarations, the issue has not yet been resolved. The prices offered by the incumbent telecom operators are prohibitive and the situation is absurd since it prevents all sorts of development. In the search for alternative routes, it was discovered that a lot of fibre is being deployed in Africa, especially as part of ongoing extensions of the power grid and to some extent also along other kinds of infrastructure. It was also discovered that the communication policies in other neighbours to Mozambique seem to be open, although the regulatory frameworks often are under-developed, leaving the operational procedures and rule enforcement mechanisms unclear.

These experiences led to the insight that a change would require a reformation and development of the telecommunication policies and regulatory environments in Africa. This message would have to be sent to the policy makers and development funding agencies and highlighted as publicly as possible to create political awareness and support. Some milestones in the background are

- In 2003, the case for open access was made by organizing a series of international workshops on Open Access endorsed by the UN ICT Task Force and sponsored by Sida . The 1st International Workshop on Open Access was organised in Stockholm in June 2003.
- In association with the 2nd International Workshop on Open Access in Stockholm 2004, InfoDev was invited to a discussion on the possibility to make an open access fibre infrastructure for Africa a target for WSIS II and make universities spearhead the development by demonstrating feasibility and benefits.
- In fall 2004, InfoDev commissioned a study on Open Access, the result of which was made available for review and comments in April 2005.

- At the AAU annual meeting in Cape Town in February 2005, KTH was invited by UEM, IDRC and AAU to make a case for national research and education networks (NRENs) interconnected by a regional backbone based on existing and emerging optical fibre cables that also could be used to peer with other global academic resources and get transit to the Internet [AAU2005]. This was presented together with results from projects sponsored by IDRC and WBI on investigating user needs, available VSAT capacity [ATICS], the IDRC's "Promoting African Research and Education Networking"-project , [PAREN] and academic procurement consortia to press prices on VSAT bandwidth [MALICO]. The important VSAT-based initiatives have created connectivity that will be significant all the way up to the point where the fibre infrastructure is ubiquitous, which will take quite a few years. Optical fibre will eventually facilitate provision of several orders of magnitude higher capacity for African universities already available to their peers in other parts of the world. It is important to recognize the sequence, overlap and importance of these initiatives.
- At the same AAU meeting, the formation of the Southern Africa Regional Universities Association (SARUA) was announced. SARUA represents 43 public universities in Southern Africa cooperating on the development of a learning model high-lighting ICT and Internet connectivity and is an important lobbying group voicing academic needs. SARUA became interested in the idea of 'an ICT Bandwidth consortium' through regional and national research and education networks (NRENs) and requested assistance from IDRC in developing an approach for its members to improve their generally parlous state of connectivity.
- The 3rd International Workshop on Open Access in Maputo in May 2005, organised by UEM under the auspices of the UN ICT Task Force and sponsored both by IDRC and Sida, was dedicated to presentation and discussion of NRENs, Pan-African fibre backbones and fibre owner plans for deployment of fibre.
- During June-July 2005, the study resulting in this report was discussed adding experts from Malawi, Zambia, and Rwanda.
- In August 2005, a kick-off workshop was organised in Johannesburg to decide on the detailed work plan. Those present were Godfrey Chikumbi, Anders Comstedt and Björn Pehrson from KTH, Americo Muchanga, from UEM, Margaret Ngwira from University of Malawi, Duncan Martin from TENET/SA, Issa Nkusi from Rwanda IT Authority, Adam Lishan, Addis Ababa University, Steve Song and Heloise Emdon from IDRC, Bob Hawkins from WBI and Ben McGarry from SARUA. IDRC and WBI had decided to support the study financially and use SARUA as a channel for this purpose.

1.4 Other important events defining the context

During the last decade, a number of parallel discussions in telecom industry about telecommunications infrastructure for Sub Saharan Africa have converged and focus on EASSy as a major component in a backbone infrastructure for the region. The convergence eventually led to a discussion about the merits of satellite communications versus a fibre based solution built around EASSy. This discussion was manifested in the NEPAD meeting in Johannesburg in July-August 2004 and the subsequent bilateral meetings held between NEPAD and the various proposed projects ending up with the NEPAD proposal on a rationalized fibre network topology for Sub-Saharan Africa October 2004. The key element in this proposal was to complement the original EASSy plan with terrestrial links to landlocked countries providing at least two connections to other countries from all SSA countries, using physical elements of other proposals. The debate has after this point concerned business aspects and financing rather than technical solutions.

There has been a divide between the traditional operators, proposing closed club structure, and those regarding the backbone infrastructure as a utility open for new players as the market is just about to open up. The latter group wants to open up for alternatives driving a more competitive market place like the rest of the world, based on high volume low price rather than low volume high price. In this group you find representatives of consumers, donors, financial institutions and policy makers giving more priority to the general development of society than to protecting the interests of a limited number of industrial players. This difference in perspective culminated at WSIS, Tunis November 2005, when the World Bank announced that they wanted EASSy to adopt an Open Access policy in order for the World Bank to support the project.

This tension could be expected to continue up to the point where the financing and rules around EASSy are settled. Several of the closed club proponents have no financial strength to raise the necessary capital on their own. The fact that they obviously have difficulties in borrowing on their position in the Closed Club must be interpreted as the international money market discounting a change for an Open policy by law in the not too distant future making the desired business case based on inflated prices improbable. Considering the WTO rules, and the general global trend in sector-specific regulation in this area, such as the rules focussing on dominant position in relevant industry sub-markets, it seems an obvious position for anyone to take outside of the East African incumbents.

1.5 Supporting the transition to high volume/low price markets

It is argued in this report that the introduction of the National Research and Education Networks (NRENs) according to what is outlined will actually serve the purpose to enable a more controlled transition for operators from a Low volume/High price model to a High volume/Low price model with less risk of ending up in what must be their biggest fear: Getting stuck in the Low volume/Low price profitability trough during the change.

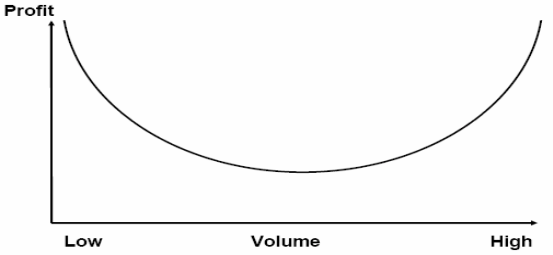

Figure 1: Illustration of how profit varies with available capacity. Scarcity drives high prices while abundance drives new applications and traffic volumes

The transition from high price/low volume market to a low price/high volume market can be facilitated by public-private partnerships of mutual interest for governments as well as, supporting the operators to transform the market by taking the following steps:

Step 1 Current policy is quick return on investment and closed access leading to high prices and little innovation.

Step 2 Lower price and Open Access stimulates innovation and competition, which among other things will cut the bills for public communication (20 -40% of total traffic volume in developed countries and probably more in developing countries)

Step 3 Even lower prices stimulate industry usage and thus volume growth and demand for more advanced value-added services for operators and higher tax revenues for governments

Step 4 Non-profit prices lead to a more egalitarian society with opportunities for all

2 Objectives and goals

The objective of the work behind this report was to present a model for how to provide African universities with the same network connectivity as their peers on other continents. The model agreed on consists of a fibre based National Research and Education Network (NREN) in each country to provide access for all academic institutions in the country. These NRENs would be peering via a regional broadband academic backbone to share resources and support trans-border research and education. The regional backbone would also offer peering via the global academic backbones, such as Internet2 [Internet2], Géant, Eumednet, Alice, Tein [DANTE], and others, to share global resources, as well as transit to the Internet.

The goals agreed on at the Johannesburg kick-off workshop for this study included

- A presentation of the telecom policies and regulatory frameworks Southern and Eastern Africa, in theory and in practice, taking Tanzania as a benchmark for other countries to relate to, since it was considered to be one of the more open and developed, at least formally.
- A report on available fibre links, preferably dark fibre, including transborder routes, which could be used to connect universities in African countries and eventually be interconnected to form a regional backbone and connect to other continents. The focus was on owners of fibre cables along alternative infrastructure, especially along the power grid, rather than traditional telecom operators, and on discussing possible value chains and business models breaking the predominant low volume/high price business model and suggest support to industry of the path to a transformation to achieve a high volume/low price model.

Just a few days after the kick-off, it was discovered, inter alia via the EASSy home page, that the studies of the EASSy consortium proposed models that seemed to provide an opening for a university consortium to buy in at the wholesale level like any other player. Since this was immediately recognized by all involved as a potentially faster way to reach the goals than negotiating bits and pieces of terrestrial fibre, this changed the focus of the study. The results are being discussed with NEPAD and others. It was partly disseminated in a presentation in Tunis 14-15 November 2005 during WSIS.

3 Policy and Regulatory Benchmark, the Case of Tanzania

While conventional development thinking emphasized primary education as a critical ingredient of economic development in Africa, there is a recent shift to higher education to take the advantage of the economic opportunities afforded by the knowledge economy. The Commission of Africa report [ComAfrica] states,

"…Building capacity takes time and commitment. Weak capacity is a matter of poor systems and incentives, poor information, technical inability, untrained staff and lack of money. We recommend that donors make a major investment to improve Africa's capacity, starting with its system of higher education, particularly in science and technology."

Academic connectivity is a key for revitalization of the higher education in Africa. A number of countries and development agencies are paying a great deal of attention to the strategies that promote broadband connectivity to schools and universities. Although academic specific initiatives are useful, an integrated national broadband strategy is far superior to enhance higher education connectivity in the long run. This paper aims to provide a policy and regulatory benchmark for the Southern African Regional University Association's fibre initiative using a Tanzanian open and competitive optical fibre backbone infrastructure initiative as a case.

3.1 A National Vision and Commitment for Broadband Infrastructure in Tanzania

A major driving force for broadband development in Tanzania was government's commitment to promote open and competitive backbone infrastructure. Government's broadband strategy was outlined in its National ICT Policy that was adopted in 2003. The national ICT Policy stipulates that,

"Tanzania should have a universally accessible broadband infrastructure and ICT solutions that enhance sustainable socio-economic development and accelerated poverty reduction nationally; become a hub of ICT Infrastructure regionally and be a full participant in the global Information Society." [Tz ICT Policy]

Other key issues identified by the ICT policy include building effective carrier of carriers infrastructure, establishing a national Internet backbone and involving financing institutions and private sector to provide funding for a national backbone infrastructure [Tz ICT Strategy].

3.2 Converged Regulatory and Licensing Regime

Tanzania followed an open and competitive regulatory framework over the last decade. It established one of the first dynamic regulatory bodies in Africa, the Tanzania Communications Commission and Tanzania Broadcasting Commission in 1993 and introduced reforms to the communications and the broadcasting sector. Initial liberalization focused on opening up the mobile, data, ISPs, TV and radio broadcasting market. In 2001, the incumbent telecom service provider the Tanzanian Telecommunications Company Limited (TTCL) was partially privatized through a sale of 35% of its equity to a strategic investor. The company was given exclusivity on fixed line voice for a four year period that ended in February 2005.

In parallel, Tanzania set off a multi-stakeholder ICT policy development initiative in 2002 that led to the development of a national ICT policy and its adoption by the Government in 2003. The National ICT Policy for Tanzania made an explicit commitment to regulatory convergence and ICT infrastructure development. The broad objectives of the ICT policy were to [Tz ICT Policy]:

- Provide a national framework that enables ICT to contribute towards achieving national development goals
- Transform Tanzania into a knowledge-based society through the application of ICT
- Provide a national framework to accommodate the convergence of information, communication and technology including media.

In response to national ICT policy theme on convergence, the government established the Tanzanian Communications Regulatory Authority (TCRA) in 2003, by merging the Tanzanian Communications Commission and Tanzania Broadcasting Commission to regulate telecommunications, broadcasting, ICT applications, the provision of postal services and management of radio spectrum. Subsequently, TCRA adopted a new converged licensing framework to guide the ICT sector and prepare for the post-exclusivity period [TCRA].

The converged licensing regime allows for leasing of the excess capacity of communications infrastructures owned by utility companies such as Tanzania Electric Supply Company (TANESCO), Tanzania Railways Corporation (TRC), Songo Songo Gas Company (SONGAS) and Tanzania Zambia Railways Authority (TAZARA) to provide communication services to customers after acquiring the necessary licenses from the Authority. Moreover, it provides a framework for all communication service providers to build nationwide backhaul and distribution network infrastructure and interconnect to each other.

The framework provides a technological and service neutral regime where a licensee has freedom to choose technology which is most efficient and cost effective and to take signals from the market as to which services are most in demand. A licensee can be authorized to provide different services under a single license or obtain:

- Network Facilities license to rollout and provide network infrastructure
- Network Services license to make bandwidth, broadcasting service or space segment available to customers
- Application Services license to provide Internet, cellular service, etc
- Content Services to engage in radio broadcasting or provision of electronic media.

The regulatory framework allows for provision of services to different geographic segments of Tanzania or nation wide. The aim is to:

i) Support the development of a state of the art communications infrastructure – both nationally and internationally.

(ii) Further liberalization of the Communication Industry so as to produce a more effective and responsive industry to end – user needs.

(iii) Provide a choice of high-quality, high functionality and affordable services to citizens.

(iv) Attract inward investment

(v) Establish Tanzania as a hub for regional communication traffic and services.

3.3 Open National Backbone Infrastructure Initiative

Following the adoption of a national ICT policy and a converged licensing regime, Tanzania embarked on an initiative for development of an ideal and open national backbone network architecture in 2005. The multi-stakeholder initiative aims to create a national Optical Fibre Cable (OFC) backbone network through consolidation of segments of the existing and planned OFC networks from different national utility companies and the incumbent and by bridging the eminent gaps between them.

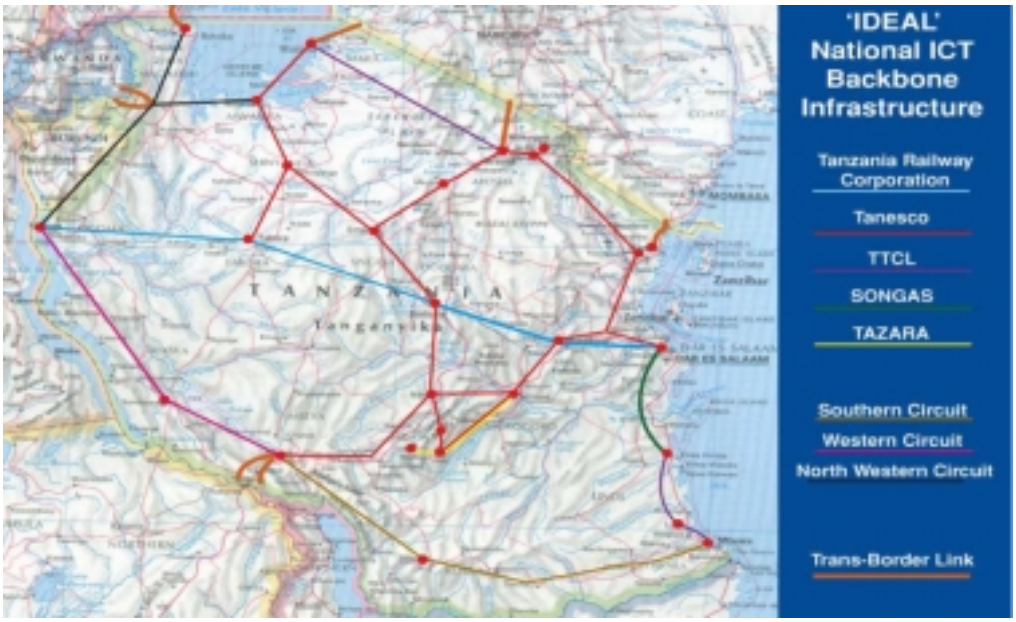

Figure 2: The "Ideal" National ICT Backbone Infrastructure discussed by stakeholders in Tanzania

The national broadband backbone initiative is one of the first in the Africa region and has a number of features that could be emulated by other countries. The main building blocks of the unified national backbone infrastructure were:

3.3.1 High-level Government Support

High-level government support was a key factor for the progress that was made by Tanzania in launching a unified national backbone infrastructure initiative. The initiative has a support of the President and other members of the Cabinet; the Minister of Communications and Transport and his Permanent Secretary are the key drivers of the project. Government was instrumental in establishing the vision and the policy and regulatory framework, putting the necessary institutional arrangement in place to take the initiative forward and in mobilizing financial and technical resources for carrying out a study on broadband infrastructure requirement.

3.3.2 Participatory Process for the Development of an Ideal National Backbone

Tanzania has developed a tradition of multi-stakeholder partnership in the ICT sector. The Tanzania national backbone plan was prepared through a broad based partnership comprising 1) a Steering Committee led by

Permanent Secretary of the Ministry of Communications and Transport, TCRA and representative of key stakeholders 2) a Technical Working Group composed of experts skilled in broadband connectivity drawn from major utility companies, TTCL, Ministry of Defence and National Security and international experts and 3) a Report Writing Working Group drawn from the above stakeholders to produce a document accessible to all the stakeholders. This led to the publication of a document entitled Technical Investigation on the National ICT OFC Backbone Infrastructure in Tanzania [TCRA].

3.3.3 Choice of Advanced State of the Art, Capacity Rich and Efficient Technology

The proposed national OFC backbone network offers the use of the latest bandwidth-rich transmission technologies such as Dense Wavelength Division Multiplexing (DWDM) and Synchronous Digital Hierarchy (SDH) to guarantee ubiquitous capacity, security, cost effectiveness, quality and performance. The plan proposes the construction of 6,997 km Optical Fibre Cable of which 3,522 km, including 2,653 km of 48 cores and 869 km of 24 cores. A total of 3,475km will be rebuilt, including 3,430 km of 48 cores and 45 km of 24 cores. About 160km of two HDPE pipe duct system will be constructed in urban areas.

3.3.4 Leveraging Existing Infrastructure

The unified national backbone project intends to uses existing segments and planned networks by multiple national utilities institutions like TANESCO, TRC, SONGAS, TAZARA and TTCL taking comparative strengths of each institution into the account. In addition it intends to make use of the right of ways, power supply systems, equipment rooms and physical facilities to reduce cost and approval procedures, in the case of right of ways.

