Feasibility Study for AfricaConnect

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Abstract

FEAST is a one-year feasibility study for the joint AU-EU AfricaConnect Initiative commissioned by EC to explore the feasibility of deploying a regional backbone connecting dedicated National Research and Education Networks (NRENs) to each other and to similar resources on other continents. The feasibility is judged by the NREN readiness, avail-ability of a terrestrial infrastructure, the political and regulatory endorsement and commercial conditions for access to necessary resources.

The main finding is that the primary bottleneck is the readiness of the NREN communities. Less than one third of the 53 African states have communities that are reasonably ready. Another third has some awareness but still work to do to get ready. From more than one third there was no response to our requests for contact. The research and education network communities are de facto organised in three subregions, North, Eastern and Southern, and West and Central Africa.

Contrary to general expectations, availability of infrastructure in terms of optical fibre is not a bottleneck . Most universities are located where optical fibre cables are already deployed or will shortly become deployed. Policy and regulation is mostly in principle permissive, but the awareness of the importance of NRENs and their needs is too low and the regulatory frameworks often under-developed or poorly enforced, leading to lengthy implementation processes. Affordable access to links is an obstacle in the implementation.

The markets for broadband links are with few exceptions not yet competitive and the operators need time and push to transform from high price-low volume to low price-high volume business models. Incentives provided by the policy makers and regulators to drive the transformation would be very useful. The neutral research and educat-ion networks can play important roles in this process, just as on other continents.

Our conclusion is that five to ten African NRENs could be connected in a first phase during 2010 . Our recommendation is to proceed to connect as many as possible in the AfricaConnect initiative, spend an effort on selected applications that can demonstrate immediate benefits motivating further investments, and support capacity building for a next phase.

1. Introduction

This paper reports on the findings of the Feasibility study for AfricaConnect [FEAST] commissioned by the European Commission and a fact finding study commissioned by the Association of African Universities [AAU]. The research leading up to the findings has been conducted via physical visits, workshops and email discussions involving policy makers, regulators, communication operators, infrastructure owners as well as faculty members, students and research and education network communities in about 30 African countries. Many of the contacts come from long-standing institutional and individual cooperation in the areas of research and education.

With few exceptions, African universities lack access to the same resources for research and education as their peers on other continents. This is simply due to the fact that they are not connected to the global research and higher education network infrastructure consisting of dedicated high capacity regional networks.

The consequence is that research and higher educa-tion requiring such access can currently not be conducted in Africa. Since such activities constitute a significant part of the global research and higher education, Africa is not well represented in the global research community.

This is not just a matter of improving the connectivity to Internet in general. Transit to the public Internet is not enough. An equally important bottleneck is the lack of direct peering with other research and higher education networks. This bottleneck can be removed only by creating dedicated National Research and Education Networks (NRENs) connecting research and tertiary level education institutions in each African country to a Regional Research and Education Network (RREN) interconnected to the peer infrastructures on other continents.

At the same price as African universities currently pay for VSAT transit links to Internet only, with low bandwidth and high delay, universities on other continents get dedicated networks with up to 10 000 times higher bandwidth, much lower delay and **both** transit to Internet in general via commercial transit **and** peering with the dedicated networks established by the global research and higher education community.

2. Readiness of the research and higher education communities

The establishment of a research and education network infrastructure in Africa similar to what universities on other continents have access to, will require a transition from satellite links to terrestrial networks. This transition is not trivial. It will require extensive cooperation between institutions, substantial capacity building of human resources as well as investments in facilities, such as campus networks, access networks, national and regional backbone networks connecting to intercontinental links.

The FEAST method to assess the readiness concurs with regionally developed models [Greaves]. The first prerequisite is that there is an awareness and demand from the research and higher education institutions and national as well as (sub)regional organisations having the capacity to meet this demand. The main parameters used to judge the awareness and readiness are discussed below

2.1 User needs and requirements

During our interviews with policy makers and regulators, we have sometimes met a lack of understanding of the needs of the research and higher education communities beyond a bit faster email and web access to the general Internet.

