First Mile, First Inch

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Abstract: Access to Information and Communication Technologies (ICTs) remains one of the biggest challenges to Africa in leapfrogging the development chasm. The African digital divide can be in part attributed to a restrictive regulatory policy that entrenches the monopolistic power base of the local Telco. Innovation is a key driver for change and what is needed is a mindset that empowers communities at the local level to embrace technology and create community owned networks enabling and supporting local economic development. The regulatory environment should support innovation and provide for a "bottom up" approach to community owned networks. The aim of this paper is to give an interim report on a study of a multi-disciplinary series of projects in Sub-Saharan Africa exploring the technological and social consequences of innovative low-cost telecommunications.

Keywords: first mile, first inch, wireless technology, social research, user uptake, regulatory policy.

1. Introduction

Access to Information and Communication Technologies (ICTs) remains one of the biggest challenges to Africa in leapfrogging the development chasm. The African digital divide can be attributed to a number of factors including poor infrastructure, lack of skills, high telecommunication costs and restrictive regulatory policy that entrenches the monopolistic power base of the local Telco.

Many African countries are dominated by a single telecommunications provider and this monopoly has had the effect of denying people access to telecommunications particularly in rural areas. This is primarily due to two reasons; high cost of services and the fact that the "first mile" of the telecommunications infrastructure is the most expensive and least desirable for the Telco to manage and maintain.

Innovation is a key driver for change and what is needed is a mindset that empowers communities at the local level to embrace technology and create community owned networks enabling and supporting local economic development. The regulatory environment should support innovation and provide for a "bottom up" approach to community owned networks.

First Mile, First Inch (FMFI), funded by the Canadian IDRC, is a multi-disciplinary series of projects that seeks to innovate different ways of providing connectivity to the user (First Mile) and streamlining the interface between the user and the computer (First Inch). This will include a range of First mile technologies including WiFi, power line communications (PLCs) and mesh networks and Fist Inch technologies such as IVR, Voice messaging and HLT.

1. Objectives

The aim of this paper is to give an interim report on a study of a multi-disciplinary series of projects in Sub-Saharan Africa exploring the technological and social consequences of low-cost telecommunications implemented in remote schools, clinics, NGOs and telecentres. In addition to development and application, research teams are exploring how people interact with the new technologies and how their daily lives may be changed through such interaction.

In order to understand and assess the contribution to development made by the interventions created by this project, the following objectives were identified and a methodology called Outcome Mapping was used to plan, monitor and evaluate the programme.

- To develop innovative information and communication technology (ICT) technologies
- To implement "first mile" solutions
- Changed behaviour in the use of ICTs – how the use of ICTs has changed community life,
- Cost and benefits of solutions – to quantify what is meant by low cost connectivity,
- Scalability and replicability of technologies – the viability of rolling out the solution ,
- Influence on policy and regulation – demonstration of project benefits to the regulator.

2. Background

In most developing countries the telecommunications monopoly has inhibited the development and use of innovative technologies, and it has been proven in other parts of the world, such as Indonesia that innovation can create equal access to all.

This needs to be done through a change in mindset, one that suggests a different view of the way infrastructure is rolled out by putting the end user first. Research has shown that such an approach that focuses on the end user can create a bottom up momentum whereby communities are empowered and have a sense of ownership of their own communications infrastructure. Through the use of innovative ICTs and a "just do it" approach communities can create networks that in turn create new demand for ICTs on shoestring budgets. This is the philosophy of the First Mile First Inch (FMFI) project.

3. The project

This study is based on current and new work to support the use of ICTs in various communities in Southern Africa, in particular non governmental agency (NGO) networks, rural schools, primary health care facilities, and community telecentres in Angola, Mozambique, Namibia, Zimbabwe and the emerging under-serviced area license holders in South Africa.

It was a condition of selection for each of these projects that upstream connectivity i.e. the link between the local access provider and the internet or PSTN, already existed and the focus would be on how to provide broader access within the community.

In Angola, Namibia, Zimbabwe, Mozambique and South Africa, technical innovation coupled with social research is creating affordable and sustainable connectivity in rural communities. The main emphasis of the research is on "first mile" and "first inch" technologies, which departs significantly from the traditional "last mile" thinking. The project's title (First Mile First Inch) reflects its innovative approach.