The unified national backbone infrastructure project aims to establish three main rings, namely northern, western and southern rings to form a carrier of carriers network which can be leased to network services or content providers. The design principle emphasizes:

- Open access to broadband network without geographic constraints
- Ample capacity to meet medium and long term demand of the domestic and regional customers and transmission requirement by different operators including, fixed , mobile and high speed data communication network and multimedia applications providers
- Detailed analysis of layout of the existing network and the gaps, transmission system, the network architecture for DWDM and SDH layer, network configuration, protection methods, network management system, power supply and physical facilities
- Convergence and interconnection with emerging regional broadband networks such as the East African Submarine Cable (EASSy) Project.

3.4 Regulatory and Governance Issues

The progress discussed above shows that Tanzania has made a significant stride in adjusting its regulatory regime to innovations and national development goals, adopting a converged licensing regime and putting a broadband plan together. To an extent this has reduced regulatory burden and the need for sophisticated interconnection regime. However, this raises a number of important issues that should be addressed in order build on the gains so far. These include:

3.4.1 Managing governance, cost structure and commercial arrangement between traditionally distinct operators

The convergence of formerly distinct networks and services operated by utility companies and the incumbent (TTCL) through a unified national backbone raises various commercial, cost, technical, operational, political and demand challenges that need to be discussed and resolved for smooth deployment of the network. Tanzanian gas, railways, electricity and communications companies have different decision-making, interest and experience in the communications sector. Effective institutional and commercial arrangement among these traditionally distinct operators is important to promote access, price, quality of service, and innovation to the customers.

A management entity, broadband development office or a clearing house that operates the backbone infrastructure may be a possible solution to manage the needs of multiple operators, provide interconnection and define commercial arrangements; however, this requires careful considerations of interests of all the operators and the local realities.

3.5 Fair Access and Bilateral Interconnection Regime with Neighbouring Countries

Tanzania will be an important hub to its bordering countries (Burundi, DRC, Kenya, Malawi, Mozambique, Rwanda, Uganda and Zambia), particularly after the completion of the East Africa Submarine Cable System

(EASSy). Burundi, Malawi, Rwanda and Zambia are landlocked countries and rely on countries like Tanzania for their backhaul traffic. In view of this regional role, Tanzania should develop a suitable cross-border interconnection regime that addresses the need of these different countries. Bilaterally negotiated interconnection agreements would be important to strengthen regional cooperation and promote connectivity within the SADC region. TCRA has a key role in balancing the act between neighbouring countries' needs for cost-based fair access to the backbone with commercial interest of the local broadband consortia.

3.6 Creating Favourable Conditions for Distribution of Access from Backbone to End-users

The promotion of last mile connectivity from a backbone to end users should go hand in hand with the creation of a national optical infrastructure. Tanzania has an enabling environment that allows application service providers or local consortia to build and own dark fibre that links to the backbone infrastructure and promote alternative technologies such as Broadband Fixed Wireless access. However, there is still a lot to be done in allowing small and large businesses, academic institutions, public sector organizations, communities and individuals to register their interest to procure services together. Among the challenges are establishing an interconnection regime conducive to last mile access providers and stimulation of a business climate for new entrants to provide services at competitive price.

3.7 Implications to the Southern African Region

The Southern African region varies widely in the level of infrastructure development, the policy and regulatory maturity and economic development. However, many of the development challenges including those in the ICT sector are similar; therefore the process that was adopted by Tanzania remains valid. Tanzanian progress discussed above indicates that the development of broadband connectivity requires a significant government commitment and the creation of broad based national ICT policy that views broadband networks as long-term critical infrastructure. Broadband connectivity should be seen as a public good like other utility – water, power, roads, sewerage system and it should be integrated to broader infrastructure and development planning.

Public policies on economic and social development, national security, investment, regulation, competition, Internet services will all have impact on the development of the a broadband infrastructure. Governments have responsibility to foster networks and infrastructure that enable them to achieve efficiencies in delivering e-government, e-health, e-learning and e-information.

Southern African governments need to establish a vision and stir a process towards unified national broadband infrastructure as a foundation of strong economic and educational system development. Countries like Botswana, Malawi, Mozambique and Zambia have already developed national ICT policy and implementation plans similar to that of Tanzania but scarcely address the issue of telecommunications policy around incumbent monopolies. The implementation of these policies should begin with a solid national broadband strategy and consideration of open access principles to allow for greater participation of various services at different levels of the supply chain. The monopoly incumbent approach has left most of these countries with the perspective that the only viable supply chain is a vertically integrated telecommunications service.

Open and competitive regulatory framework paves the way for different providers to come together to establish a nationwide backbone network. The capacity of the regulator to develop an enabling technology neutral regulatory framework is another important building block to effective broadband infrastructure deployment. Regulation should be designed to foster convergence, competition and innovation. Apart from Tanzania, Mauritius and South Africa have taken significant steps in this direction, but other countries in the SADC region have yet to develop technology neutral and converged licensing regimes that facilitate broadband deployment.

A weakness that has been repeated in regional telecommunications and ICT policy process across numerous countries in southern Africa is the inability to coordinate local participation in telecommunications policy, network planning and deployment. The Tanzanian case shows that government coordination role and good faith is as important as willingness of different providers to work together towards a common goal. To promote a unified broadband network and improved connectivity, policy makers and regulators in the region should:

- Share experiences in the deployment of a converged backbone infrastructure that leverage the capacities of utility companies
- Work together to remove regulatory constraints that impede the establishment of an integrated regional network and free flow of traffic between countries
- Harmonize regulatory frameworks to promote both regional backbone networks, and to allow third party network operators to deploy and manage their own network infrastructure including dark fibre locally and regionally
- Establish differential licensing fee structure (or abolish licensing fees) to promote efficient academic connectivity in the region.

4 Policy, Regulations and Business models in practice

Regarding policy differences in the different countries involved in this study, and their route to more open and competitive markets there are some notable differences in their development. In this study, we have defined an open policy and regulatory environment as allowing NRENs to build private networks based on own and leased dark fibre and connect them trans-border to other NRENs and regional backbones.

South Africa on one hand, with stronger administrative structures and powerful entrenched interests has a legacy that has effectively prevented a change to a more open market. The debate has for several years been focussed on the conditions for allowing just one additional competitive operator to be established rather than opening up entirely. The competitor is even called the Second Network Operator (SNO) and the discussion has focussed on the rules for this SNO rather than on a broader general liberalisation.

In the other countries, a legal exclusivity period has been granted the incumbent as a way of keeping the valuation up in the privatization process. There are analyses indicating a doubling of the value when such an exclusivity period has been granted. In almost all countries, these exclusivity periods ended during 2005, opening up for new players to be established and private networks, such as NRENs, to be allowed. However, due to the still weak policy and regulatory environments, it may take time before enthusiastic support of new players will be the norm.

In essence SA has transformed from a legal monopoly to a legal duopoly while the others are in the middle of the process going from monopolies to open markets.

The prospects for an NREN to be a proactive, positive and well-recognized force in the transformation of the national telecommunication environment are most likely better in the countries that are heading towards open markets.

4.1 Malawi

The Malawian regulator, MACRA, has declared its support for the NREN project, MAREN and committed assistance to issue a concessionary Academic Networking Licence and to create a conducive and enabling environment for MAREN. A formalization of this commitment is currently in progress.

4.2 Mozambique

The current telecommunication law in Mozambique allows any entity to own and operate a network, including an international gateway, for data communication purposes. Many ISPs and Universities do have their own networks and gateways today though they use satellite rather than cable. The law itself does not say anything about technology. It is also possible for owners of communication infrastructure, such as fibre, to lease it to other organizations.

The director for Postal and Telecommunication Services at the National Regulator INCM, confirms that MoRENet can get a permission to have a landing point in Mozambique of the EASSy fibre cable if it is to be used solely for data communication.

The way MoRENet envisages this is such that a link could come to the Eduardo Mondlane University where all the universities could connect, including the connection to the Mozambique Internet Exchange that is also hosted at UEM.

Peering with TDM could be effected either at the IX or at the landing point if they decide that they would like to take advantage of the landing point as well.

It is needless to say that UEM is very much interested in participating in the process to ensure that access a landing point of the EASSy cable to provide the much needed bandwidth to the Mozambique academic community as well as to any interested entity.

4.3 Rwanda

The telecom policy and regulatory framework in Rwanda allows anyone to lease dark fibre to build a private network and connect to international gateways. Telecom operators and universities have VSAT licenses and are connected to the international upstream of their choice. In the discussion about access structure to EASSy, the government is considering having a stake in the landing point, in order to ensure open access for new actors, and combine the landing point with the Internet Exchange Point, Rinex (www.rinex.org.rw).

4.4 South Africa

As mention above, SA is in transition from being a monopoly (TELKOM) to being a duopoly (TELKOM and SNO) and there is no further opening of the market in sight at this time as regards the provision of fibre-based telecommunications infrastructure. It is open to others to offer wireless Internet access.

A private academic network owned and operated by the universities is thus currently not possible. The SA NREN, TENET, is rather a procurement consortium buying links from Telkom, currently being the only licensed operator actually providing services. The Second Network Operator (SNO) has been licensed and is expected to start providing services sometime after mid-2006.

Between South Africa and its neighbours, Mozambique, Swaziland, Lesotho, Namibia, Botswana, there are many fibre connections, in principle. The challenges to use this capacity, however, include not only the regulatory issues but also business models and pricing. The operators often have the attitude that since fibre links offer better quality of services than satellite links, the price should be higher.

This attitude is harmful for the economic and social development of the region. Prices have to come down and become more cost-related. Again, universities are probably one of the best user groups to initiate this development. A transition to a low margin, high volume situation demands some indication of a potential for a higher volume.

Two test cases involving different challenges, both of principle importance, have been studied.

- The Maputo-Johannesburg link owned by Motraco, a subsidiary of ESKOM and EDM, the parastatal power utility companies of SA and Mozambique. The challenge in sorting out how this can be used has involved confirmation from policy makers of what existing policy and regulations actually apply, and the fact that the connection requires cooperation between different infrastructure owners. It turns out that ESKOM, as a stakeholder in the SNO, has transferred the use of their infrastructure for communication purposes to the SNO. It has so far not been possible to get a quote for the use of this connection.
- The connection between TENET and Mbabane in Swaziland. The challenge in this case involves questioning the international accounting rate system and the relation between the academic backbone and the national operators.

Other trans-border connections involving SA that could be explored include connections between Johannesburg and Gaborone in Botswana, Maseru in Lesotho and Windhoek in Namibia.

4.5 TCRA, Tanzania

The Tanzanian regulator TCRA is open for a private academic network, including international connection. The NREN is organized on paper. The bottleneck now seems to be funding. The Tanzanian regulatory framework has been discussed already in section 4.

4.6 The Communication Authority of Zambia and ICT Policy

The Zambian regulator, Communication Authority of Zambia (CAZ), has declared an open attitude to a private university network based on leased fibre from ZESCO and/or CEC. It is now up to the universities to organize an NREN and submit an application for a license.

CAZ was established in 1994. This was because of the Telecommunication Act which got rid of the State sanctioned monopoly in communications and officially transferred all communications regulation to CAZ. The regulatory jurisdiction for CAZ includes, licensing of all communications providers in Zambia (wired, cellular, value-added, etc.), national radio spectrum management, competition and interconnection oversight, service level monitoring, pricing and tariff approval, fee collection, complaint resolution, communications research and development promotion, and other areas. The other Policy issues are handled by the Ministry that deals with communication which is the Ministry of Communication and Transport. The act provided for nine Board members for CAZ. In March 2005, the Zambia ICT policy was submitted to the cabinet and is still waiting approval. “It has taken over two years for Zambia to issue an ICT policy document. That might sound a long time but it took Ghana over four years and Florence Etta, formerly of IDRC estimated that it has taken Kenya 12 years. When it is issued, Zambia will become Africa's 29th country to have a policy of this sort writes Balancing Act's Zambia correspondent Timothy Kasolo” [Zm ICT Policy].

The new ICT policy addresses issues such as, Zambia’s position in the global information society and its commitment towards the cause both regionally and globally. It addresses how Zambia sees ICT and it's involvement regarding ICT issues globally. Social and economic implications of ICTs in National Development have also been described mainly focusing on poverty reduction through use of ICT in education, health and agriculture. The situational analysis of ICT in Zambia is focused on social and economic factor dealing with issues such as Human resource development, research and development, public access, media and cultural heritage, ICT sector, telecommunication and supporting infrastructure, e-government, e-commerce, agriculture, health, tourism, environmental and natural resources, youth and women, legal and regulatory framework, security in the information society and policy implementation. Zambia has a vision that the country will transform into an information and knowledge-based society and economy supported by consistent development and pervasive access to ICTs by all citizens by 2020.The vision includes elements to help achieve its goals which are [Zm ICT Policy].:

- The Government recognizes the strategic opportunities and benefits that Information and Communication Technology offers to accelerate social and economic development across the country.
- The Government realizes that access to information and knowledge are some of the prerequisites for wealth creation and for effective participation of Zambia in the global economy currently dominated by information and knowledge-based societies.
- The Government further recognizes the critical role that a high capacity, reliable and geographically distributed telecommunications backbone infrastructure covering the entire country can offer in accelerating ICT penetration; providing access to information and knowledge resources, domestic and global markets as well as in creation of empowerment opportunities for all Zambians.
- The Government acknowledges the need for integrated national planning in order to ensure that other sectors of the economy benefit from the deployment of ICTs as part of social and economic development;
- The Government is aware that the transition from a natural resource to a knowledge-based economy will depend on visionary leadership as well as the availability of quality human resource needed to steer the nation into an information society;
- The Government is cognizant of the global and regional trends of the convergence of technologies, services and products and the resulting impact in managing the telecommunications, computing, broadcasting, media and postal services sub-sectors.
- The Government is fully aware that ICTs alone cannot have an appreciable impact on Zambia's development prospects unless the use of ICTs in the society and economy is done within the context of poverty reduction and other programmes addressing a number of critical success factors at central and local government, community, organizational and individual levels as well as in the society at large.

The Telecommunications Act No. 23 of 1994 confers upon the Communications Authority the mandate to issue Licenses. Any person may apply to the Communications Authority for a License under Section 6 of the Telecommunications Act. All licenses shall be in writing, and shall be available for inspection by the public. There shall be such types of licenses and classes thereof as the Authority may prescribe in accordance with the provisions of the Act. To obtain any kind of license from CAZ, the following procedure should be followed:

Stage 1	Applicant obtains an official Licence Application form from the Communications Authority at a fee of K10,750 plus VAT.
Stage 2	Applicant fully completes the application form and sends it back to the Communications Authority together with a processing fee. At the moment this fee is K50,000.00 plus VAT.
Stage 3	The application is scrutinized by the Communications Authority. Clarification between the applicant and the Authority where necessary is made during this stage.
Stage 4	The Communications Authority prepares a summary of the application and submits the application to the Board of Regulators.
Stage 5	The Board of Regulators approves or rejects the application.
Stage 6	If the application is approved, the Communications Authority subjects the application to comments from the public and other interested parties.
Stage 7	If the application is successful the licence fee is requested to be paid and a licence issued.
Stage 8	The unsuccessful applicant may appeal against the decision to the Minister of Communications & Transport.

To own and operate a private network, the telecommunications license operating fee has to be paid to CAZ per year. However, if your private network is built on infrastructure owned by any telecommunication company with license, then no license is required. For instance, if dark fibre is leased from a company with carrier's carrier license, then no license is required as long as that fibre is not used to provide any public service. The operating fees are shown in the table below, and private network is under category B4.

LICENCE	OPERATING FEE
A1-Basic local	2% of the gross revenue less VAT
A2-Basic Long	3% of the Gross Revenue less VAT
A3-Basic	3% of the gross revenue International less VAT
A4-Rural	0%
B1-Basic	5% of the gross Revenue voice less VAT
B2-Data	5% of the Gross Revenue less VAT
B3-All other e.g. Internet, Public Payphones, etc	5% of the Gross services e.g. Revenue less VAT
B4-Private Network-Telecom	Per year
Terminal Vsat	Per year
Small Vsat	Per year and all other
C1 - Cellular	5% of the Gross Revenue less VAT
C2 - Cellular	5% of the gross National Revenue less VAT
C3 - Cellular	5% of the Gross Satellite Revenue less VAT
C4 - Paging	5% of the Gross Revenue less VAT

5 Available Fibre infrastructure

The next strand of countries to the north is not as equipped with fibre. There are however, bits and pieces and there are plans. The purpose of this activity would be to summarize what is available, what is planned and what should be pushed for as a complement from an academic networking point of view, including other planned infrastructure projects, such as railway, roads, power lines, pipelines that need to be influenced to include fibre.

Trans-border connections should be explored connecting universities in Mozambique, Malawi, Tanzania, Zambia, DRC, Rwanda, Zimbabwe and Angola.

The result will be presented to raise awareness and stimulate discussions among all supporting stakeholders. A few concrete deployments that may be desirable to demonstrate feasibility should be proposed.

5.1 DRC

Examples of fibre available in DRC include different links along other infrastructure, such as

- Along the railway between Lubumbashi - Lobita
- The Western Power Corridor project (Westcor) will produce power at the Inga Falls in the Congo River (DRC) and distribute poser to DRC, Angola, Botswana, Namibia and South Africa. The plans also include optic fibre for broadband telecommunications links to be leased to operators and to increase trade in electricity by investing in joint-venture projects.

5.2 Kenya

Kenya Telecom has some fibre. The fact that its subsidiary Safaricom has built its own microwave-based transmission system for their GSM network indicates that the backbone of Kenya Telecom has its limitations.

Kenya Data Corporation (KDC) has lately invested in a number of fibre links between major cities, most notably Nairobi – Mombasa.

The availability of fibre in the Kenyan power grid remains to be explored in detail, but it is clear that fibre is available in the High Voltage transmission system for the purpose of controlling the grid.

5.3 Malawi

Malawi is landlocked and has borders with Mozambique, Tanzania and Zambia. The population is today about 13 million with an average yearly growth of around 3.2 % and a GDP per Capita of 200 USD. About 85 % of the population works in the subsistence sector, mainly engaged in small holder farming.