We have emphasized that the needs are national, not only individual or institutional. Access to dedicated high performance research and education is necessary if the nation wants their research and higher education institutions to be able to fulfil their missions. It has been shown in other parts of the world that growth in the deployment of the Internet is mirrored in an increase in economic development of the nation.

Failing to provide such resources will make the institutions fall behind, incapable of participating in most international research areas and cause frustration leading to brain drain.

The FEAST study has identified a few Lighthouse Demonstrators providing examples of end-user applications that are just waiting for better connectivity and could start operating as soon as the institution at which the researchers are located get connected to their NREN connected to a regional network connected to the world.

Such applications are important in order to demonstrate immediate success of the investment made so that the investors are willing to provide the necessary funding to connect more ready NRENs.

Two such examples are

1. The Malawi-Liverpool Wellcome Trust Malaria Genome project at the University of Malawi College of Medicine in Blantyre could immediately start sending the data collected from DNA samples of persons with Malaria for analysis by their partners in Liverpool via the network rather than via hard disks

. They will even be able to do the analysis on-line and speed up the research cycle substantially.

2. The High Performance Liquid Chromatograph (HPLC) laboratories set up at Makerere University in Kampala and MUHAS in Dar es Salaam in cooperation with Karolinska Institute in Stockholm can be used to find faked drugs and monitor drug concentration in the blood stream of the patient under treatment. The laboratories would become more efficient if connected to each other to facilitate cooperation on interpretation of measurements, and to the technical maintainers to reduce travelling costs.

The ERINA4Africa project is gathering more examples like this and the eIAfrica project is spreading awareness of the importance of e-infrastructures like these to policy makers.

2.2 Campus networks and services

The ultimate purpose of research and education networks is to provide services to students and faculty members empowering them to do research, teach and learn on advanced levels. The establishment of an appropriate infrastructure to accomplish this requires an institutional awareness and leadership.

The quality of campus networks and connections between NREN members are consequently both important readiness parameters. This is a matter of awareness and dedication of the institutional leadership.

2.3 NREN readiness

On the national level, there needs to be an NREN organisation recognized by the research and higher education institutions in the country.

The organisation and its plans should be endorsed by the relevant policy making ministries and regulators. The organisation needs to be properly staffed to handle both administrative and technical matters and to have the capacity to negotiate connectivity deals on behalf of their members. The human resources need to include directors, a business administrator and system and network administrators.

2.4 Subregional organisations

The development of research and education networks in Africa is de facto divided in three subregions:

1. The North African states are participating in the EUMEDConnect project [EUMEDConnect] since 2001. The establishment of a sub-regional network owned by the states in the North-African sub-region is being discussed but has not yet happened.

2. In Eastern and Southern Africa, the Ubuntunet Alliance was formed in 2005 [Ubuntunet]. The Alliance now has ten full members and a few more

pending members. Discussions are in progress between the Ubuntunet Alliance and DANTE to prepare for cooperation on regional connectivity and capacity building in the AfricaConnect initiative.

3.The ECOWAS and CEMAC member states in Western and Central Africa are about to formalize the WACREN community[OA2009].

The regional networks are necessary to manage the complexity of the global infrastructure and to facilitate peering agreements keeping regional traffic regional within the continent.

2.5 Acceptable Use Policies

In order to promote proper use of resources and not to be perceived as commercial operators, the regional and national research and education networks need to publish Acceptable Use Policies (AUP) and Connection Policy (CP) stating that the purpose of the network is to serve non-profit research and higher education institutions and nothing else. The policies need to be enforced by excluding violators, for several reasons: One reason is to make a clear statement that NRENs are not competitors on the commercial communication market; Commercial conditions for leased network capacity routinely demand this if NRENs and RRENs are going to be in the forefront of the transformation to a high volume - low unit price market also in Africa; Another reason is that the policies of similar networks in the rest of the world need to be mirrored . The publication of an AUP and CP is thus one of the prime prerequisites.