The "First Mile" refers to connectivity between access devices and access providers but represents a more bottom-up analysis focusing on the end user. The rapid development in recent years of wireless technologies and open source applications show dramatic potential for this approach. The "First Inch" component of the project addresses the fact that it is often not enough to place technology in the hands of users and that technology must be adapted to the local environment in order to meet user needs.

The research demonstrates how the first mile in poorly served rural and marginalized communities can be bridged with WiFi and innovations like powerline communications as well as other off-the-shelf or DIY technologies. The first inch project leaders have developed voice and video applications, as well as open source software solutions to provide voice-based and local language scripts as appropriate interfaces with computers.

4. Technology Description

The definitions of “first mile” and “first inch” can be summarised as:
“First Mile” – the links between access devices and the local access providers.
“First Inch” – the applications and access devices operated by the end-user.

The Upstream Backbone is defined as the link between the local access provider and the rest of the internet or PSTN. The diagram below illustrates this conceptual model:

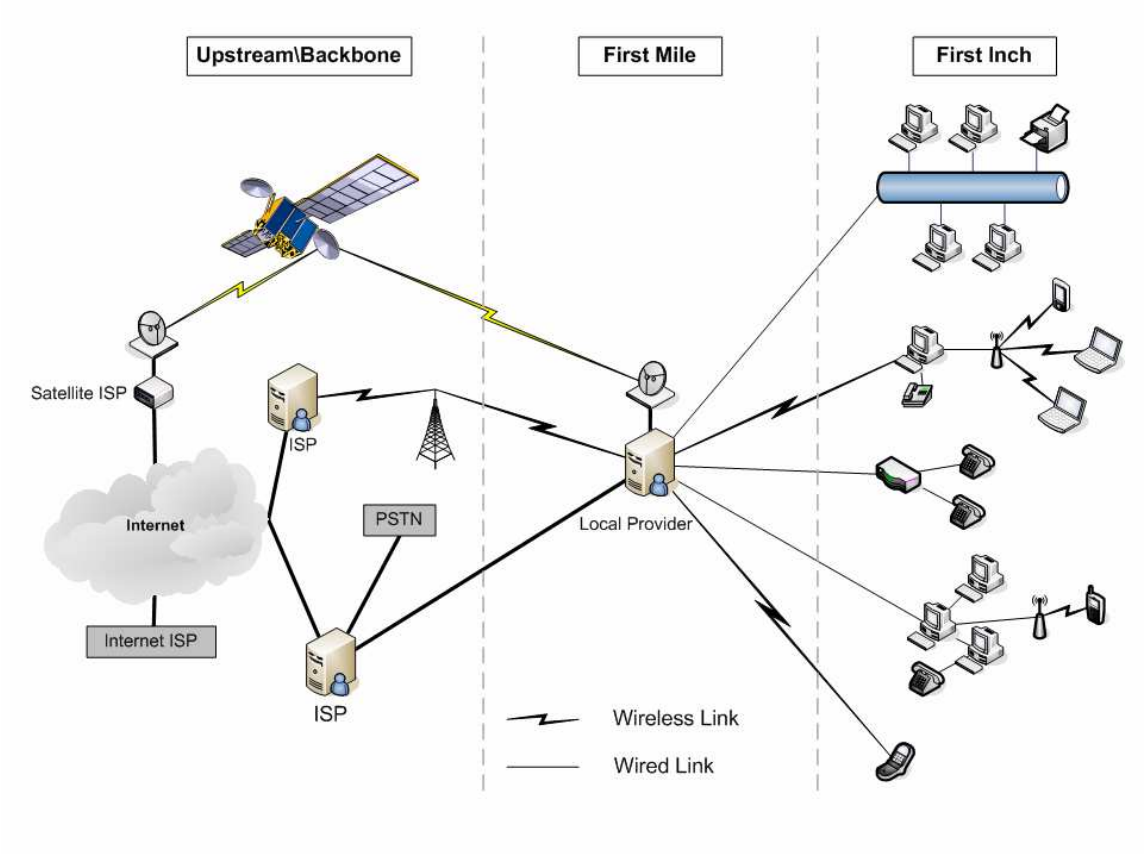

Figure 1: Model of the Connectivity Chain

The "first mile" comprises connectivity technologies such as WiFi, wired Ethernet, powerline technologies, bluetooth, narrowband HF/VHF/UHF and mesh networks employing any of these technologies.