Malawi is self-supporting with electricity. The present total installed capacity is 284 MW and the consumption is 860GWh. The hydro power from Shire River is the main source representing 259 MW. In addition to this, there are a number of small diesel power plants with a total capacity of 10 MW. There is also an old 15 MW gas turbine. In the southern part of the country the network is meshed (alternative routes are available), while the northern part is radial. The parts farthest up in the north are connected to the grid at one section through a 33kV old line. However long-term major projects with repercussion on load demand in the northern region are the uranium mining and the Ntwara Corridor projects. These planned national projects will influence stepwise increase in the power annual load. ESCOM, the power utility company is also the main fibre owner in Malawi.

5.3.1 ESCOM Fibre Network Projects

ESCOM, (Electricity Supply Corporation of Malawi Ltd) was incorporated in 1998 as a limited liability Company under the Companies Act of the Republic of Malawi. It is owned almost wholly by the Government of Republic of Malawi (99%), while remaining shares of 1% are held by Malawi Development Corporation (MDC).

ESCOM, in line with the Strategic Transmission Business Plan (2004-2010) has embarked on introduction of fibre optic communication technology to establish inter-city and international telecommunication links using the power line transmission grid and the inter-connectors.

ESCOM Fibre Optic Communication Network project aims at constructing fibre optic links from Blantyre to Karonga via Chintheche, Lilongwe to Mchinji in Zambia and Phombeya to Matambo in Mozambique. This will cover a total distance of 1,280 km to be implemented in three phases in a period of 6 years thus 2004-2012.

ADSS (All Dielectric Self Supporting, 12-strands) fibre optic cables will be deployed on existing steel tower power lines and OPGW (Optical Ground Wire, 12-strands) on new steel tower power lines. ADM (Add/Drop Multiplexer) equipment will be installed at substations along the fibre optic links to cross-connect traffic.

The first phase , Blantyre–Lilongwe (294 km) is being financed by DBSA (Development Bank of South Africa) and the adjoining portion, Lilongwe–Salima (75km) financed by NDB (Nordic Development Bank), under rehabilitation of Lilongwe B-Salima 132 kV line and installation of a Transformer at Lilongwe B project. Phase two is for Salima-Chintheche- Mzuzu (343 km). Phase three is for Mzuzu- Livingstonia- Karonga (225km). The

Phombeya- Matambo link is to be financed by the World Bank under the Malawi –Mozambique 220 kv interconnect project.

Project implementation will be managed by ESCOM. Later a subsidiary company will be established to manage the operations and development of the fibre optic communication network. The network will operate as a ‘ carriers’ carrier backbone route for Telecommunication providers, operators and users in the country for both local and international traffic.

Phase 1, Blantyre – Lilongwe (294 km)

This phase is being financed by DBSA (Development Bank of South Africa) and the adjoining portion, Lilongwe – Salima (75 km) financed by NDB (Nordic Development Bank), under rehabilitation of Lilongwe B-Salima 132 kV line and installation of a Transformer at Lilongwe B project.

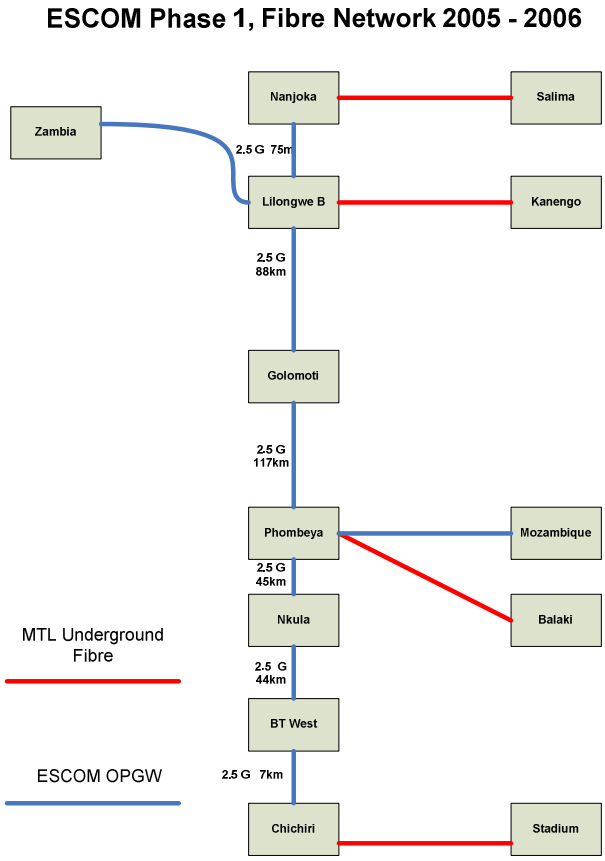

Figure 3 : ESCOM phase 1 fibre project

The Blantyre-Nkula-Golomoti-Lilongwe and the Lilongwe–Salima fibre optic links are scheduled to be operational by February 2006. The new steel tower transmission lines Lilongwe-Salima, and stringing of Nkula-Lilongwe second circuit will cost-effectively facilitate the introduction of fibre optic communication systems. An ADSS 12 core cable will link Blantyre West substation to Chichiri control center in Blantyre. This will be installed on the existing 7 km 66 kV transmission line. Terminal equipment complete with Add/Drop multiplex equipment shall be provided at Blantyre West and Chichiri control center.

Phase 2, Salima – Mzuzu TC and Malawi – Mozambique Interconnection

The purpose of the project is to rehabilitating the 132 kV over head transmission line, 343 km, wooden poles power transmission line (Salima-Mzuzu) with steel towers complete with 12 core OPGW cable and SDH, ADM. The project will be implemented in two years beginning 2006 up to 2008. This covers the substations in Nanjoka / Salima, Nkhota-kota, Dwangwa, Chintheche, Mzuzu and connects the TV system to studios in Mzuzu.

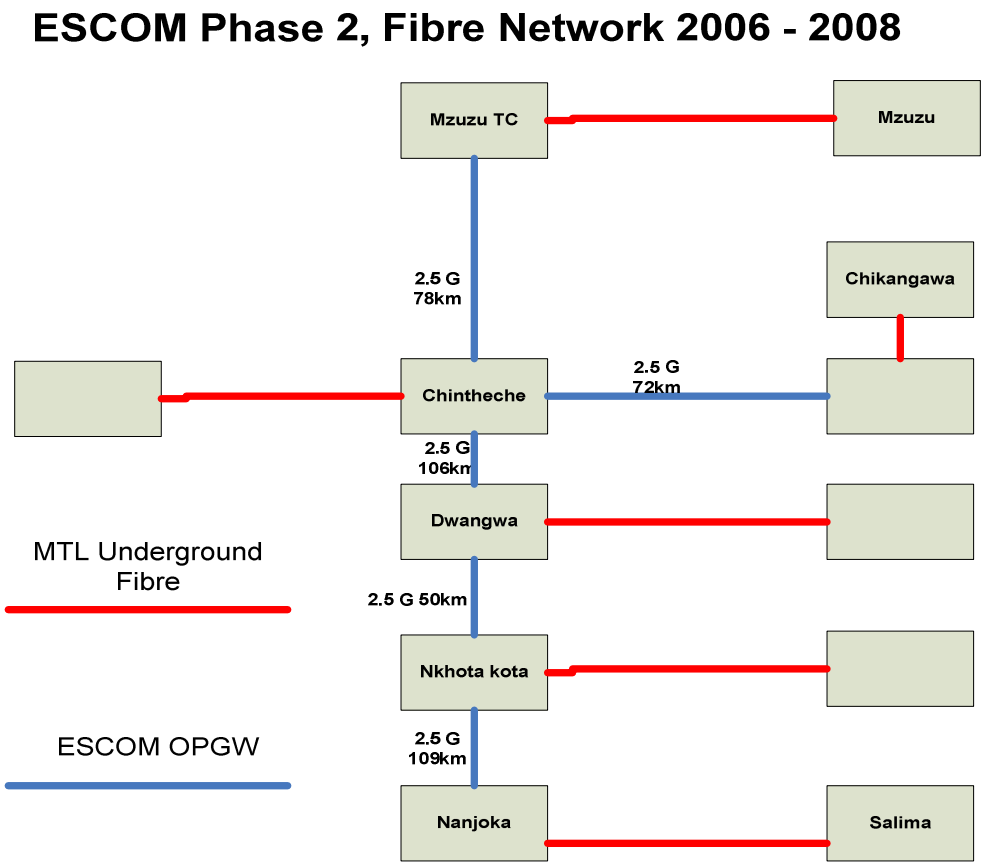

Figure 4: ESCOM Phase 2 Fibre Project

The 200 km 220 kV Mozambique- Malawi interconnection, planned to be operational by mid 2008, will be the first big transmission line of the interconnected Malawi grid with that of Electricidade de Mozambique (EDM) of Mozambique. The Phombeya – Matambo Power Supply interconnection will include a fibre optic communication link to provide telecommunication services for Data , SCADA, Fax , Voice, Teleprotection and TV signals from the control centre at Chichiri power station to Matambo through Phombeya substation.

The communication link will be 12 core OPGW fibre optic cable from Phombeya to Matambo with a T-termination to the planned OPGW (Nkula-Lilongwe) fibre optic communication link at Phombeya Terminal equipment complete with Add/Drop multiplex equipment will be provided at Matambo and Phombeya .A control building will be required at Phombeya to house the communication equipment.

Phase 3 Mzuzu TC – Karonga

This phase of the project involve rehabilitation of the Transmission line 66 kV, 205 km from Mzuzu to Livingstonia complete with OPGW cable. The existing wooden pole lines will be demolished and a new line will be constructed in parallel with the existing line as a single circuit line on lattice steel towers with three single conductors of “Lynx” in a triangular configuration and one overhead optical earth wire. Another portion of phase 3 will involve installation of ADSS cable on the existing 66kV, 98 km steel tower line from Livingstonia to Karonga. The Phase 3 project will be implemented from 2008 to 2010.The SDH, ADM and DC equipments will be installed in the substations at: Mzuzu, Ekwendeni, Bwengu, Livingstonia, Uliwa and the access system to Wovwe generation station (21 km away), Karonga and access to TV system studios at Karonga.

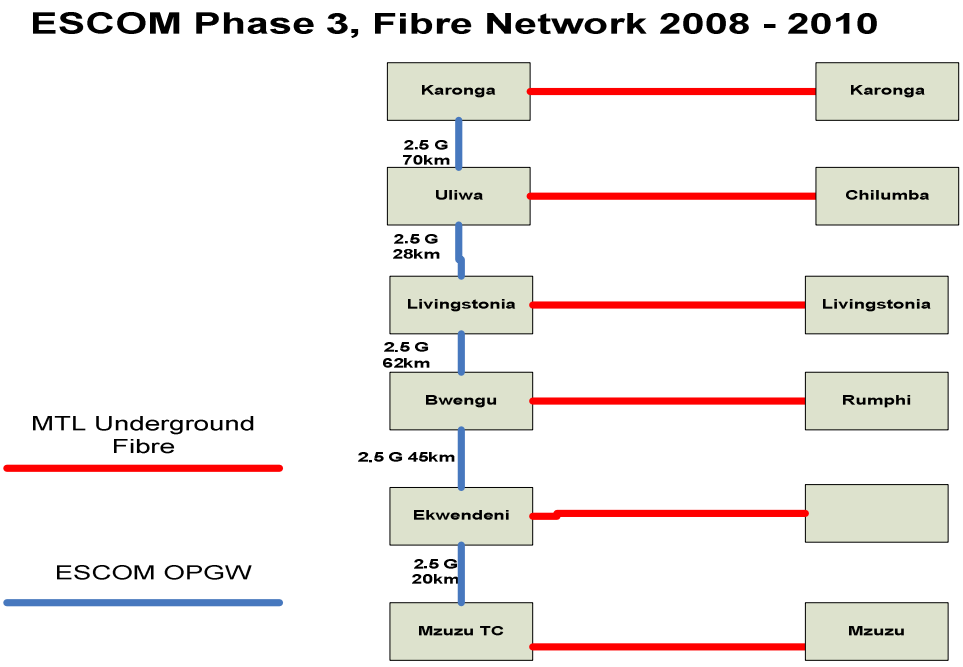

Figure 5 : ESCOM Phase 3 Fibre Project

5.4 Mozambique

Mozambique has access to the Indian Ocean and has borders with Malawi, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

There are currently three fibre owners in Mozambique:

- TDM, the national parastatal telecom company
- TVCABO, a Cable TV network provider currently owned by TDM and Visabeira, a private company
- EDM, the national parastatal power utility company deploying fibre in their power lines

We have discussed the need and possibility of providing MoRENet with capacity in the range of 10/100/1000 Mbps, preferably via dark fibre. Procurement documents are being prepared by UEM on behalf of the Ministry of Science and Technology.

5.4.1 TDM

The fibre network of TDM currently includes an extensive network in Maputo and a submarine cable connecting cities along the coast up to Beira. This cable is being extended up to Zambezia province and this phase is expected to be concluded by July 2006. The network in Maputo can accommodate all universities to be connected by MoRENet in the city of Maputo while there are universities outside the city that cannot yet be reached via a terrestrial network. The plans for extensions are illustrated in Figure 5.

It is unlikely that TDM is prepared to provide dark fibre access or wavelengths for MoRENet, although they have within their fibre network plans to connect UEM by fibre.

Regarding the connection of MoRENet to Johannesburg, TDM has offered MoRENet a preferential rate with a reduction of about 40% to the international link and about 50% of the local links. This is a good discount but because the international link is just a half-circuit to be matched by Telkom in SA it means in fact that the total link will be about 120% of the existing VSAT connection , ie, the link to Johannesburg will still be about 20,000 USD/month including taxes for 2Mbps duplex.

Figure 6: TDM Fibre infrastructure in Mozambique

5.4.2 TVCABO

TVCABO has a separate fibre network in the city of Maputo. Since it is using the companies use the same conduit as TDM, the points of presence are the same. They are, however, not allowed by TDM to provide UEM with dark fibre. The reason for this might not be merely political but also because they seem to have few strands of fibre and do not know the future demand. They may be willing to provide access to wavelengths, however. Also from a pricing point of view, TVCABO seems more interesting than TDM.

5.4.3 EDM

Fibre is installed in the Southern part of the country,

EDM has fibre is installed in the Southern part of the country, in the capital city Maputo and its neighbourhoods. The optical fibre network connects several power substations in Maputo, being mainly used for *Teleprotection* purposes, but also for voice communication (between substations), Data and Internet access. According to EDM, only one out of the available twenty four pairs of fibre is currently being used.

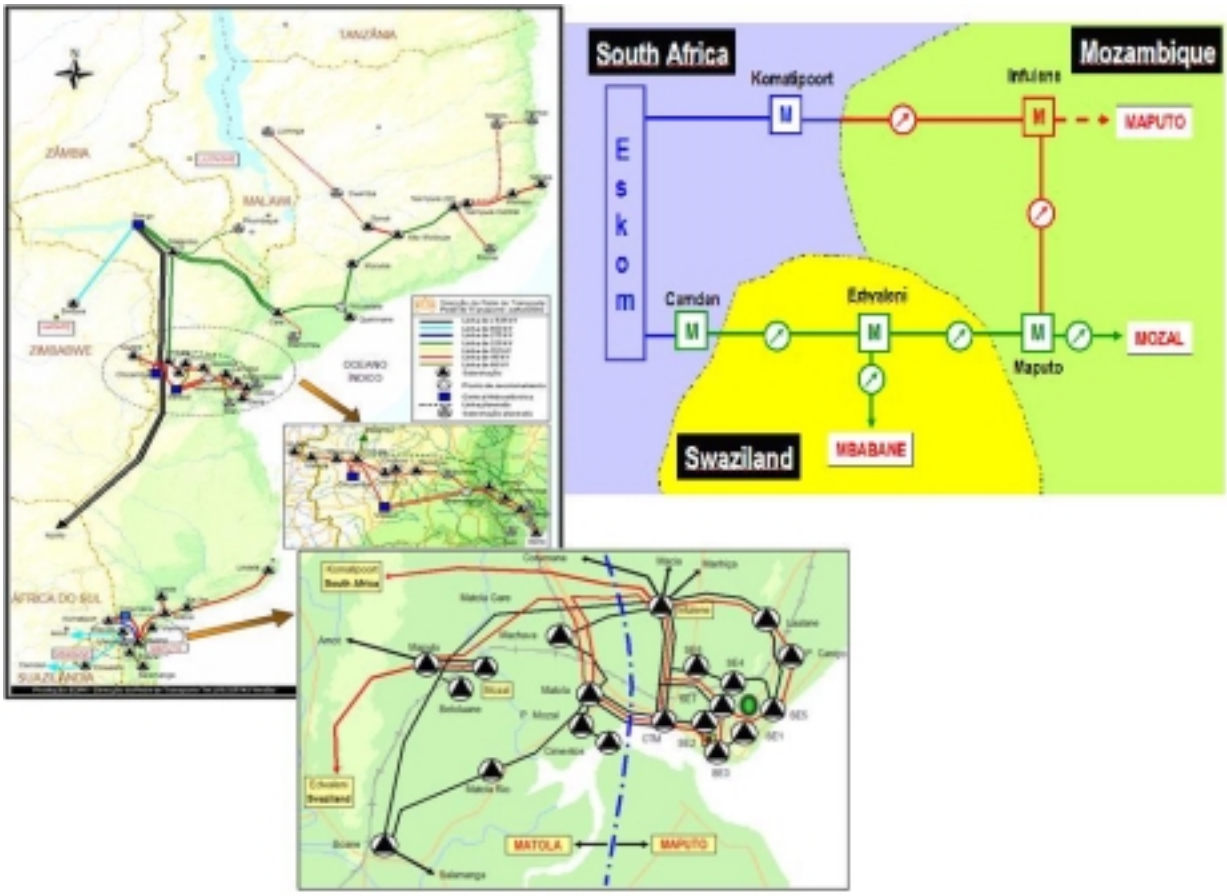

Figure 7 EDM Fibre infrastructure in Mozambique

Besides the fibre within the city, EDM also has a transborder 622 Mbps fibre ring interconnecting power stations in Maputo (Mozambique), Komatiport (South Africa) and Edwaleni (Swaziland). The planned power lines will include a fibre by "default". There is also a proposal for a fibre interconnecting Mozambique – Malawi.