2.6 Assigned numbers

In order to design dedicated IP-networks, there is a need for provider independent assigned numbers including IP-address space, both IPv4 and IPv6, and AS-numbers. In Africa such numbers are provided via AfriNIC. Normally they are handed out on an institutional level. There is a need for national and regional coordination to avoid fragmentation and to optimize routing table sizes. To accommodate this, there is an agreement to delegate number series to NRENs as Local Internet Registries (LIR).

The implementation of this process of providing assigned numbers has been terribly slow. Due to the potential delays involved in each step, the status of the applications for assigned numbers for the regional national and institutional networks is another key readiness parameter.

2.7 Network Design

The next step towards an operational network is a network design and procurement documents for links and network elements. The existence of such plans is an important sign of readiness.

2.8 Political endorsement

The concept of dedicated research and education networks developed in the form of a bottom up user driven cooperative process is at times unexpected and its potential poorly understood by ministries of research, higher education and communication. The culture is often top down, in particular where a competitive communication market has not yet developed. All stakeholders need to be brought into the picture.

The concept of research and higher education institutions being customers wanting to lease links and establish dedicated networks with more capacity than until recently was more than the whole country were using, can lead to confusion. Not least persons in and around the incumbent telecommunication operator are confused looking at this as competition as they would very much like to sell fractions of the capacity to universities at elevated value-added prices.

Endorsement and required permits/licenses from the national regulator are informally no doubt influenced by this. Formally, in the cases where the regulator is clear over its role and has a reasonable legal framework, this is less of a problem as long as the RENs are non-commercial, serve a closed user group of research and higher education institutions and lease dark fibre or capacity between nodes from licensed operators rather than deploy owned physical infrastructure. In most cases, NRENs would not be likely to deploy wire-line infrastructure outside campus areas [TERENA].

2.9 Access to infrastructure

Operators are normally not equipped to immediately meet the demand of NRENs that want to get access to resources on the same level as their peers on other continents. However, the rapid transformation envisioned by operators as they get exposed to the changes provided by international fibre links and national backbone loops creates less of a problem with this group if solutions to manage the transformation to high volume low price state are helped by positive actions with the NRENs. A challenge they face is to accept and embrace the idea that universities will not be the residential type of individual customer of managed bandwidth that they may have hoped for.

The availability of affordable leased lines and modern relevant ICT supply chains are likely to develop at the same pace as a Telecom policy supporting sharing of infrastructure and competition on services. Commercial funds in combination with soft loans to deploy backbones reaching most cities with key universities, seem to be increasingly committed also in less dynamic Telecom markets. The major remaining problem of affordable access seems to be backbones to more remote university towns and the local access there.

3. Infrastructure

3.1 Campus networks

Starting from the end-users, the transition from a satellite-based infrastructure to a terrestrial network is a challenge in many ways. In order to benefit from substantially higher capacity and direct access to academic peers via dedicated networks, former VSAT gateway owners have to pool resources with neighbours and hand over full control of their own, but narrow and expensive Internet connection provided by a commercial operator on another continent, to a local IT-department.

From an infrastructure point of view, the deployment of campus networks is mainly an awareness challenge since they do not involve Right of Way issues. The main requirement is a dedicated institutional leadership that sets aside the necessary budget for infrastructure, servers, clients accessible for users and an adequately staffed ICT service. The passive infrastructure should be optical single mode fibre cabling between optical distribution frames (ODF) in wiring closets in each building on campus and twisted pair cabling to outlets at all locations where the network should be accessible via wired and/or wireless access points. The passive infrastructure may involve switches and routers with future-proof Gigabit Ethernet (10/100/1000 Mbps) ports

A majority of the institutions we have been talking to have deployed or are in the processing of deploying such networks, although you could often wish they had more powerful computers available for end-users.

The campus network has to include a network operation centre supporting performance and security monitoring. trouble shooting and active enforcement of the Acceptable Use Policy [bwmo].

3.2 Local access links

Continuing upstream from the NREN member institutions to the NREN hub(s) the local access networks constitute the most severe bottleneck.

Surprisingly few of the larger cities, where there are many research and higher education institutions, have a metropolitan area network in which the institutions can lease dark fibre or affordable broadband capacity. This is, in many countries, now the main bottleneck.