The "first Inch" focus on access devices such as traditional PCs, recycled PCs, thin clients, handheld PDAs and cellular devices. The first Inch includes the applications running on these devices (open source software), starting with basic internet access and email, and embracing VoIP telephony, voice-mail, instant messaging or chat and more specialised applications and interfaces designed around the specific needs of the end-user.

5. Results and Lessons Learned

This project seeks to demonstrate how rural communities can overcome failures in regulatory policy by implementing innovative, low-cost connectivity solutions and applications in order to promote sustainable development. This is the viewpoint of the "FMFI project".

At the local level, FMFI focused on a variety of identified needs which was important in terms of creating the demand for ICTs. It has, for example, improved communication between doctors, health workers and clinic sisters in the Eastern Cape and Mpumalanga provinces of South Africa; given students in remote Mozambique villages access to curriculum for distance education and regular contact with their university tutors; and

provided Internet access through a wireless terrestrial connection to the war-affected town of Huambo in Angola.

The lessons learned are grouped under the following objectives:

- To develop innovative information and communication technology (ICT) technologies
- To implement "first mile" solutions
- Changed behaviour in the use of ICTs – how the use of ICTs has changed community life,
- Cost and benefits of solutions – to quantify what is meant by low cost connectivity,
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To develop innovative information and communication technology (ICT) technologies

It is vital to ensure that all the connectivity components, both backbone and first mile, are in place in order to be able to provide the end user with useful tools and applications.

In order to create access in deep rural, underserviced areas VSAT has commonly been used in combination with wirless (wifi) technology. This overcomes many of the infrastructure challenges such as no fixed line telecommunication networks. In support of the "just do it" philosophy of FMFI home-brew cantennas have been developed using a coffee tin in place of an expensive antenna.

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A further innovative use of wifi was the deployment and testing of mesh network in a rural context. By using community connection points structured as a mesh network, all the project participants are able to enjoy interconnectivity and access to communications and the Internet either directly or indirectly through applications running on the mesh.

Other innovations include the use of power line communications to transmit the internet signal into people's homes. A modem fixed to the plug-point in the home is connected through the power line grid to the municipal fibre optic network thereby creating broadband access.

To implement "first inch" solutions

A number of "first inch" applications have been developed that address the challenges of connectivity in remote rural areas.

In order to overcome the problem of constant power outages a "store and forward" technologies have been developed in the health domain. This provides semi-synchronous (synchronous when available, asynchronous when not with store and forward) text, voice & video exchange between the doctor and the sister when the network is down and even when the power is out.

Messages with images, videos, text and voice are automatically sent to the other party when the network connection is regained. This means that the sister can still create patient messages to send to the doctor and that the doctor can respond to these cases in an asynchronous manner, when he has the time.

The primary community-oriented goal was to prevent unnecessary travel by sick patients from the clinic to the hospital, as transportation in these poverty-stricken and geographically dispersed areas is difficult and expensive for the local inhabitants.

Changed behaviour in the use of ICTs – how the use of ICTs has changed community life

Development in the use of ICTs will be furthered by a better understanding of community cultures and languages and the interface between people and technology. A methodology called Outcome Mapping was used to monitor changes in behaviour of key users. The Tsilitwa, Eastern Cape telehealth project, for example, demonstrates how a rural clinic sister with no prior PC or typing skills can be trained in the use of ICTs for delivering healthcare in a rural community.

The clinic sister has been involved in the Telehealth project at Tsilitwa since its inception in 2002. Throughout our interaction with Sister Patricia there has been a steady development in her skills as a healthworker as well as her personal development. The sister is proficient in the use of the internet and e-mail. She knows how to use the digital camera and can e-mail images to specialists in East London. Sister Patricia has become a champion for rural telehealth, she has developed self-confidence illustrated by talking at conferences, motivating others, advocacy and training.

Cost and benefits of solutions – to quantify what is meant by low cost connectivity,

One of the main obstacles to universal access in Africa is the high cost of telecommunications. Costs vary across the continent and are largely dependent on the regulatory and policy framework within a particular country. Such frameworks, such as in Angola, Mozambique and South Africa, typically stifle competition and contribute to the high costs of telecommunications.

The connectivity in the Huambo telecentre, Angola is via VSAT with local distribution through WiFi and dial-up links. The telecentre in Huambo is the hub for the distribution and serves 8 wireless as well as 24 dial-up customers, covering government, NGO's, banks, business and educational institutions. The current cost for the satellite connection is $2250 per month. An attempt is being made to share the cost of the connectivity between the customers on a cost recovery basis.