5.5 Rwanda

In its effort to transform Rwanda from a predominantly agriculture economy into a service-oriented one, the Rwandan government is pursuing the creation of a knowledge-based economy, in which ICT will play an important role [Rwanda ICT Policy]. The National ICT plan [Rw-NICI] guided by the government's ICT policy is actually leading toward a knowledge-based economy. RITA, Rwanda Information Technology Authority (www.rita.gov.rw), has been created to ensure a suitable implementation of the plan with good coordination of the ICT efforts.

RITA has entered a Public-Private Partnership with Terracom, a private ISP, with the objective to bring new communications services to Rwanda. Public administration, Universities, schools and other business sectors are making use of fibre backbone. The government network, GovNet, is currently using one fibre optic backbone for its intranet and another one to connect externally. GovNet covers ministries and other government agencies in Kigali and some remote nodes in other provinces. The goal is to cover all the government nodes in Rwanda.

5.5.1 Terracom

Terracom (www.terracom.rw) has deployed an optical fibre backbone which is currently more than 300 km. Terracom and the former parastatal telecom company Rwandatel (www.rwandatel.rw) merged in October 2005 (www.terracom.rw/hype.php).

5.5.2 Electrogaz

Electrogaz, the parastatal power utility company in Rwanda, recently made a study on deploying a fibre network in its power network. The study was motivated by the company needs to remotely monitor and troubleshoot electrical devices located in remote areas and to use that infrastructure for their internal applications.

5.6 Uganda

The market for infrastructure is dominated under exclusivity rights by the two carriers MTN which is the Second Network Operator and UTL, the old PTT. Both are additionally enjoying strong growth in the mobile phone market, as is Celtel, and all are expanding their coverage. Also in Uganda the carriers are now in a phase where consumer density is growing in urban areas calling for measures to cope with the growth. Trunk networks are being reinforced, in some cases by new fibre cables.

Figure 8: Fibre Optic cable being installed for MTN in Kampala, May 2005

Outside urban areas coverage is problematic. The civil unrest in the north is holding back investments. The new ICT policy and the Telecom Act prepared 2005 has not been passed by parliament yet. The route towards a more open licensing regime moving beyond the duopoly in several sub-markets is unclear. One can expect fibre to be available connecting Kampala to both Kenya and Rwanda before any discussion on EASSy connection to landlocked countries has been finalised. Conditions on NREN use of any such fibre are currently not clear.

5.7 Zambia

Zambia is landlocked and bordering Angola, Botswana, DRC, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe. The economy is dominated by copper mining since independence but is heavily dependent on international assistance. Despite a population of 11 million, Zambia has just 2 universities, the University of Zambia in Lusaka and Copperbelt University in Kitwe. Zambia generates large quantities of hydroelectric power, particularly in Kariba and Kafue. The network is designed for the big users in the Copperbelt province, but is also serving all major towns. The country is covered by both analogue and digital microwave networks owned by mobile operators, power utility and railway transport companies, but does not yet have a national fibre backbone. Zambia has, however, all infrastructures required to set-up a fibre network by utilizing electric power lines, railway and oil pipe line and there is deployment of fibre in progress along the existing transmission power lines. There are two major fibre owners, the parastatal Zambia Electricity Company (ZESCO) owning about 200 km fibre and Copperbelt Electricty Company (CEC) having 520 km fibre in operation.

5.7.1 Zambia Electricity Company (ZESCO)

ZESCO Limited is the main producer of electricity in Zambia. Zambia has an electricity generation capacity of approximately 1,600 MW mainly generated by the Kariba North Bank Power Company and ZESCO's Kafue Gorge and Victoria Falls power station. This is transmitted along the four-line 330 kV backbone of the national grid. Kafue Gorge has an installed capacity of 900 MW with six machines. Kariba North bank has an installed capacity of 600 MW with four machines. Victoria Falls has an installed capacity of 108MW.There are also small hydro generating stations at Lusiwasi, Musonda falls, Chishimba falls etc.

All the major power stations are connected to the national grid for transmission of power to the main industrial areas of the Copperbelt and Lusaka. The national-grid consists of 330 KV line from Kafue gorge and Kariba, and 220KV line from Victoria-falls. Efficient transmission of power requires the establishment of substations along the way to allow the transformation to lower voltages. Some of such substations are Leopard hills substation, which transforms from 330KV to 132 KV and 88KV, Kabwe step-down, which transforms down to 88KV, Pensulo substation, Luano and Kitwe substation, which transforms down to 220KV.

To meet the voltage requirements for industrial and domestic use, the voltage is further transformed down to a 33KV, 11KV and 0.4KV. This forms the distribution network. Some of the major substations in the Lusaka distribution network are Coventry, Roma, UNZA, Kafue round about and Fig tree etc (Figure 9, below).

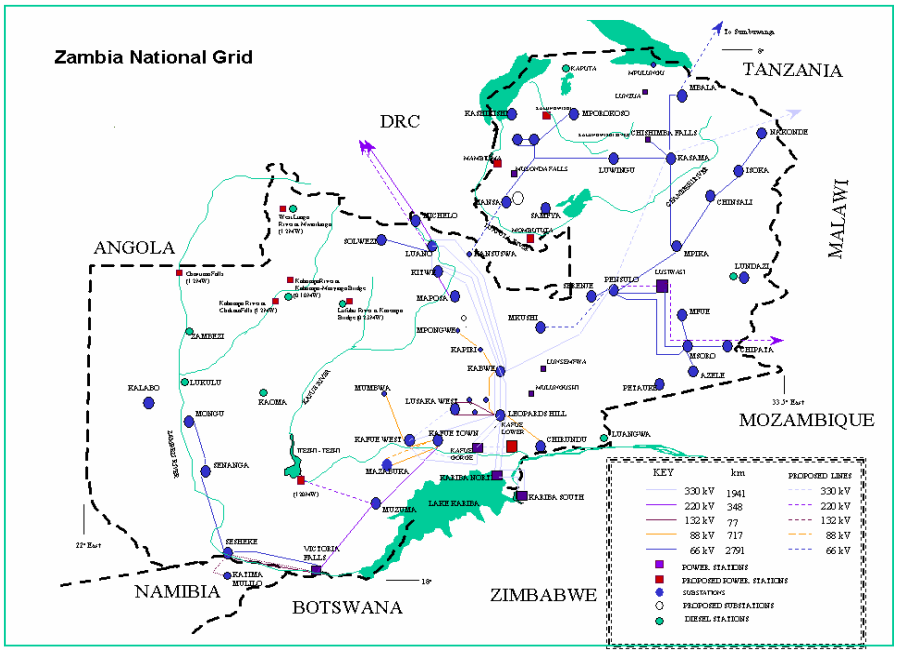

Figure 9: ZESCO National Grid

The ZESCO telecommunication network is reinforced with microwave interconnections covering the 330KV high voltage line from Luano to Kariba. The microwave radio like any other transmission equipment supports also the main services of telephony, data transmission, tele-protection, and differential protection., ZESCO thus own transmission lines for power as well as for the digital microwave network.

ZESCO has installed a 200km 330kV transmission line from Luano in Chingola on the Copperbelt Province to Kansanshi mine in Solwezi on The Northwestern Province. This project was commissioned in November 2004. The project included fibre with capacity of 155Mbps (STM1), which will be upgraded to 622 Mbps (STM4) in the phase one project described below. This is the only existing fibre network belonging to ZESCO at this time. The project final cost was about US$23million. An expansion is in progress and will happen in the phases described in the following sections, resulting in an infrastructure described in the figure below:

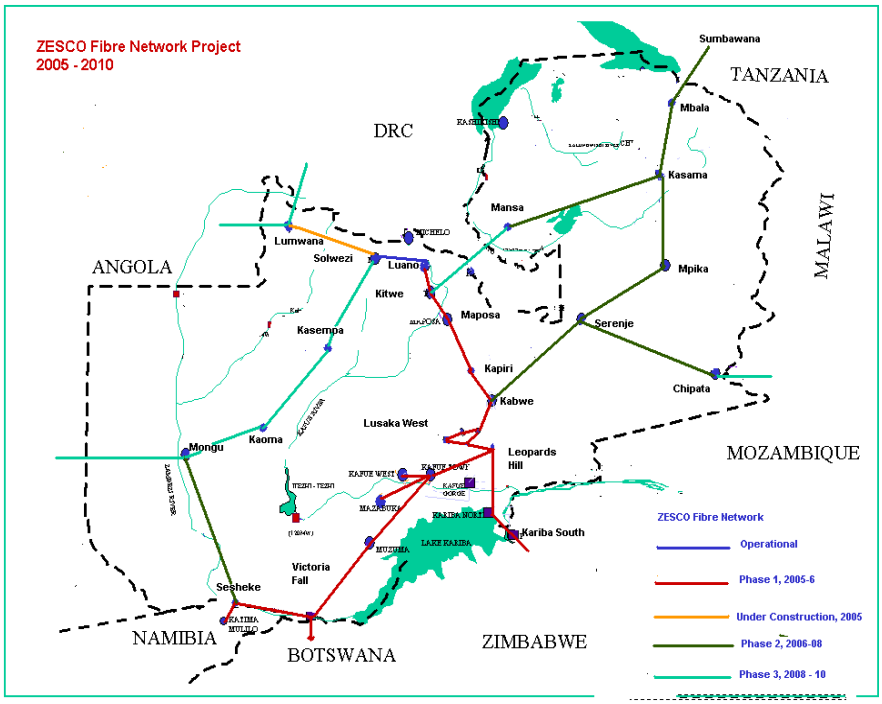

Figure 10: Complete proposed national fibre infrastructure, 2005 - 2010

Phase 1 National Backbone

The objective of the first phase is to establish a national optical fibre backbone and telecommunications network based on Synchronous Digital Hierarchy (SDH), including Add/Drop Multiplexers (ADM) and regenerators with transmission capacity up to STM-16. Transport interfaces will be STM-16 in the backbone. In the access network, the interfaces will mainly be STM-4.

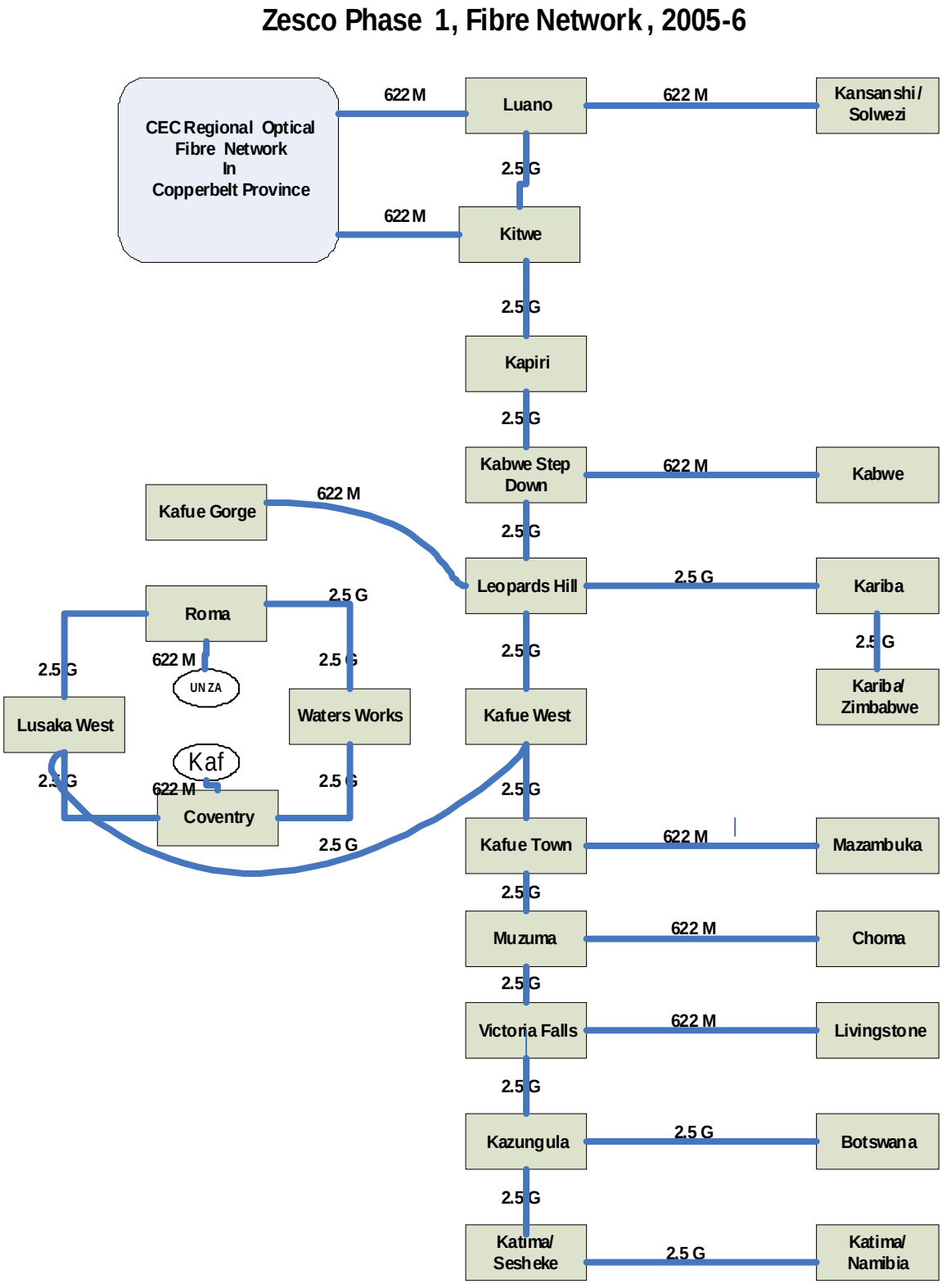

Figure 11: Zesco phase 1 fibre project, Namibia to Solwezi.

The first phase involves installation of optical fibre on existing power lines from Victoria Falls in Livingstone to Luano in Chingola, close to the DRC border. New 220 kV line from Katima Mulilo in Namibia to Victoria Fall in Livingstone is being constructed, but the SDH equipment installation will be part of Phase 1. The distance Luano – Kansashi has been deployed earlier but the existing STM1 will upgrades to STM4. This phase will also include interconnection to Namibia, Botswana and Zimbabwe. The implementation of the whole phase 1 project will take two years and be finished in the end of 2006. The OPGW will form the backbone of the network on high voltage transmission lines from 88 kV to 330 kV. However, to get to access nodes near the towns, ADSS will be used on distribution line voltages of 33kV and 11 kV lines. Additionally, optical fibre approach cables (OFAC) will be laid underground from the substation gantry to the equipment room.

The equipment will provide for Optical Line Interface, which will work at 2,5 Gbps with standard long-haul optical interface. On the tributary side, the Network Element will provide access to the constituent electrical signals through 2Mb/s, 34Mb/s. 140Mb/s and 155 Mbps (STM1) electrical interfaces. The equipment will also support 'Ethernet over SDH' capability at IEEE standard 10/100BaseT interfaces, Gigabit Ethernet (GBE) interfaces at 1000BaseT (optional) & optical GE interface at 1000BaseLX at 1550mm single-mode optical interfaces.

Two other major projects are currently also being implemented in Phase 1: the extension of the 330Kv line from Kansashi in Solwezi to Lumwana in Mwinulunga and the construction of 220KV line from Victoria Falls to Namibia, including the SDH equipment. The Lumwana power supply project will involve building of a 65km, 330kV transmission line from Kansashi substation in Solwezi to the Lumwana Mine site near Mwinilunga. A bulk substation will also be built to enable ZESCO supply power to the Mine at the required voltage. ZESCO and Equinox have signed a Memorandum Of Understanding for ZESCO to undertake the design and construction of the transmission line to supply power to the Mine. This project will eventually extend to the interconnection with DR Congo and Angola which will provide further downstream benefits to all users. The Lumwana power supply project will take about 18 months to complete, starting August 2005. The project will result in extension of 200km fibre from Luano in Chingola to Kansashi in Solwezi.

Transport interfaces will be STM-16 in the backbone. In the access network, the interfaces will mainly be STM-4. Phase 1 of ZESCO fibre network project is shown in the Figure 11 above;

Phase 2 Provincial Towns Fibre Networks

This phase includes installation of optical fibre on existing power lines from the national backbone, which will be implemented in phase 1, to provincial towns. It will also include Zambia – Tanzania Interconnect between Mbala in Zambia to Sumbawanga in Tanzania. The project will run for two years from 2006 to 2008. In June 2005 the Government of Zambia, Kenya, Uganda and Tanzania signed a memorandum of understanding for Zambia – Tanzania Interconnect project, that will enable Zambia to construct 330kV power transmission line with fibre to supply power to East African Countries. Zambia is in the process of engaging experts to review the studies done on the Tanzania/Zambia interconnect.

Phase 3, Fibre Ring and International Gateways

The third phase will involve installation of optical fibre on existing power lines in order to form a complete ring. Also, transborder connection Zambia – Malawi, Zambia – Angola, Zambia – DRC interconnection will be implemented in this phase.

The type of optical fibre will be is Optical Ground Wire (OPGW - 24) on existing transmission lines. However, in places where power lines do not exist, digital microwave link (16x2Mbps 1+1) will be installed, like Kaoma-Kasempa and Mansa-Kitwe links. Phase 3 will commence in 2008 and end in 2010.

At the end of all these project , the fibre network covering the whole country will be implemented as shown in Figure 10 above.

Copperbelt Energy Corporation PLC (CEC)

CEC is the owner of most of the already existing fibre covering roughly 520 km in the Copperbelt province of Zambia and reaching Copperbelt University in Kitwe. CEC is a privately owned Electric Power Transmission and Distribution Company in the Copperbelt of Zambia. The company's power network covers a geographical area of about 6000sq km consisting of about 802km of 220kV and 66kV power lines. The Company also owns and operates an extensive analogue telecommunication system that mirrors the power network by connecting all 34 substations. The telecommunication system facilitates the transmission of signals for the Supervisory Control and Data Acquisition (SCADA) system, primary asset protection, voice communication, remote metering and general data transfer.