As an example, the incumbent in Tanzania, TTCL, say they have too little fibre in their metropolitan area network to lease dark fibre and as a consequence charge astronomical prices for capacity to cross a street. The institutions initially therefore plan to use wireless links to connect their campuses to the NREN.

In Maputo, there is at least some competition, since both the incumbent Telecom operator and the para-statal power utility company have fibre to lease in the city and the institutions are discussing the establishment of Maputo Gigabit Network connecting them.

Several of the incumbent operators have a poor end-user base, often just a few percent of the user base of the mobile phone companies. If the latter become full service houses, a road they have embarked upon, the incumbent operators will be even more subject to competition in the backbone business and servicing broadband to major commercial users. The traditional wired telephone (POTS) business will be hard to protect and will likely fade away. ADSL will be under strong competitive pressure from mobile broadband 3G and HSDPA installed by GSM operators, LTE is just around the corner and WiMAX will be an alternative from other providers.

The relative scale advantages of the wireless operators over the former incumbent operator with its sparse wire-line footprint, combined with environmental factors like population demography, purchasing power and use habits, will most certainly create sets of surprisingly different market dynamics in African markets.

The Cable-TV networks are small and virtually non-existent as viable competitors outside the more affluent areas in the capital. They will likely try to maximise their leverage of any existing plant by introducing DOCSIS3 as it comes down the learning curve, but the numbers will likely be small.

However, all of the various new and legacy networks will increasingly deploy or rent, if available, optical fibre based capacity in their “middle mile” sections of the local network. In this respect they will not differ from the strategies deployed elsewhere in the world. There will be a combination of distance and capacity factors driving the fibre further out in the various networks. We will, just as in more developed markets, need fiber to each neigbourhood (FTTN). The question is just at what rate and what the most influential factor will be.

Fibre to major mobile phone base station sites are already a business planning reality, also in Africa, even if implementation is held back not of financial but more Right of Way and legal reasons.

3.3 National links

Before summarising our survey of national fibre backbones, we discuss the market development in general.

General development of the fibre market

Initially, access to the new infrastructure will be granted in and immediately around the capital city and perhaps a few other major commercial centres. This needs immediately to be complemented with national backbone links to all district centres in the country and, maybe in a second phase, to all towns.

The expansion could be looked upon as a step by step refinement of a hierarchical network structure between the points reached by international cross border links all the way down to the local access network. For illustration purposes it could be useful to look at it as a two layer structure even if it could take other forms. The initial coarse grid will very likely be connecting all the major district centres just due to the fact that they are district centres; concentrations of commercial and administrative centres and the obvious immediate commercial base for any new demanding communication services.

There is also an important link to the electrification programs in the countries already at this level. The district centres are the first ones to be reached or upgraded by electrical power high voltage trans-mission lines requiring optical fibres built into the grid just to control the electrical transmission system. There is unfortunately a little understood and appreciated intersection between the power and communication industries. The cost of adding more fibre strands than the few pairs needed for the control system to the optical fibre core of the grounding wire, is marginal. This is by far the most simple, fast and cost effective way of making any fibre backbone available. The marginal added cost are two orders of magnitude lower than most other alternatives: In the order of USD 200 per km for a fibre pair to USD 10000-30000 for a standalone optical fibre cable.

As electrification of Africa will increasingly mean gridification of all major towns there is a strong correlation between these two activities. Anyone who has the control over the spare fibres in the power grid will have a profound influence in the National Telecom Backbone market.

However, we can notice some confusion in making this asset available from the side of the power companies. First of all, they have in several cases been prevented from at all making it available by the legal systems in the form of counter-productive licensing restrictions set up to protect the incumbent telecommunication operator at all costs. Secondly, most power company executives have had little or no appreciation for the dynamics in the telecommunications industry. As an example, they have not recognised the price elasticity as the bandwidth market turns from scarcity to abundance. This is not an African problem but was equally visible in the US and Europe as these markets opened up an fibre was introduced.