The company, in its present state, was formed on 21 November 1997 as a joint venture between the government of Zambia, Cinergy Corporation of the United States of America, National Grid Transco of the United Kingdom

and five private investors, referred to as the Local Technical (LTTPD). Ownership is split as follows: Cinergy Global Power (38.5%), National Grid Transco (38.5%), the Zambian government through ZCCM Investment Holdings (20%) and the LTTPD (3.0%).

CEC sources power from two points within Zambia from ZESCO, at Luano and Kabwe, and from a third point in the Democratic Republic of Congo (DRC), as shown below in the figure below

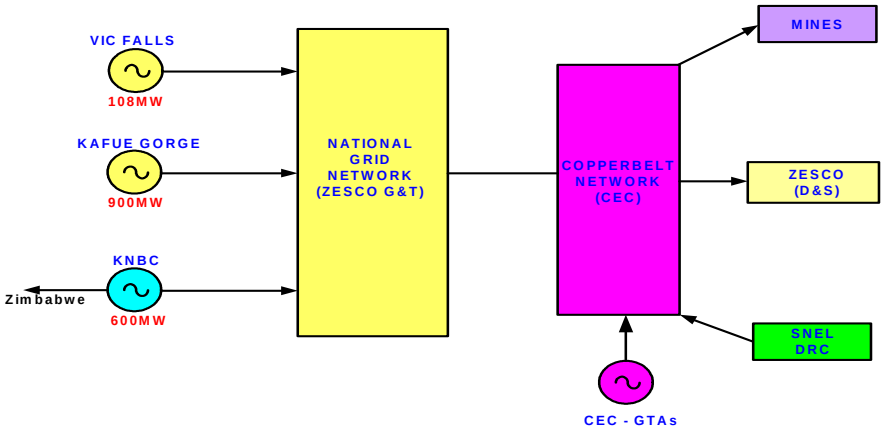

Figure 12: CEC Network

The company's infrastructure includes 802 km of 22 kV and 66 kV transmission lines; 1,275 MVA of 220/66 kV transformer capacity; 520 km fibre optic network and 80 MW of gas turbine emergency generation capacity. This comprises two by 20 MW at Luano substation, two by 10 MW at Bancroft substation and 10 MW at Maclaren substation, all of which provide back up to ensure critical water-pumping requirements are met. CEC also owns part of the Luano and Kitwe 330/220 kV substations at which points its grid joins with ZESCO.

CEC Regional Fibre Network

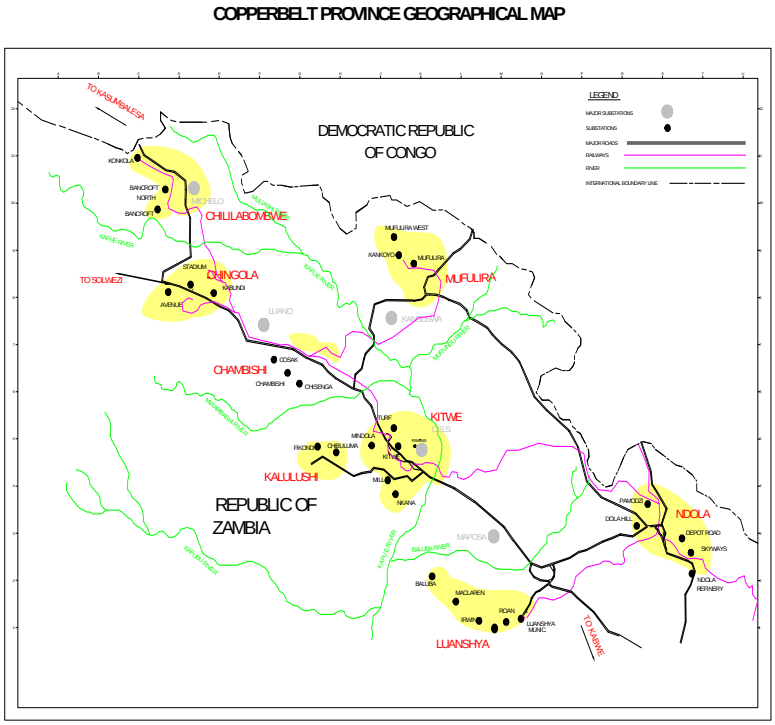

Figure 13: Geographical Coverage of CEC Network Populated areas (cities/towns) in yellow. Black dots represent the location of CEC substations connected to the SDH network, which are also the points at which external traffic could enter and exit.

The company has installed OPGW cable network throughout CEC's service territory (CEC's territory stretches throughout Zambia's Copperbelt Province) interlinking cities and towns. This involved the replacement of about 520 km of earth wire with a 24-strand fibre optic ground wire (OPGW) to link all of CEC's 220 kV and 66 kV substations. At substation level, the technology installed makes use of Synchronous Digital Hierarchy (SDH) equipment and associated digital multiplexers. CEC expects at least 25 years of life out of the OPGW cable.

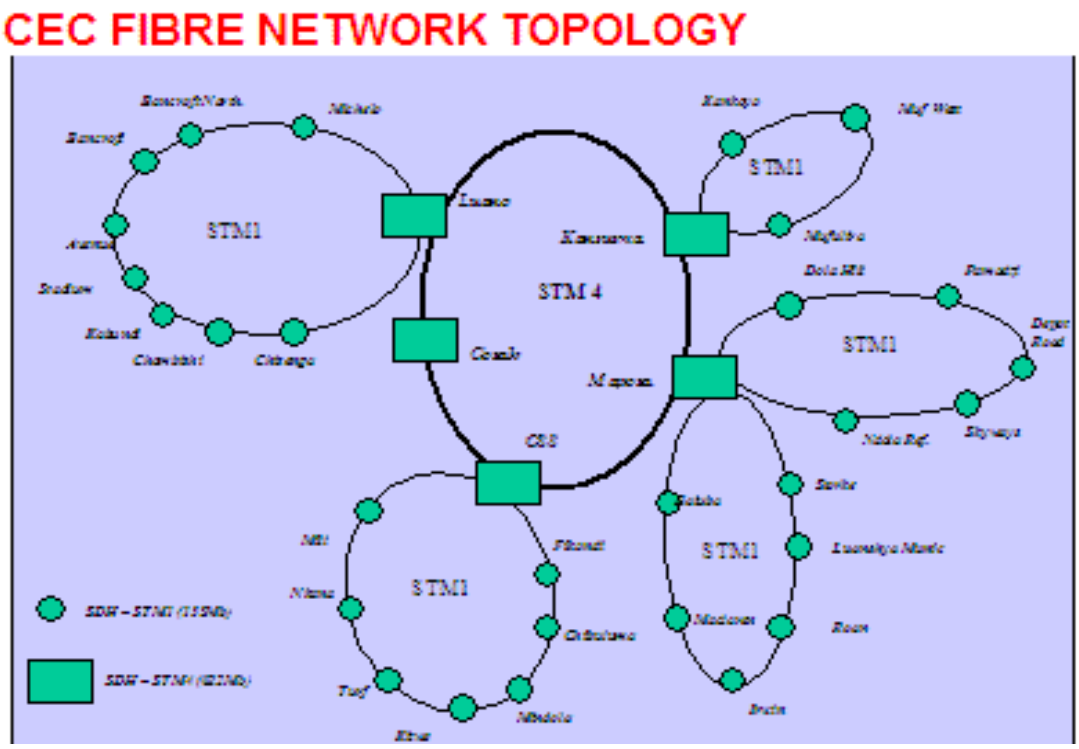

Figure 14: CEC fibre network topology

Zambia – Tanzania Interconnection Project

A transmission interconnection involving Zambia, Tanzania and Kenya has been proposed, for the purpose of facilitating export of power surpluses from Zambia and other Southern Africa Power Pool (SAPP) countries to East Africa, which is experiencing a deficit of electricity. The planning of this project is being managed by the Office for Promotion of Private Power Investment (OPPPI), together with their counterparts in Tanzania and Kenya. The Zambia-Tanzania Interconnection Project involves construction of 700 km of 330-KV transmission line, 600 km on the Zambian side and about 100 km on the Tanzanian side. Kenya have already engaged a team of experts to do feasibility studies for the Tanzania-Kenya portion, but Zambia is in the process of engaging experts to review the studies done on the Tanzania-Zambia Interconnect.

CEC intends to participate in the development of the Zambia-Tanzania interconnection project, which will enable delivery of power surpluses from Zambia and other southern African countries to the East African region, which has a power deficit. The World Bank has expressed interest in financing the project but this has not yet been approved. The World Bank funding, if approved, would cover for technical, financial and economic feasibility studies and also the actual construction of the lines for the Tanzania/Zambia interconnector and the internal reinforcement of the Tanzania transmission system.

DRC - Zambia Interconnector

CEC is working with partners in the DRC to increase capacity of the DRC-Zambia interconnect from the current 210 MW to 500 MW. This would allow for additional power to be wheeled from the Inga power station in the DRC to other SAPP countries. This strengthening of the national grid will see construction of a second 220 kV line from Luano in Chingola (Zm) to Karavia near Lubumbashi (DRC), with 45 km of the length in Zambia and 92 km in the DRC. The design stage and environmental assessments have already been conducted and the project itself is earmarked for completion by the end of 2005.This project will also involve deployment of fibre from Luano in Chingola to Karavia near Lubumbashi.

6 Business models for dark fibre

The selection of a reasonable model all begins with an assessment of the entire potential value chain in the country or region in question: What players are doing what on what level and not least what kind of customer and end-user structure can be expected. All business models for dark fibre obviously assume that a transition from a vertically integrated market to a horizontally layered market has developed at least a bit. In markets where policy makers still want to micro-manage who gets to do what, also in aspects of not using scarce resources, this is typically not possible. You have to evolve your regulatory regime past the concept of limiting the number of entrants by elaborate licensing and instead support a “the more the merrier” policy.

When selecting a position you then have to look at your relative strength versus other players to figure out what a reasonable and sustainable role you could have. The conditions of access to infrastructure also become even more an issue since there is little or no alternative. From a competition point of view, it might be an advantage to duplicate resources. If this is not possible for economical reasons, an alternative is to require open access to share such resources. Obviously, such access has to be under non-discriminatory terms and all competition issues regarding access to essential facilities have to apply.

The situation in a low income and scarcely populated country that just recently left a telecom monopoly situation is of cause not easy to judge. There are numerous pitfalls that simply do not exist when you compare with superficially similar companies in other markets.

6.1 Legal framework, conflict resolution, trust

One thing to start with is what you can expect from the legal framework and how well you can master any unexpected deviations from what is supposed to be a straight forward situation. Most new players have not done particularly well in being the very first in a certain business niche, often challenging the incumbent over a seriously protected business, like international voice traffic. Even if they come out victorious nagging some market share, the delay may be lethal. A decision may even come after the new company has folded running out of cash waiting for the decision. Most EU regulators regard this as a major problem in their conflict resolution processes. This problem also surfaces in the various consultations that regulators have with the new operators a decade after the first liberalisation, the current consultation by the UK regulator Ofcom being a good illustration. Avoiding head-on clashes is in many cases a much better option for a poor new entrant. In any case, your business concept has an edge if you are not depending upon an unwilling incumbent operator to share any essential facilities and loose market shares in the process. Many new operators also cite this as the major reason to build instead of buy. Life is considered difficult enough without letting the erratic performance of any subcontractor play havoc with your operation. The scope of what is core business easily becomes too wide. Good African examples of this are the mobile phone companies that build trunk networks even when belonging to an old wire-line company. The trust is not there, even inside the group.

6.2 Greenfield vs. Number Two

The closer you are to be active in the lower layers of the telecom business, like laying cables, the more you will be faced with big, structural, 100% sunk costs with little or no chance to change over the lifespan of the investment, a decade or more. At higher layers, you often have more flexibility and not least shorter life. We will now focus on the problems at the lower layers since the situation at hand starts with a fundamental lack of infrastructure. The comparison with developed countries can easily end up with judging the wrong parameters looking at coming in as number two. Instead, the challenge in this case is to start thinking about sharing the green-field infrastructure investment in a reasonable way, also with the incumbent.

6.3 Logistics, footprint and endurance

Several of the new infrastructure building companies during the boom years in the US and EU a decade ago also missed out on the practical problems of interfacing with lots of parties regarding Right-of-Way leaves. Just creating all the necessary personal relationships with municipalities, street authorities and not least other infrastructure companies like gas, water, power etc, became a logistical nightmare in a situation where time-to-market and first mover advantage were prime considerations, not long range cost and utilisation. Without a comprehensive footprint you simply couldn't do business. They also ran out of gas pretty consistently, not only because the general collapse of the trunk route market between capitals, but also just from finding it too difficult to negotiate all route permits. Having resolved these issues all of a sudden became a bankable asset, prompting numerous swap deals, not only on fibre but also on duct space. All this to get a backbone footprint enabling enough business as this is closely tied to scope and density relative to any competitor. Then came an understanding that the missing link was "not highways but on-ramps" and the market for trunk infrastructure stalled. However it did not stall for those players that had a focus on local access infrastructure connecting customers feeding their backbones. In general, most companies building new fibre from scratch have not made it if they have not been able to do one or more of the following:

- Leverage the fibre position into defendable positions higher up the value chain in a market with limited numbers of players, or
- Enjoyed and strictly focused on cost advantages or an established position both versus suppliers and customers.

Local electricity companies teaming up with national broadband providers is a typical combination of the latter.

6.4 Cost advantage, supplier relations, consumer contact

It is therefore not surprising that many electrical power companies have been keen to enter the telecom infrastructure market. They do it from having a local presence, having resolved the Right of Way issues and in many cases established pole lines and duct space that could carry a thin fibre optic cable too at little cost. Piggybacking fibre on their plant is something that they can understand and do at low cost and low complexity, not demanding elaborate organisational expansion. They also may need fibre to control their own plant, the power network, at least in the HV transmission system. Looking closer to individual users, they have in most cases also evaluated their end-customer relations and concluded that this may be of substantial value. “We already send this customer a monthly bill. Why not also include a line for telecom service?” The emerging broadband market saw several power companies embarking on this trail. One can guess that some of this was also tied to a liberalised power market where power sales, a very cost sensitive commodity, were in desperate need of bundling with another product. The situation gets even more complex by the cross subsidy discussion between the power grid, a monopoly market, and the telecom network, supposedly open and competitive.

6.5 Investing in a greenfield situation

Tanzania is an example of a country that lacks both comprehensive telecom infrastructure and a power grid serving more than a small part of the country. Given the obvious cost advantages of piggybacking deployment of fibre on the power grid expansion, at least the High Voltage transmission grid, where fibre is anyway needed for power grid control in modern systems, the marginal cost is just ridiculously low, or in the order of USD 200 per pair and km. Adding fibre to a Medium Voltage line further out the grid is a similar total cost but unfortunately the power company does not need the fibre for its main business. The telecom users will have to carry the total cost for the fibre cable but will not have to put up the pole line. The cost ends up on the low side of a couple of thousand USD per km. This is anyway cheaper than a separate pole line that ends up north of USD 10,000 per km, while for a buried cable in duct where the cost is normally considered to double or triple in most environments, i.e. 30.000 USD per km. The big advantage of buried cable is the lower maintenance, however.

Piggybacking on other infrastructure development, sharing civil works, 80-90% of the CAPEX for a separate fibre line, is of cause an alternative too. Unfortunately, an assessment of the “Ideal Backbone Network” in Tanzania, an interesting first iteration of a joint multiparty structure, shows that the only party having a substantial expansion of new kilometres of infrastructure is the power company, TANESCO. Most others do provide some existing route kilometres of fibre, but adding fibre takes mainly advantage of the existing Rights of Way, not cost sharing in construction. Power distribution networks normally also have some location advantages, providing more choice to select suitable points to branch out locally to cover smaller towns and villages. The cable will normally, on one route, contain fibres that are a part of a national backbone optical structure and fibres that are used locally to connect a string of local towns. The cable structure will be similar to the power line routes, but the logical use of individual strands could be quite different. Particularly since there will be several users, operators, having their fibre in the cables set up in different transport network topologies.

We are now creating so much complexity that the average power company will ask itself if and how much it really want to get into leveraging its low cost position into a telecom venture doing more than what it knows best, maintaining a cable plant. TANESCO is also typical for a developing country in that it is facing a major challenge in its main business: Its HV/MV grid is just covering a fraction of the country, generation is inadequate, and the number of annually connected households is not keeping up with population growth according to WB data. The company is clear over this and wants to have a partnership with someone exploiting the gradually growing footprint of fibre connected to the core grid. Since Tanzania will have a number of districts with a separate, stand alone local power grid, normally MV /LV where fibre will be included in the rural expansion programs before it becomes a part of the total grid, there will also be openings for interesting temporary combinations of fibre-microwave-fibre or VSAT-fibre to expand infrastructure possibilities. The rural electrification programs create another key asset for ICT, availability of electricity. One could envision different partners in different local “fibre islands” simply because of cost and local know-how in managing a local entity.

For a National Research Network connecting universities, the prime question is of course the fibres in the core grid, providing communication links from universities around the country to key facilities in Dar es Salaam, international transit connections, Internet Exchange Point and universities in the city.

An exciting question will be how both the expansion of the High Voltage transmission power grid and the Rural Electrification programmes will be influenced by the need to swiftly extend the fibre links to all neighbours of Tanzania. The power transmission grid needs to be extended or upgraded (incl fibre) to enable Tanzania to participate in the international regional power pool, get more efficient power production and wider coverage. The Rural Electrification programmes will no doubt open for fibre close to the borders in a way not fully understood at this point. The fibre border crossings may not necessarily be a future High Voltage line. Since all investments in the electrification are more or less entirely depending upon donor support, the business model actually includes donor behaviour too.

6.6 Adding complementary fibre

Obviously this will open up for complementary, separate fibre cables being deployed, not hundreds of kilometres but maybe tens of kilometres. One could even envision submarine cables crossing border lakes like to Malawi.

6.7 NRENs as demanding customers

The NRENs will no doubt be a positive force in getting the major routes established, also across borders. They will in several ways act as anchor customers, also paying up front for investments, but mainly as demanding customers challenging the situation for the parties involved in the provision of infrastructure. This is a not so obvious advantage for the other commercial and competing parties using the infrastructure, but also for the provider. There will be a lot of jockeying for position and adding a substantial non-commercial user to the roster will create some stability to an Open Access situation and prevent a too early consolidation of the number of customers on the infrastructure level, focussing all users of this on cost effective participation in network expansion rather than playing games aiming at preventing other carriers access to certain key routes. There is lots of evidence from markets where one or two carriers could, or thought they could, dominate access to a city or a metro area by deploying these tactics. Since Tanzania, like most other countries do not have the control fabric to deal with this simultaneously with the massive expansion programmes needed, players must find dominance by exclusivity to infrastructure a less tempting alternative. A clever use of the NRENs will assist in this, to the advantage of both the infrastructure provider and not least the regulator who could embark on a road to less micro-managing and more soft regulation.

If not observant, the infrastructure provider can otherwise end up in a difficult situation if the number of carriers being separate customers becomes too low. This will complicate the pricing models in a way that goes beyond this paper to explain. Essentially, the infrastructure provider needs a healthy number of carriers as separate customers on non-discriminating terms.

The NRENs will also teach the entire market that it is perfectly possible for any entity to be a customer on any level in the value chain. NRENs are, like other users, evaluating Buy or Make all the way down to the dark fibre level everywhere possible. The communication around EASSy has shown that traditional telcos in SSA resist this process as it creates a more transparent market place. They need, however, to be exposed to this thinking for managerial and educational reasons.

7 National Research and Education Networks

Academic networking in Africa is entering a new dynamic period as optical fibre is becoming available. In many places, VSAT is still the short term solution but at some locations, fibre is already an alternative. While satellite connections are vertical and mostly connecting connectivity islands to other continents, fibre links are horizontal and provide new opportunities for cooperation between universities to share resources and costs. To fully exploit these opportunities for cooperation, there is a need for national organisations to address the national aspects, which may vary between the countries and a regional organisation to address regional issues, including procurement and management of regional and international bandwidth. In this section the national organisations are discussed while the regional issues and the Ubuntunet Alliance is discussed in the next section.

Among the advantages of a national backbone for peering between academic institutions (NREN) are:

- Faster Internet connections and connections between all universities at lower cost enabling the universities in the different countries to have a connection to other academic and research networks in the region and outside of the region.
- Sharing of human, financial and technical resources and technical resources, such as caching servers, supercomputers, a national grid, virtual libraries, etc
- Closer cooperation using applications such as, virtual classrooms, virtual lectures, seminars, etc; and to engage in research collaboration that require access to huge amounts of bandwidth.
- Possibility to use applications such as data, telephony and video using the same infrastructure, what translates in reduced costs for communications between them.
- Strengthen the position of academic networking in relation to authorities, industry and other parts of society.

For this to happen there is a need to:

- Assess the current situation in terms of information and communication technology in each university.
- Create an understanding of the benefit of a research and education network within universities in the country
- The technical design of a network providing connectivity for the universities.
- Assess the cost for establishing and operating the network
- Identify the mechanisms for financing the operation of the network

- Assess the regulatory environment that is required for the establishment of a national private network for tertiary level education and research institutions, the interconnection of this network to other networks in the region and in regard to the use of particular applications, such as VoIP.

7.1 DRC REN

The Democratic Republic of Congo (DRC) is the third country on the African continent after Sudan and Nigeria with a land area of 2,267,600 square km. It has a population of 58,784,400 inhabitants. Its has as capital Kinshasa and its largest cities are Kinshasa, Lumbumbashi, Mbuji-mayi, Kolwezi and Kananga. The land is divided into the city of Kinshasa and 10 provinces. These include Bandundu, Bas-Congo, Equateur, Kasai-Occidental, Kasai-Oriental, Katanga, Maniema, Nord-Kivu, Orientale and Sud-Kivu. Dissected by the Equator, the DRC is located in the center of Africa where it has frontiers with Angola and Zambia at the south, Uganda, Rwanda, Burundi and Tanzania at the East, Sudan and the Central African Republic at the north and Congo Brazzaville at the west. Its landforms include (1) the Congo River basin occupying the central and northwestern parts of the country (2) savannah grasslands extending to the border with Angola (3) a plateau with heights over 5,000 feet and volcanic mountains of the Great Rift Valley in the east and (4) the peaks of the Shaba plateau rising Southeast. The DRC hydrology includes the 2,733 miles long Congo River system and its many tributaries and a number of lakes fronting its eastern borders: Lakes Albert, Edward, Kivu, Mweru and Tanganyika. The river Congo is navigable for almost 900 miles and its basin contains the planet's largest rain forest.

Figure 15: Democratic Republic of Congo

Higher education in the DRC

The advent of National Research and Education Networks using fibre technology provides a new opportunity for filling the gap between western countries and Africa in terms technology by (1) allowing access to the Internet to as many African institutions as possible (2) delivering traffic at high bandwidth and (3) allowing national, regional and international research collaboration.

By its size, its population and its localization at the centre of the African continent, the DRC should play a capital role in this emerging African research panorama. The DRC higher education system is structured around three main public universities, 18 Advanced Technical Institutes, 16 Advanced Pedagogical Institutes, a School of Agronomy, several private universities, technical schools and colleges scattered around the country.

The three public universities are

(1) University of Kinshasa created in 1954 as a catholic affiliated university called Lovanium university.

(2) University of Kisangani created in 1956 as a protestant affiliated university called university of Congo.

(3) University of Lubumbashi created in 1956 as an autonomous university under the control of the ministry of education.

All these universities include several schools with different educational and research programs such as medicine, engineering and science (Mathematics, Biology, Chemistry, etc).

The number of private educational institutions in DRC may be estimated to over 250. Some of these institutions have proved to be of high quality. These include for example

(1) Catholic Theology Schools of Kinshasa (Facultes catholiques de Kinshasa)

(2) Bukavu Catholic University (Universite Catholique de Bukavu)

(3) Graben Catholic University (Universite Catholique du Graben)

(4) Autonomous University of the Great Lakes (Universite Libre des Pays des Grands Lacs)

(5) Protestant University of Congo (Universite Protestante du Congo), and

(6) Provincial universities (University of Mbuji-mayi, Kongo, etc.)

At the moment of the writing of this paper, most of the universities of the DRC are members of the Association of African Universities and have adopted the idea of national research network.

The DRC NREN

The DRC is recovering from an eight years long multifaceted war that led to a destruction of its infrastructure for education and research. However, according to a recent report of the UN, higher education in DRC has been resilient to that war by exhibiting growth in enrollment at all levels. The DRC REN has the objective of improving helath, e-training and research.

- Health: DRC is deeply affected by the Malaria pandemic as well as many other tropical diseases. The DRC NREN could enhance communication on a wide variety of health issues and allow expert knowledge dissemination and Web consultation.
- E-training: The DRC high educational system is structured around a training system where experts are committed to teaching in various campuses separated by thousands of kilometers. The high bandwidth provided through the NREN will allow E-learning and web seminars to cut down the travel costs.
- Research: The high bandwidth provided by the NREN will promote joint research projects to be carried between different high education institutions located in the DRC or in the region as well as the access to external research networks such as GÉANT.

Some of the planned activities within the DRC NREN framework include

- An evaluation of Internet connectivity in higher education institutions and assessment of needs in order to prepare these institutions for the inclusion to the DRC NREN.
- Local and regional workshops on NRENs to create awareness.

A pilot including (1) connecting all universities in Kinshasa and (2) Cross border connectivity with Congo-Brazzaville and Zambia. The pilot will be used as a show-case for the implementation of NRENs/RRENs.

A pilot project

The linking of Universities of Kinshasa and Lubumbashi to reliable VSAT connections through a VLIR (Free University of Brussels/Belgium) funded project has opened the doors to new research opportunities for both universities. However these links are costly. Contacts have been made recently with the African Virtual University (AVU) to find ways of decreasing cost. Kinshasa and Lubumbashi are separated by a distance of approximately 1600 km. There is currently no plan to cover this distance by fibre.

Kinshasa has one of the largest universities of the country and several other private and public organizations that provide good quality education. These include

- Protestant University of Congo
- Catholic Theological Schools of Kinshasa
- Advanced School of Applied Science (Institut Superieure des Techniques Appliquees)

- Advanced School of Commerce (Institut Superieure du commerce)
- Advanced School of building and civil engineering (Institut de batiments et des travaux publics (IBTP))
- Pedagogical Institute of Gombe (Institut Pedagogique de la Gombe (ISP Gombe))
- LIFASIC

These institutions are located in the close geographic area making interconnections by fibre realistic in a close future. Furthermore, the first steps are being taken to connect UNIKIN to the Kinshasa Internet Exchange and agreements have been made to use UNIKIN as a HUB for the other institutions.

Cross border connectivity

We are investigating the possibility of a cross border connectivity pilot project with Congo and Zambia. As illustrated by the figure below, Kinshasa is separated from Brazzaville in Congo by the Congo River. The distance between the two cities is short (1.6 km to 3.0 km). Laying a fibre under the Congo River would allow fast connectivity between the universities of Kinshasa to the university Marien Guabi in Brazzaville.

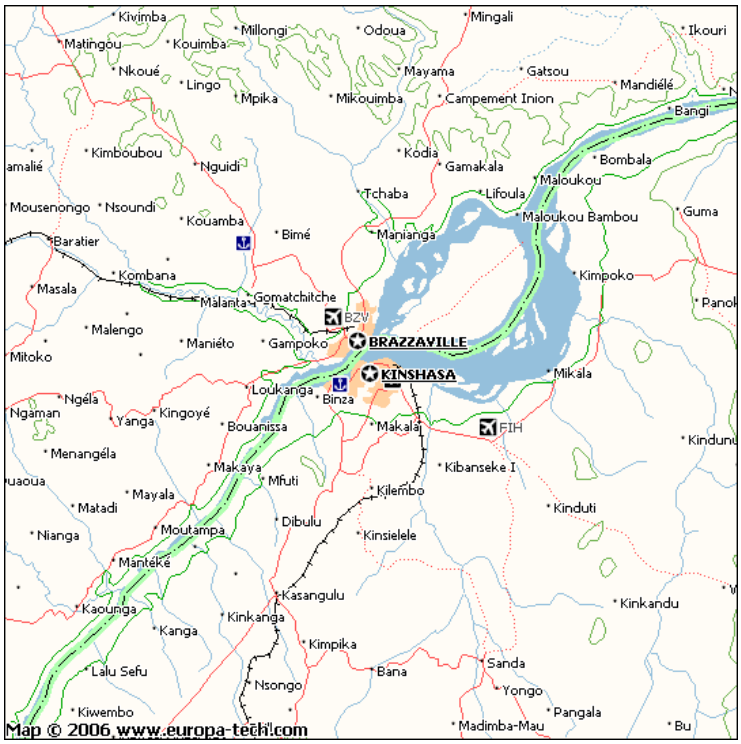

Figure 16: Congo-DRC cross border connectivity

The university of Lumbumbashi is located in the Katanga region, a mining zone that connects DRC to the port of Lobito in Angola (1900 kms) and Zambia via the Copperbelt region using the railway as illustrated by the figures below. This can allow cross-border connectivity with these two countries using a fibre layered along the railway line.

Figur 17: DRC-Angola crossborder connectivity

Figure 18: DRC-Zambia cross border connectivity

Note that the Western Corridor project initiated by the SADC to ensure sustainable supply of energy in the SADC region by building an electricity power line from INGA in the DRC to South Africa. Is another avenue to be explored for fibre connectivity in the SADC region. This project is expected to supply power to Angola, Botswana, the DRC, Namibia and South Africa initially and later to the rest of the region. This power is being designed to carry a fibre that can be used for cross border connectivity between several countries in Southern Africa Region.

Conclusions

A brief overview of the high education in DRC and sketched some directions towards the implementation of the DRC NREN and the initial steps towards a Regional Research and Education Network interconnecting the DRC, Congo and Zambia. The implementation of NRENs in Africa will be successful only if the African higher education institutions are endowed with decent IT infrastructures allowing these institutions to be connected to the NRENs. Based on the experience of the DRC, we recommend to the different stakeholders in NRENs to look ahead of and beyond the service perspective sometimes overstated in order to enhance the existent IT infrastructures in Africa and promote research.

The DRC NREN Task Force has been tasked to

- Create awareness through workshops and meetings,
- Contribute in the rehabilitation/creation of higher education network infrastructures, and
- Coordinate the creation of research entities and programs such as (1) planning postgraduate sandwich programs between local universities and overseas institutions, (2) enhancing the role of the Diaspora in the DRC higher education system and (3) participating in the design and implementation of the DRC NREN and the future Central African RREN.

7.2 KENET, Kenya

KENET (www.kenet.or.ke) was initiated in 1999 and the Kenya Education Network Trust was formed on October 27, 2000 by five founder institutions, all universities. Currently KENET has 33 member institutions. A complete list is available via the website.

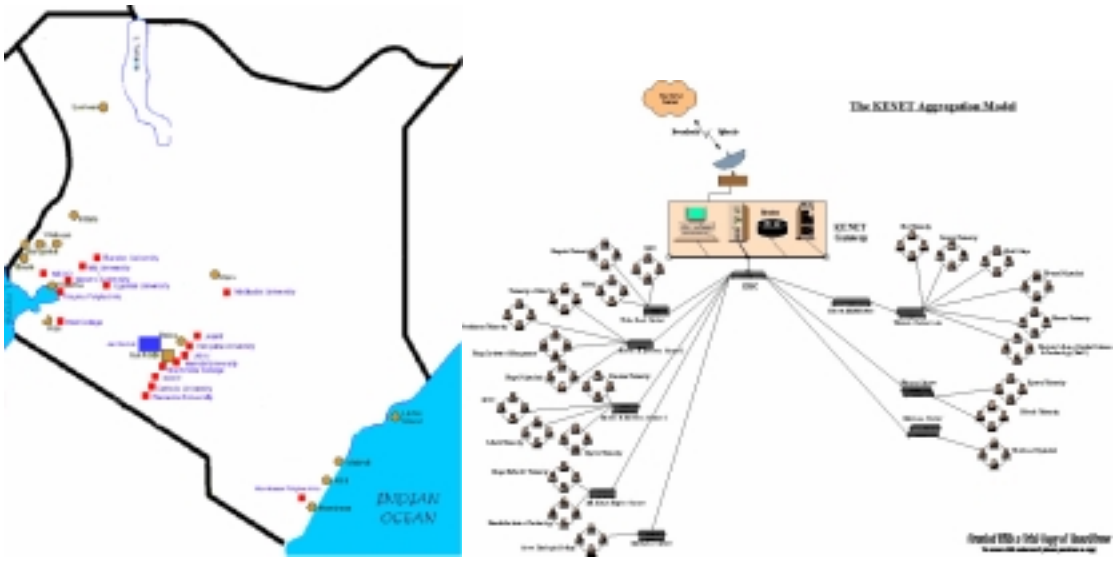

Figure 19: a) Location of institutions connected to KENET and b) topology of the KENET network (from the KENET website)

7.3 Maren, Malawi

MAREN, the Malawi Research and Education Network formed a Task Force in mid 2005. In spite of its low age, the Task Force has provided several groundbreaking deliverables:

- MAREN is one of the founding members of UbuntuNet Alliance for Research and Education Networking.
- The MAREN Task Force has supported a campus fibre networking project for academic institutions in Blantyre, funded by MIMCom and managed by KTH [Blomberg].
- Obtained access to ESCOM Fibre for academic networking for three years to connect the campuses in Blantyre, Lilongwe and Mzuzu. Project planning for this project is in progress.
- Contributed to the discussion about an Internet Exchange point to be established in Blantyre.

- Support of the Regulator, MACRA, for academic fibre connectivity, including licenses if needed.
- Close relationship with the Ministry of Information, Science and Technology, both at PS and Ministerial level.

7.3.1 Institutions for tertiary level education and research

Malawi has the following institutions of tertiary education and research:

University of Malawi	
Bunda College of Agriculture,	Bunda
Chancellor College, Zomba	Zomba
College of Medicine with Queen Elizabeth Hospital (teaching hospital)	Blantyre
- Mangochi District Hospital Research Center	Mangochi
- Wellcome Trust Malaria research center	Blantyre
- Apple Study Project (Wellcome Trust) for Malaria research	Blantyre
- Malaria Alert Center/Blantyre Malaria Project	Blantyre
- John Hopkins University Malaria Project	Blantyre
Kamuzu College of Nursing, Lilongwe and Blantyre	Blantyre and Lilongwe
Polytrechnic,	Blantyre
Mzuzu University	Mzuzu
Malawi College of Accountancy	Blantyre and Lilongwe
Malawi College of Health Sciences	Blantyre and Lilongwe
National College of Information Technology	Blantyre and Lilongwe
Livingstonia University	Livingstonia

University of Malawi, Bunda College of Agriculture

Established in 1966, one campus only, 40 km from Lilongwe in rural area, with two rural hospitals and one secondary school nearby. 110 Faculty, 622 Undergraduate, 40 Post graduate. Education profile: Agriculture, Development Studies, Environment, Forestry, Food Science, Agricultural Policy Research Unit, Several Post Graduate Programmes

Fibre campus backbone, MALICO VSAT funded partly by World Bank Drought Recovery Project140 connected out of 250 computers, Until 2003, leased line via SDNP but slowed by 14.4 kb/s at local telephone exchange. Then SDNP radio link – better but inadequate – infrastructure for radio link still in place, then MALICO VSAT 256 kb/s down and 128 kb/s up

University of Malawi, Chancellor College and University Office, Zomba

Established in 1965. Located in Zomba, 65 km north of Blantyre in the mountains. Escom fibre will not come through Zomba. Many related institutions: Forestry Research, Geological Survey, National Statistical Office, 20 km north, National Aquaculture Centre, Teacher Training College (Degree granting), Educational Research Centre.