Given the Right-of-Way advantage of the power companies, most countries would likely do best in recognising the position of the power companies as being associated with all the necessary characteristics needing sector regulation: Levering a monopoly position into a different sector and having a cost base far below all alternatives are reasons enough.

Nevertheless, there are a number of ongoing projects trenching cable outside the power industry, both from incumbent telecommunication operators and new players, mobile phone operators as well as metro broadband providers. These projects have a high relevance regardless of the fibres in the power grid. There are obviously timing and footprint issues, but first and foremost control issues. With an exploding demand being foreseen, none of these companies can bet their future on a partly whimsical and unpredictable process regarding fibre being available or not in the power grids on a reasonable, fair and timely manner

There is thus, going to be a number of players that would build their own buried fibre backbone links. Some will partner with competitors to get a lower cost base, some will go alone to later sell to others. There will no doubt be a number of cost sharing mechanisms increasingly adopted as players realise that the backbone transport market swings from scarcity to abundance and that this is just a non-differentiating input in their value creation to be acquired at as low cost as possible.

There are a number of different government interventions possible in the backbone development process. The obvious one is the traditional protection of the vested interests in the old, often defunct PTT, now often partly privatised, but with a clear financial interest from government anyhow.

This is the next structural battlefield after international submarine cable connectivity and initial cross border capacity turns scarcity to abundance on that level.

Survey of available national fibre backbones

In several countries there are national optical fibre backbone networks deployed, being deployed or planned, in some countries even more than one. Several countries are supported by The World Bank in this endeavour, via their Regional Communication Infrastructure Program [RCIP] and/or their Science Technology and Higher Education Program [STHEP]. Many countries have different sorts of agreements with China involving deployment of fibre and active equipment.

Arab League countries

Of the Mediterranean countries, Morocco, Algeria, Tunisia and Egypt have reasonably developed communication infrastructures and operational NRENs, all participating in the EU-funded EUMEDCONNECT project. The development in Libya and Mauritania are behind and slow. Sudan and Ethiopia both have monopolistic incumbents deploying fibre backbones with a reasonable coverage. Djibouti is small and well connected via many sea cables. Eritrea is not active and Somalia suffers from security problems although there are plans to connect at least Somaliland and Puntland via fibre to Djibouti. A branching point of SEACOM is laying idle waiting on the sea floor.

EAC countries

In East Africa, Kenya and Rwanda are probably the most developed in Africa with three independent actors each and already operational backbones. In Kenya there is Kenya Telecom, Kenya Data Networks (KDN) and the Government of Kenya who is deploying a national open access infrastructure. In Rwanda, there is the former incumbent, Rwandatel, MTN and the government of Rwanda via Rwanda IT Authority (RITA) including infrastructure deployed by the power utility company Electrogaz. In both these countries the NRENs are fully endorsed and actively supported by their governments and regulators.

The Government of Tanzania has been discussing a national backbone for many years based on pulling together fibre deployed in several different infra-structures, such as the power-lines, gas and water distribution pipelines and railways, but it has not yet materialized. The regulatory framework is open but the mobile operators that want to pull their own fibre have a hard time getting Rights of Way.

The backbone of Uganda is planned but only partly available. Burundi is behind but work is in progress.

SADC countries

In Malawi, the incumbent, MTL, is very active but there is little competition. They are connected to SEACOM in Maputo and offer Internet connectivity at 1700 USD/Month, The incumbent in Mozambique, TDM, has fibre to the Malawi border. In Zambia there is operational fibre in the Zesco and CEC power-lines connected to South Africa via Namibia.

Zimbabwe has enough national fibre for an NREN but is still isolated.

Botswana, Namibia, Swaziland and Lesotho have the necessary fibre to establish their NRENs but are dominated both by own and South African incumbents. Angola and DRC still suffer from lack of infrastructure investments.