Approximate numbers: 300 Faculty, 2500 Undergraduate, 300 Post graduate. Programmes include Computer Science, Science (inc Physics) Law, Education, Humanities, Social Sciences plus 3 Research Centres. Several Post Graduate Programmes e.g. Law, Economics, Education, Industrial Chemistry, Biology . Was Zomba node of SDNP

Vice Chancellor and University Management located at University Office 2 km from Chancellor College. Fibre campus backbone but bandwidth management presents a problem. MALICO VSAT for connectivity, 512 kb/s down and 128 kb/s up

University of Malawi, College of Medicine, Blantyre

Established around 1986. Also research centre and student placement at Mangochi District Hospital on the Lake about 150 km away. 50 Faculty, 280 Undergraduate, 25 Post graduate Blantyre, Education profile: Medicine, Dentistry, Radiography, Public Health. The hospital also have associated research centres/projects in separate buildings on campus. MALICO VSAT for connectivity, 512 kb/s down and 128 kb/s up

University of Malawi, Kamuzu College of Nursing, Lilongwe

Established 1978. Main campus in Lilongwe and a smaller campus at Blantyre. 77 Faculty, 331 Undergraduate, 0 Post graduate Education profile: Nursing, Nursing education, Midwifery, Continuing education, HIV/AIDS awareness training

Lilongwe campus hosts SDNP Lilongwe VSAT, 110 connected computers out of 130 connected via 64 kb/s link from SDNP VSAT on Lilongwe site, campus wide network. Blantyre campus has a radio link from College of Medicine although possibility to connect to MIMCOM fibre to College of Medicine

University of Malawi, Polytechnic

Established in Blantyre in 1966. 589 Faculty, 2635 Undergraduate students, 30 Post graduate students. Education: Engineering – civil, mechanical, electrical, business studies, architecture, management, environmental health. Education and Media Studies Hosts SDNP Blantyre node VSAT. Approximately 150 out of 270 computers connected to Internet via 128 kb/s SDNP VSAT connection

Mzuzu University

A relatively new Public University with one single campus 350 km north of Lilongwe. Established 1999. 200 Faculty, 800 Undergraduate Students, 30 Post graduate students. Education: adult and health education, ICT, Library Science and Media. 100 out of 250 computers connected to the Internet via MALICO VSAT 256 kb/s down and 128 kb/s up.

7.4 MoRENet, in Mozambique

In Mozambique, VSAT is still the short term solution for universities in general but at some locations fibre is already an alternative, such as in Maputo and between Maputo and Beira. To stimulate the development, the MoRENet project has been established under the Ministry of Science and Technology. The focus is to create a national research and education network (NREN) connecting the academic institutions and research centres in Mozambique. The following institutions are considered:

Maputo	UEM	Universidad Eduardo Mondlane	www.uem.mz	Public
	ISPU	Instituto Superior Politécnico e Universitário	www.ispu.ac.mz	Private
	ISCTEM	Higher Institute of Sciences and Technology of Mozamique	www.isctem.com	Private
	ISUTC	Higher Institute of Transports and Communications	www.isutc.ac.mz	Private
	UP	Universidade Pedagógico	www.up.ac.mz	Public
	ISRI	Instituto Superior de Relações Internacionais	www.isri.ac.mz	Public
	ACIPOL	Academy of Police Sciences		Public
	UDM	Technical University of Mozambique	www.udm.ac.mz	Private
	USTM	Universidade Sao Tomas		Private
	UMMA	Universidade Maria Mãe da África		Private
	INE	National Institute of Statistics	www.ine.gov.mz	Public
Manhica	CISM	Manhica Malaria research center	www.manhica.org	Public
Beira	UC	Universidade Católica	www.ucm.ac.mz	Private
Beira	UP	Universidade Pedagógico	www.up.ac.mz	Public
Quelimane	ISPU	Instituto Superior Politécnico e Universitário	www.ispu.ac.mz	Private
Nampula	UC	Universidade Católica	www.ucm.ac.mz	Private
Nampula	UP	Universidade Pedagógico	www.up.ac.mz	Public
Nampula	UMBB	Universidade Mussa Bin Bique		Private
Pemba	UC	Universidade Católica	www.ucm.ac.mz	Private

7.5 Rwanda NREN

Kigali Science and Technology university (KIST). Research centers and Universities to be connected to the Rwanada NREN are listed below:

KIST	Kigali Science and Technology University	www.kist.ac.rw
NUR	National University of Rwanda	www.nur.ac.rw
KIE	Kigali Institute of Education	www.kie.ac.rw
	Adventist University of Central Africa	

ULK	Université Libre de Kigali	www.ulk.ac.rw
IRST	Institut de Recherche Scientifique et Technologique	www.irst.ac.rw
ISAR	Institute des Sciences Agronomiques du Rwanda	http://www.isar.cgiar.org
SFB	School of Finance and Banking	http://www.sfb.ac.rw
ISAE	Institut Superieur d'Agriculture et d'Elevage	

KIST is the first public technological university in Rwanda. KIST and NUR have fibre campus backbones of more than 4 km each providing local users with high speed connection within the campuses.

7.6 TENET/SANREN, South Africa

TENET, Tertiary Education Network (www.tenet.ac.za) is the de-facto South African REN. It is controlled by Higher Education South Africa (HESA), the association of vice-chancellors of South African universities. TENET may become, or be subsumed within or replaced by the South African National Research Network, SANReN, which the South African Department of Science and Technology intends to establish.

TENET is a non-profit association founded in August 2000 jointly by the then Committee of Technikon Principals and the SA Universities Vice-Chancellors' Association which bodies have since merged to form Higher Education South Africa. The number of members participating in TENET is currently 42, including 25 para-statal academic institutions and several major research institutions, but also the University of Swaziland and the National University of Lesotho. The complete list of members is available at the website.

TENET's main purpose is to secure ICT services for the benefit of its members, including

- Management of contracts with service providers
- Ancilliary operational functions in support of service delivery
- Provision of other value-added services in support of the higher educational sector in South Africa.

Due to the regulatory situation an NREN, owned by the universities, operating its own fibre infrastructure is not possible. Like all ISPs, it could operate its own switches and routers and have its own peering and transit arrangements with other networks, but would have to buy the underlying transport services from Telkom.

The existing NREN, TENET, is rather a procurement consortium buying Internet access services from Telkom, currently being the only licensed operator actually providing services. The Second Network Operator (SNO) has been licensed and is expected to start providing services mid-2006. The Internet access services are bought from TELKOM, the sole provider of network services in SA until 2006-07-31 when the Second Network Operator (SNO) starts to operate. TENET has a contract with TELKOM as the preferred provider until 2007-12-31 but can select another operator unless TELKOM matches any competitive bid.

The TENET network provides International connectivity via bandwidth on the SAT-3 Submarine cable and makes use of TELKOM's international peering arrangements in London, Amsterdam, New York and Ashburn, Virginia, as well as of TELKOM's backup arrangements via the SAFE cable between SA and Malaysia. The SAT-3 connection also offers a provisional connection to Geant, the European Commission's Research Inter-connect Network, via a GRE tunnel to the Géant PoP in London.

7.7 TENET, Tanzania

The Tanzania Education Network, TENET, was agreed in principle already in 2002. There is, however still no funding available for the interconnection of the universities, TENET is meant to link all the higher education and research institutions, some 30, into one Virtual Private Network to ease access to international Internet bandwidth but also to ensure economies of scale and to have a bigger negotiation capacity for bandwidth costs through a common forum. TENET will ensure that it is easier for universities to communicate with each other through such technologies as VOIP (Voice on Internet Protocol). There are a number of such cross-cutting projects that are vital to Tanzanian post-secondary education institutions if they are provided the necessary forum to identify and prioritize their joint needs.

7.8 RENU, Uganda

In January 2006, the Vice Chancellors and Chief Executives of nine Research Organisations signed the MoU that will lead to the establishment of the Research and Education Network for Uganda (RENU) as a legal entity. The RENU MoU was signed by the universities below. Other Universities are invited to subscribe to the open MoU.

Gulu University

Joint Clinical Research Center

Kyambogo University

Makerere University

Makerere University Business School
Mbarara University
National Agricultural Research Organisation
Uganda Christian University
Uganda Matyrs University

Signatories of the RENU MoU

7.9 ZAMREN, Zambia

The NREN Task Force in Zambia is still in a formative stage. The discussion includes discussions about ownership and organization, content and services and technical issues regarding network establishment and operation. The latter includes the following parts:

7.9.1 Lusaka and Kitwe Gigabit Academic Network

This phase will involve the creation of fibre network that will connect all colleges and research institutions in Lusaka with the University of Zambia as a hub and the same in Kitwe with Copperbelt University as hub.

UNZA	University of Zambia, Great East Road Campus	www.unza.zm
ZCAS	Zambia Centre for Accountacy Studies	
NIPA	National Institute for Public Administration	
HONE	Evelyn Hone College	
ZIBC	Zambia Insurance Business College Trust	www.zibc.ac.zm
ZAMIM	Zambia Institute of Management	
	Institue of Economic and Social Research	
NRDC	National Resources for Development College	
ZABMAC	Zambia Business Management and Accountancy Centre	
ZARI	Mount Makulu Research Station	
	Chalimbana Teachers Training College	
	Chaima College of Health Science	
UNZA	University of Zambia, Ridgeway Campus	
COOP	Cooperative College	
	Greenwood Institute	
	Lusaka Vacational Training Centre(ex LUSAKA TRADES)	
UTH	UTH School of Nursing and Midwivery	
ZASTI	Zambia Air Services Training Institute	
	National Scientic Research Station	
ZAF	Pilot and Ground Training School	
DEFENCE	Staff College	
UTH	The University Teaching Hospital	

Institutions in Lusaka

CBU	Copperbelt University, Riverside Campus	www.cbu.edu.zm
KT	Kitwe Trades	
KTC	Kitwe Teachers Training College	
COSETCO	Copperbelt Secondary School Teacher's Training College	
ZIBSIP		
CBU	Copperbelt University, Mwekela College of Forestry	

Institutions in Kitwe

	Northern Technical College	
	ZAMTEL Training School	
	Theological College of Central Africa	

Institutions in Ndola

Alternatives for interconnecting the institutions in Ndola to the Kitwe hub are being discussed.

7.9.2 ZAMREN

The Academic fibre networks within Cities are in this phase interconnected to form Zambia Research and Education Network, ZAMREN. The interconnection will use the fibre network being deployed by ZESCO from Lusaka to Kitwe while on the Kitwe side, the CEC fibre will be used. This entails starting discussions with ZESCO and CEC, on leasing the fibre from them. The complete ZAMREN will be formed upon connecting these City Academic networks and should be targeted for completion by 2008.

7.9.3 ZAMREN Connection with RREN

The next phase will involve trans-border connectivity to other National Research and Education Networks in the neighboring countries. The University of Zambia can be connected to The University of Namibia or The University of Zimbabwe and later on be connected to any university in Tanzania once Zambia-Tanzania Interconnector and EASSY project is finished. The Copperbelt University may be connected to the University of Lubumbashi, using CEC fibre network. In this phase ZAMREN will be connected to Ubuntunet leading to the rest of the world.

8 Regional backbone alternatives connecting SSA internally and to the world

The role of the regional backbone is to facilitate

- trans-border academic peering in Africa.
- global academic peering via Géant, Internet2, Eumednet, TEIN, ALICE, etc
- consortial procurement of Internet access for all NRENs

The alternatives envisaged include both submarine and terrestrial optical cables.

SAT-3 is established and already used by TENET in SA. Future discussions based on connecting to SAT-3 will mainly involve price issues and transit for other countries through SA.

The general discussion on backbone capacity for Eastern Africa has involved several alternative proposals of two different types: a submarine cable alternative similar to SAT-3 along the east coast and a terrestrial fibre alternative, mainly along power lines, to create an entirely terrestrial grid.

The advantage of a terrestrialgrid is that it connects a lot of population centres where traffic could be inserted and extracted

8.1 SAT3-WASC/SAFE

This is today the only fibre optic system connecting SSA to the rest of the world by fibre. The cable system has two halves that operators can arrange redundancy by. A structural problem is of cause that the two ends are in different continents which demands further arrangements to connect India with Europe.

The system, that connects several but not all states on the Africa west coast, has been in operation since 2003 and is controlled by a consortium of operators that enjoyed monopoly status at the time of installation. The expectation that SAT-3 would drive down connectivity prices Africa – Europe to a level similar to US – Europe has not been met. Instead, there is a growing concern that the system is enjoying a more than healthy high price level. Back of the envelope calculations suggest that the USD 600 million investment has already paid for itself, despite just 3 years into operation of its 15 to 20 year life.

Regulatory concern, not least in South Africa, has been growing as the relative importance of access to international connectivity on reasonable terms has been identified as a key factor to drive the market development, creating a level playing field in markets that have not yet fully rebalanced their tariffs, nor worked out reasonable interconnect agreements. It is of cause fully understandable that the operators enjoying control and ownership of SAT-3 do not want to let go of this asset providing them with a competitive advantage that could be leveraged into dominance of the local access market even as this becomes exposed to competitive pressure. An indication of this importance is the fact that one Nigerian operator, Globacom, decided to build a cable system of its own from Lagos to the UK as they were denied equal access to SAT-3. Later, as the Nigerian government decided to break out the Nitel stake in EASSy and declaring it an asset to be commonly used by all operators, there was strong employee protests claiming that the government was crippling the company, denying it the right to successfully develop after a privatisation. Comments from financial analysts and potential investors also indicated a substantial loss of value in the remaining operation. This is a clear indication of the relative value of controlling the asset. The SAT-3 part of the system has been upgraded once from 20 Gb/s to 40 Gb/s, suggesting that at least part of the route is full up to the 20 Gb/s level. Other data suggest a lower utilisation factor, but as traffic growth is a pretty safe bet, the creation of significant excess capacity could also have a deterrent impact on potential investors of a competing cable. The business mechanics in fibre optic cables is

clear: A large, upfront investment and low, if any, incremental capacity costs. The upgrade of SAT-3 to twice the capacity did only cost less than 5 percent of the initial investment and carries no added operational costs. It fact it could be argued that it delayed future maintenance. It is anyway clear that the SAT-3 owners enjoy a first mover position, reinforcing their dominant position domestically in other segments of the industry.

Figure 20: Map out of a study commissioned by NEPAD to assess alternatives 2004

The alternative, VSAT based capacity, is still more costly to use in a high volume, urban scenario where terrestrial cable networks are available. It is also associated with a signal delay. SAT-3 capacity is therefore priced higher to charge for this better quality. For the kind of capacity universities will ultimately need to participate in projects in a global context fibre is the only choice.

8.2 EASSy

EASSy has its main future value as an insurance policy preventing any single country to act as a gate-keeper in a more fully developed East African terrestrial network. The collapsed ring structure in the technical design enables the cable system to work even when loosing one landing station. The short term value is of course to provide the very first high speed terrestrial links between East Africa and the rest of the world. The capacity in the system will be far more than needed short term. Other links in the chain are simply not at all sufficient to saturate the cable for many years, even after massive development. Once landed, the issue will be the backhaul from the landing stations and the conditions for access to these, as well as capacity in the cable.

The main focus for the consortium has so far been on creating a traditional “one country, one operator” situation with only old incumbents as partners in a business model essentially based upon a large number of half-circuits

connecting each and everyone to everyone else and also to other external parties available in the end points. This has probably been seen as a way forward to reach a level of minimum financial commitments to fully finance the initial roll-out as well as maintenance and operations the first years.

The project has attracted growing and significant support over the last years as other competing terrestrial projects have run into implementation difficulties or simply become too limited regarded as separate projects. EASSy will, on a stand alone basis, avoid or solve a lot of the problems stopping other projects. It is now a main project for NEPAD support. Donors, external investors and others have also shown a growing interest. Many, like the WBG, would like to help fund it. However, this is where the first differences begin to show. Like in any joint venture there are tensions between players with different sized financial commitments and needs. In this case, however, there are also the tensions between those that are inside the consortium and those that are so far excluded. When initiated, the members were required to have a licence to exchange international telecommunication traffic. The exclusivity rights made it easy to define the members. As the project did not materialise until recently, many markets have now opened up, at least in theory. Licensing procedures seems to be delaying the situation for many new players anyway. Some new entrants have, however, been let in through the door the last year, even if the consortium seems to have been very reluctant to allow more players in. All kinds of reasons, like the consortium being impossible to control and govern, have been provided to justify this. The majority of these arguments are recognised from other debates elsewhere as dominant players are exposed to demands of a level playing field.

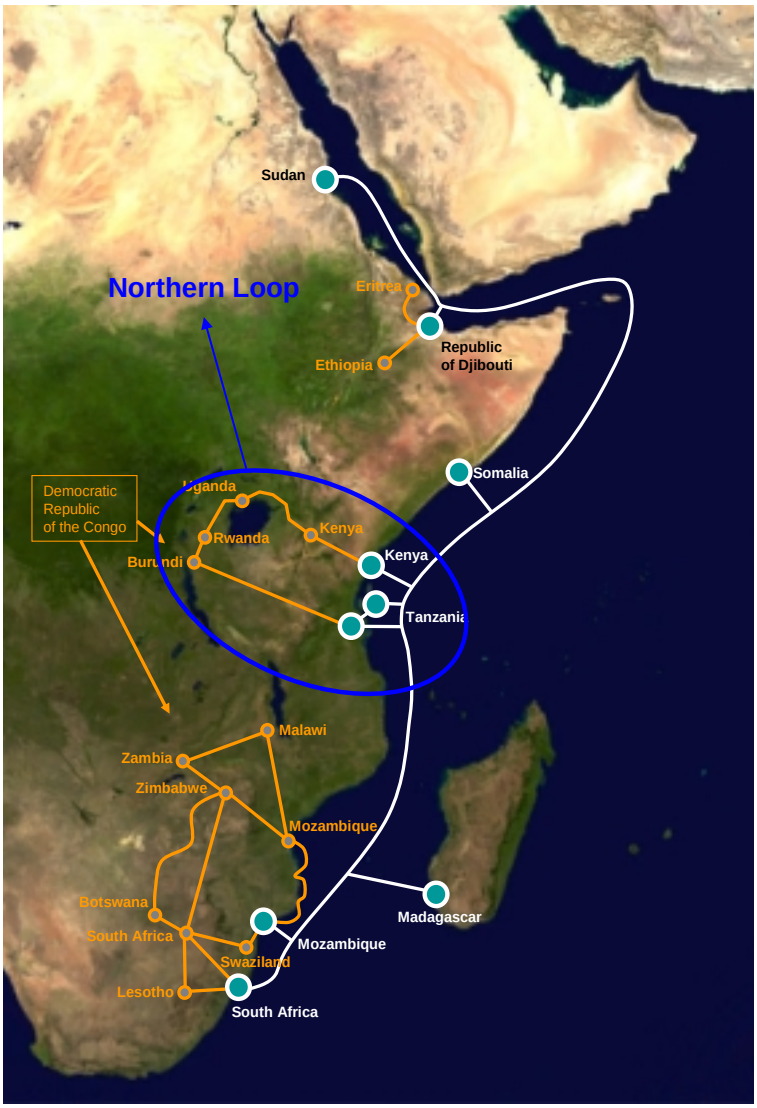

Figure 21 The East African Submarine System and the access loops to landlocked countries (From WBG Regional Communications Infrastructure Program, Briefing note, September 1, 2005)

Other operators, just now legalised to establish international traffic, find this very offensive. Regulators realise that they will be facing a coming problem and have advocated a more open and inclusive regime, even if it has been unclear on what grounds they would be demanding such a position. Policy makers have not until lately come to realise the implications for general development of a closed club and have so far just made general

statements asking for Open Access. The consortium seems to realise that they, at least superficially, must respond to this and have modified a number of positions. The first was the pricing model that gave bigger players a significant volume discount of up to 75 percent, now this seems to be down to 25 percent. They also express that new players "would later be able to have Open Access" to the cable even if they will not have equal status or any say on governance issues. "Pricing will of cause reflect the needs the initial investors have to make a profit out of their investments, their risk in being the early investors in the project". The price discussed for a future participant was a couple of months ago 700 percent of what the initial investors would pay.

In this we find a contradiction: On one hand the consortium wants to describe the project as risky demanding significant returns, on the other it wants to prevent others from entering to just share this risk. Obviously the risk is considered negative, what we have is an early mover advantage that needs to be protected by those enjoying it.

The focus has for obvious reasons been on the conditions for getting the core asset in place, the sub marine cable from South Africa to Sudan. Until last year or so the question of terrestrial connections to landlocked countries was in the backwater of all "wet" problems. This is clearly indicated by the different routes that have been indicated on various maps. The map below is from a late WBG report outlining the current proposal. The report is concerned over the lack of response in the consortium for an internal structure and governance model in the consortium, more in sync with today's and not least tomorrow's more dynamic market with many actors. There have been considerable indications that donors in various forms would like to share the risk in EASSy in exchange for a real and true Open Access regime. So far this request has been flatly rejected by the current consortium.

The conditions and circumstances for the links to the landlocked countries are not yet entirely as clear as the sub marine cable system. Several of these terrestrial links are using fibre in power lines built not with private money but in most cases directly by donor financed projects. The fact that these fibres would be used in the telecom market under or supporting non-level playing field conditions is of cause a violation of the basic conditions under which this support was provided. Unfortunately, there are indications that this risk into a different sector is not fully recognised by the parties, not power companies, nor donors and their advisers.

The various maps developed over the years also indicate the uncertainty in finding the right parties to connect to in making this a part of the global structure. It also indicates the obvious dependency that a cable system like this has in relation to other cables. The natural thing is to try to reach end-points, nodes, with lots of traffic and interconnect possibilities, as you become dependent on the conditions there. In this respect EASSy or rather its users have another problem: What will be the conditions coming from the EASSy endpoints to major global nodes? The mutual dependency of SAT-3 and EASSy as redundant routes to Europe for Africa becomes clear, but EASSy needs to find a partner from its northern end in Sudan to Europe too. How this will be done is unclear, even if some obvious cables between Europe to India lands in Port Sudan and Djibouti.

The EASSy cable may have initially been planned for telephony, which available studies indicate, but the future use will pretty soon be dominated by IP-packets coming from an array of Internet applications of which voice is just one. Co-locating national Internet Exchange Points with the landing stations of EASSy, or at least nearby, will be an important way to drive the national markets.

The concept of limiting the number of players may be seen as a traditional tool out of the toolbox marked "How to delay competition". What is complicating things is that operators may not even look the way they did previously, and even more so the fact that users may want to do-it-yourself, asking for access to capacity and network elements deep inside of what traditional operators consider their own structure.

NRENs and their international backbone counterparts are a good example of this. When approaching the EASSy consortium to buy capacity in the same order of magnitude, and one the same terms, as any of the small members, the reaction is more surprise and irritation. Or as one key officer of the consortium expressed lately: "Why are they just not buying (retail) service from us on a national level?"

In other parts of the world, the NREN buy wavelengths to build private networks for extreme academic needs in national, regional and intercontinental cables. To participate as an equal partner, the African academic community will have the same needs. This will require terrestrial fibre alternatives capable of providing wavelength division multiplexing.

8.3 Terrestrial fibre alternatives

To establish their networks and connect to the regional backbone, the NRENs will immediately need to consider leasing fibre on the national level as there will be cases where the fibre provider will not be interested in investing in the equipment necessary to provide data links. The NRENs will also very soon adopt applications that require much more bandwidth than EASSy can offer without a costly upgrade. This makes access to terrestrial fibre interesting for them also for long-haul. Terrestrial fibre connections are of course also an alternative and/or backup solution for EASSy.

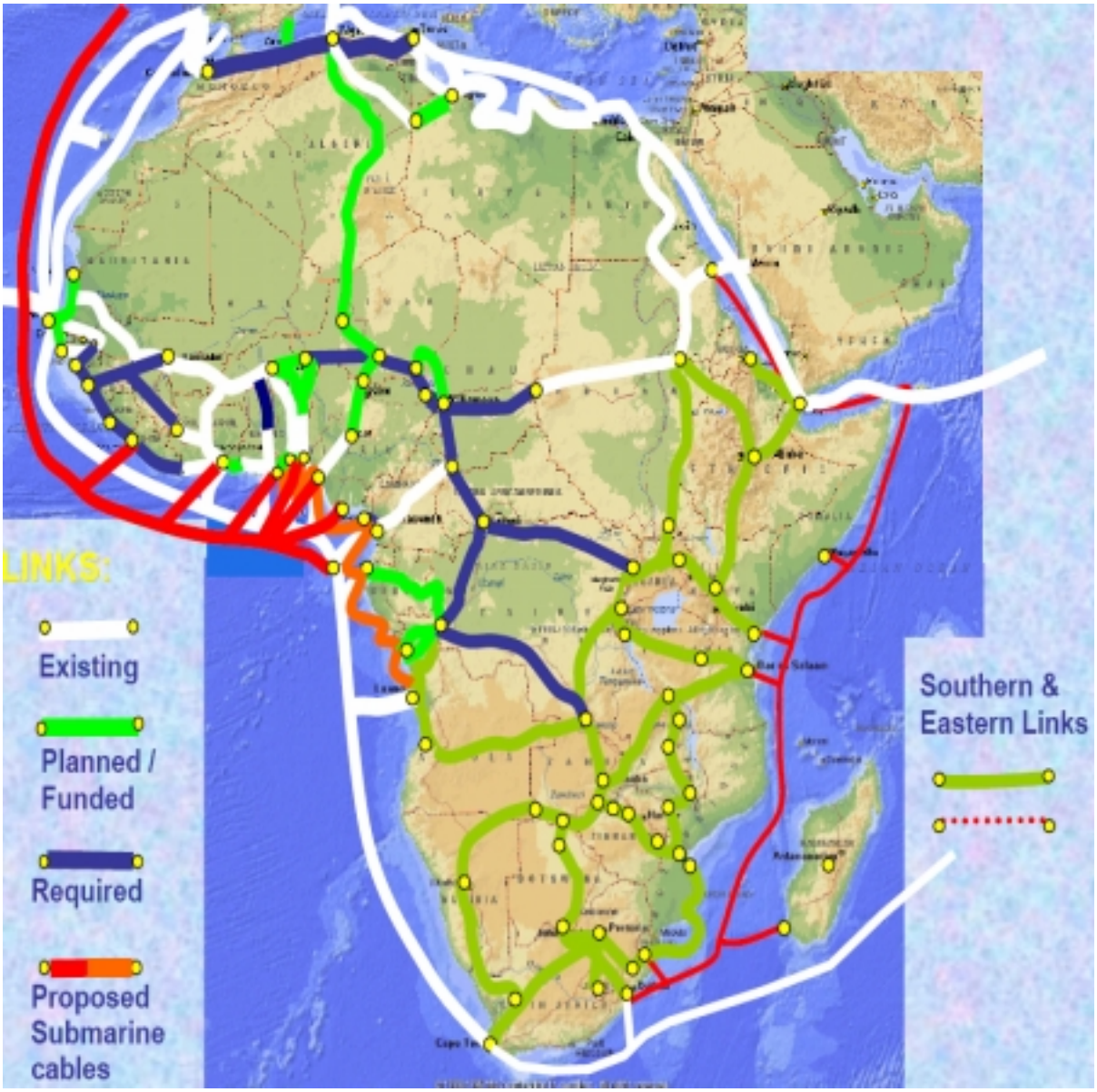

Figure 22: NEPAD plans presented at the Workshop on African University Networks, Geneva Sep 2005

There are a number of proposals for how to integrate the bits and pieces of fibre being deployed in on-going development programmes. Some of them are still unfunded. Others are suffering from regulatory or operational problems making them less of an asset on the open market. Some are too short, dislocated or just too expensive.

As can be seen in the figure above, there is an abundance of projects extending the African fibre grid, including

- Egypt (Cairo) – Sudan (Juba) exists. Extensions in various directions are being discussed. Together with SKEL below, it could connect to initiatives that lead all the way to Southern Africa.
- Comtel, Com7 and others than have been discussed for a long time. Bits and pieces exist.
- SKEL, a proposal to connect southern Sudan to Uganda/Kenya, in connection with the railway
- Zambia -Tanzania Interconnect, which is decided on the Zambian side but not yet the Tanzanian.
- Algiers-Abuja pipeline, highway and optical fibre [NEPAD2004]
- The Caurisnet proposal [Caurisnet]

Possible terrestrial connections between Sub-Saharan Africa and the Mediterranean region include combinations of the above. One example of a proposed structure some elements already exist, most notably for the Ubuntunet, Juba – Cairo.

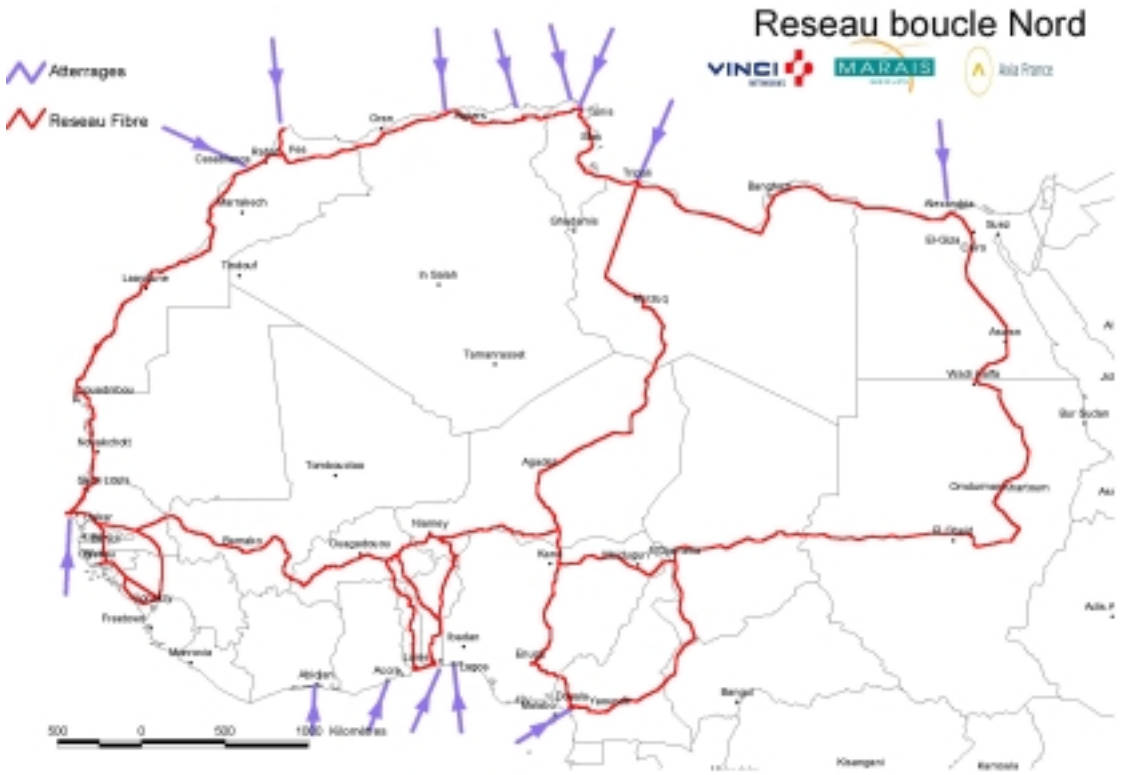

Figure 23 The Caurisnet

Along the Mediterranean coast on the African side, the EUMEDNET is present and a Pan Arab University Network is under way [PanArabUREN]. In the feasibility study it is concluded that there is dark fibre available all the way illustrated in the map below, except for 1000 km through Libya. This is an example of Ubuntunet-like networks in other parts of Africa.

Figure 24: The projected Pan Arab University Network fibre

9 Conclusions

The main findings during the study in this report are

1. The telecommunication policies and regulatory environments are reasonably open regarding private academic networks and international traffic in most countries involved in the study, with the most notable exception of South Africa. Most of the countries are in a transition from a parastatal monopoly to an open competitive market and support the idea of licensing private academic networks for universities. South Africa, however, is in a transition between a monopoly and a duopoly and there seems currently to be no opening for a private academic network license, let alone allowing trans-border traffic.
2. It turns out there is fibre available in Africa, and more fibre is being rolled out as we speak, in power grid extension programmes, along pipelines and in other infrastructure projects. Although establishing NRENs connecting most of the major universities by 2008 will not be impossible due to lack of fibre, there are, however challenges involved in getting to it:

- The fibre is not everywhere and/or not always possible to use due to restrictions in telecom policy and regulations, such as in South Africa.
- Low volume/high pricing business models used by most incumbents often make terrestrial connections even more expensive than satellite links.
- Lack of business models for leasing dark fibre, which can be expected to become increasingly available from power utility companies.

3. Major universities, their regional organisations, especially SARUA, and governments support the idea of National Research and Education Networks connecting all tertiary level universities and research institutes. All the involved countries either already have an NREN organisation or are in the process of organizing one and developing plans for establishing a network. The issue of regional interconnection, as in the proposed Ubuntunet Alliance, seems also to be non-controversial, at least in those countries where we have had the opportunity to discuss the matter at the government level.
4. The situation provides unique opportunities for universities, Ubuntunet Alliance and NRENs to contribute to a dynamic development of society, not only in the education area but in all sectors. Universities offer a neutral and non-commercial meeting place where even competitors can participate in pre-competitive development. By inviting all stakeholders for time-limited development cooperation, say three years during the period 2006-2009, for a give and take learning period, the development could take of immediately. Besides the universities themselves, the group of stakeholder could involve fibre owners, operators, content developers, users in all sectors of society, regulators and policy makers, as well as financial organisations and donors.
5. The Ubuntunet Alliance, empowered by the NRENs and backed by the universities and their regional organisations, is the only possible champion currently identified that could establish common interests in an EASSy consortium to balance the disparate commercial interests between different sized operators. This Ubuntunet Alliance influence could also simplify relations with external stakeholders representing societal interests, such as regulators. The big advantage that NRENs have in this context is that they will not compete with commercial operators. Ubuntunet Alliance as a member of EASSy will facilitate this role of NRENs to the benefit of the greater structure and balancing tensions between operators with different commercial interests.

The conclusions are obviously very positive. If a few key stakeholders cooperate and synchronize with the development of the EASSy project and its access loops to landlocked countries, the goal, to provide African universities with network access on a similar level as their peers on other continents, will be reached.

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11 Glossary of Terms

AAU Association of African Universities (www.aau.org)

AVU African Virtual University (www.avu.org)

Broadband, as opposed to Narrowband, is in this context defined as enough bandwidth not to be a delimiting factor for service provision

CRDI Centre Recherches pour le Développement International

DWDM Dense Wavelength Division Multiplexing

HDPE High density polyethylene pipe

ICT Information and Communication Technologies

IDRC International Development Research Centre (www.idrc.ca)

IUCEA Inter-University Council of East Africa (www.iucea.org)

KTH Kungliga Tekniska Högskolan, the Royal Institute of Technology in Stockholm, Sweden (www.kth.se/en/)

Narrowband, as opposed to Broadband, is in this context defined as a bandwidth which is a delimiting factor for provision of all services for which there is a demand

NEPAD The New Partnership for Africa´s Development (www.nepad.org)

NREN National Research and Education Network, a private network for tertiary level education and research in a country, connecting public and non-profit private universities and research institutes to eachother and the the Internet

PTT Public Telegraph and Telephone Administration

RITA Rwanda IT Authority

SADC Southern African Development Community (www.sadc.int)

SARUA Southern Africa Regional Universities Association

SDH Synchronous Digital Hierarchy

SONGAS

SSA Sub-Saharan Afica

TANESCO Tanzania Electricity Supply Company

TAZARA Tazania - Zambia Railway Company (www.tazara.co.tz)

TENET Tertiary Education Network, the de facto NREN In South Africa (www.tenet.ac.za)

TRC Tanzania Railway Company

TTCL Tanzania Telephone Company, the former Tanzanian PTT (www.ttcl.co.tz)

UEM Unversidad Eduardo Mondlane, Maputo, Mozambique (www.uem.mz)

WBI World Bank Institute member of the World Bank Group

WSIS World Summit on the Information Society

WTO World Trade Organization