ECOWAS countries

In West Africa, there is both national and regional fibre to connect the key universities, at least in the countries where there is a reasonably ready research and education networking community. Cape Verde has a fibre infrastructure covering the islands. Senegal is struggling with the incumbent regarding international connectivity but the Government has deployed a national backbone connecting the major universities. Côte d'Ivoire also has fibre close to all key universities. Ghana has a National Communication Backbone Company (NCBC) with fibre reaching all univer-sities. Benin is well connected but lack endorsement and understanding for the need for a research and education network infrastructure. The situation is somewhat similar in Mali and Burkina Faso. Nigeria is probably on of the most competitive communication markets in Africa but has a scaling challenge connecting several hundreds of institutions. Niger has few universities and are connected to SAT-3 but suffer from the monopolistic market structure. The Gambia, Guinea, Guinea-Bissau, Liberia and Sierra Leone have no or little activity related to research and education networking.

CEMAC countries

Central Africa is still behind. The World Bank has, however, recently announced a major investment in the whole CEMAC region [WB2009].

The most developed of the six countries is Cameroon where there is an active ministry-controlled research and education networking activity. Optical fibre is being deployed but is dominated by the monopolistic incumbent, Camtel.

3.4 Regional

Cross border links are politically difficult to get established, the main reason being the gate-keeping policies giving landlocked countries little choice to connect but by accepting a toll from a neighbour. Access to SAT-3 from Namibia and Botswana over RSA has been a classical example.

In the emerging markets, however, the actor with the most connections and internal service and content market will win. Any attempt to gate-keep will prove to be counter-productive in the longer perspective.

The East African Back haul (EAB) is a good example of structures that have now emerged as a consequence of the submarine cables starting to operate on the east cost. Still, it is not yet in operation even if it could have made use of SEACOM and TEAMS as they came up and not wait for EASSy arriving 2010.

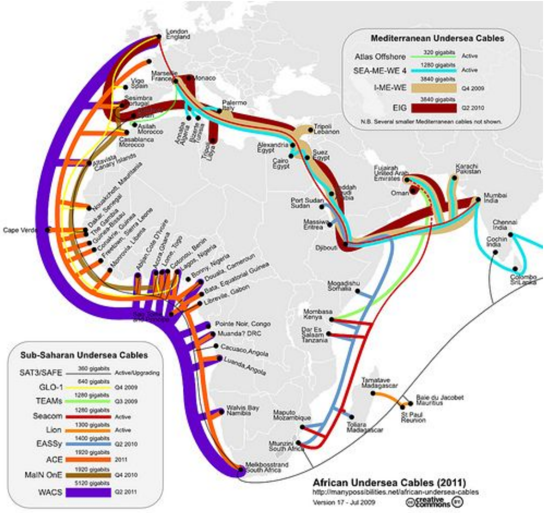
Some of the private operators have established metro rings which they now try to leverage by interconnect-ing in smaller scale national backbones that they try to stretch into neighbouring countries. KDN in Kenya is a good example of that, but it also happens in Nigeria with Suburban Telecom and of course the mobile phone companies now repositioning them-selves as cross border full service providers. MTN, Zain and Vodacom are all more or less into these is-sues, as is Orange in tying all its acquisitions and partner companies into its backbones, including re-gional submarine cables like LION.

Ultimately, there will be lots of terrestrial capacity also challenging quite a bit of the submarine cable capacity. The Cape to Cairo route envisioned by the 2005 collapsing Comtel project may be a reality in a different shape by 2015.

3.5 Intercontinental links

Several intercontinental submarine cables connecting Africa to other continents are planned and some are already operational.

The scarcity experienced until recently will soon be forgotten in major coastal cities. By the end of 2011 the situation is drastically different from early 2009. The bottleneck has moved from intercontinental connectivity to terrestrial back-haul backbones and access networks. Initially this creates some confusion since much of the rhetoric on elevated prices has conveniently but falsely been attributed to the cost of the inter-national segment. Prices are initially not coming down at the rates that could be expected.



The debate over the first submarine cable on the East coast will now be followed by a debate over what cables will complement the SAT3 cable on the African west coast. Also here we will during the next year or so see considerably more capacity coming on-line. The regulatory situation is, however, more complex and will still confuse the conditions on which this capacity will be made available in the market. One can assume that this will take another one or two years to sort out. Not least will the first East-West equatorial terrestrial cable cable influence the business dynamics of the region's telecommuncations market.

4 Policy and regulation

Policy making is in this context referring to the creation of new legislation while regulation refers to the formulation of the more detailed rules that are required in the implementation phase, as well as enforcement of the rules. There are primarily two areas of policy and regulation pertinent to research and education networks, Higher education and communication.

4.1 Research and Higher education

Policy in the area of research and higher education is normally managed by a dedicated minister of Higher education, Science and Technology, while regulation is managed by independent agencies for accreditation, quality control, research funding, etc.

One of the important awareness issues is whether the need for dedicated networks for research and higher education, or indeed the magnitude of connectivity discussed here, is fully recognised or more than marginally understood in all its consequential aspects.

It is not the case that this is understood in all countries that we have been looking into, on the contrary, it is in several cases a matter that needs to be brought onto the agenda. The quality of ICT usage in the administrations themselves is often an indication of the relative starting position for the debate.

4.2 Communication

Policy in the area of communication is normally managed by a ministry for communication, sometimes together with research and higher education. Regulation is managed by an independent regulatory agency with the role to arbitrate within and between the producers and consumers on the communication market considering the public good aspects of communication.

The important issues is whether it is de facto possible for the NRENs and their members to at least lease links from licensed infrastructure owners to deploy and operate own non-commercial dedicated networks and even get Rights-of-Way to deploy own optical fibre cables for that purpose if necessary.

Some NRENs, including KENET in Kenya and MAREN in Malawi, have licenses from CKK and MACRA respectively. MoRENet in Mozambique has a paper from the regulator INCM stating that they do not need a license to operate a dedicated non-commercial research and education network.

Even in countries where the regulatory environment formally allows this, it is not always possible to get all permits necessary to actually implement a research and education network.

5 Commercial conditions

There is an increasing number of countries that have operational national optical fibre backbones but very few of them can yet demonstrate competitive markets for broadband links. This is likely to change quite soon in those markets where the playing field is not tilted too much in favour to vested interests. The media debate is often but not always a good indicator on how far the vested interests can hold back change.

In markets where several operators complain over Right-of-Way issues you can anticipate enough commercial reason to venture into building metro rings and backbone spurs to and between the capital, the commercial hub of the country and the landing site of international submarine cables or border crossings.

Another indicator is the way the backbone fibre in the transmission network of the Electrical Power Company is commercialised, monopolised or in a more open way.

6. Recommendations

6.1 Connectivity

Our recommendation is to go ahead with the AfricaConnect initiative coordinated by DANTE, establish regional backbones based on fibre optic cables, connect them to GÉANT, which can provide peering with similar networks on other continents. A road-map for such an effort is being detailed in discussions between DANTE and Ubuntunet Alliance,

6.2 Applications

A few selected Lighthouse demonstrators, like the ones discussed above, should be supported as part of the connectivity and capacity building activities to demonstrate immediate benefits of the investments made.

6.3 Capacity building

When discussing capacity building, it is important to understand that the establishment of dedicated research and education networks will have an impact in all sectors of society. The students that get access to these networks will be accustomed to, able to exploit and require access to similar resources when they go into working life. Both public and private sector will need their competences and especially private sector will be able to pay better salaries and offer different challenges. The plans for capacity building need to take this into account. The experience from other markets is that system and network administrators, project managers and directors will be in high demand. The individuals will frequently move on and need to be replaced when moving on. There is thus a need both to reinforce the education of network engineers in general and for specific training related to the actual networks to be deployed.

Education

Few African institutions have engineering curricula on the BSc and MSc level specializing in communication networks and need stimulation to change this in order to meet the rapidly growing demand for this competence from all sectors of society as the new infrastructure becomes available. It should be considered in what form this stimulation can be provided. Ultimately capacity building will help reduce brain drain and the digital divide.

Training

The specific training necessary to make the AfricaConnect Initiative a success should be organised as part of the project itself. One of the forms for that training is the NREN twinning program coordinated by TERENA.

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