The clinic in Peebles Valley, Mpumalanga, South Africa has always wanted cheaper connectivity, but its remote location precludes the supply of ADSL and other connectivity such as leased lines would be too expensive. The clinic's IT support company has just begun working on a community mesh in the town of White River, about 20km from the clinic. This has a number of benefits. It creates local skills in mesh networking thus eliminating the need for the project staff to maintain the system. It creates the opportunity to link White River to Peebles and thus share low-cost ADSL with the clinic and mesh, probably at no cost.

At the Catholic University, UCM, Pemba, Mozambique, the connectivity solution was a VSAT connection located at the Pemba Beach Hotel. This was discontinued as UCM could no longer afford the $5 000 per month satellite fee and needed to get their own VSAT

terminal with a cheaper link. The VSAT was installed and connected to a French provider for $750 per month. It has an uplink 256K and 1MB down. To limit costs, the shared bandwidth option was used, but it tends to slow down 11AM to 10 PM as other users come on line.

There is a wired ethernet network at UCM in Pemba, Mozambique two labs, desktop workstations and laptops. This is linked to an outward wireless connection to two schools with capped bandwidth. The schools are within the range of cantennas, but the commercial option was exercised. The potential to expand the network further exists and the cantenna option will then be considered for connections to NGO's and other users.

Scalability and replicability of technologies – the viability of rolling out the solution

A major developmental challenge is how to take the lessons learnt out of a pilot project in order to achieve scalability and replicability. Evidence of how this can be done successfully has been shown by the telecentre model developed in Angola, and by the distance education projects implemented by SchoolNet Mozambique.

The Angolan telecentre is running on a cost recovery basis and through the effective use of wifi has increased the reach of access to a broader cross-section of the community. The SchoolNet project in Mozambique has developed a provincial funding model whereby schools are clustered and served by a single internet access point. The Province pays for one internet cost shared amongst a number of schools. Support is rendered by a neighbouring telecentre who manage the network and provide services to the schools.

The opportunity exists in Mozambique to extend the model further for health so that a common communications platform is created linking schools clinics and telecentres. Infrastructure can be easily extended in remote areas using wifi attached to existing cellular towers.

Influence on policy and regulation – demonstration of project benefits to the regulator.

In light of the limited information and communications technology (ICT) coverage in rural Africa, rollout of WiFi networks provides great potential to stimulate further ICT connectivity. This is due to its relatively low costs, which enables community based, or bottom up, deployment. While at the national level social objectives inform ICT policy and regulation such as universal access strategies, the current regulatory framework in Southern Africa poses significant challenges to deployment of WiFi community networks.

A key objective of the FMFI is to use evidence-based research results to influence and inform policy in the telecommunications domain. In order to do this, it was first necessary to understand the regulatory framework in each country in order to know what needs to be influenced.

The FMFI projects have shown that unlicensed spectrum and the low-cost wireless technologies that operate on these bands are of enormous value to the developing world with poor telecommunications and Internet infrastructures. Moreover, license-exempt regulations should provide a friendly environment for entrepreneurship, reducing barriers to entry and the risk of regulatory capture. By lowering costs and reducing entry barriers,

unlicensed wireless potentially enables a larger and more diverse set of actors who can provide internet access [1].

There is significant diversity in the regulation of these bands across Africa. Not only do licensing requirements and conditions change widely from country to country, but so do power, range and service restrictions as well as equipment certification requirements. Indeed, we find that as the burden of licensing for transmission on these bands is relaxed, there is often an increase in restrictions on power, range, or type of service. Furthermore, we find that regulation is still not in place in some countries, e.g. Angola and is changing in others, South Africa, while enforcement is often low in countries where regulations do exist.

The significant diversity in regulations in the region inhibits economies of scale and may discourage large entrants. Furthermore, the lack of clarity and enforcement discourages innovation and small entrepreneurs. In order to address these concerns, we propose that the FMFI partners, working with regional economic communities and international players, work to harmonize spectrum regulations in the region and build personnel and enforcement capacity. These harmonized regulations should accommodate and encourage license-exempt transmission over the standard 2.4 and 5 GHz bands.

The variety of regulations within regions or continents discourage investment by regional operators as they impede economies of scale for equipment supply and service strategies, that depend on license restrictions (Galperin, 2005; Neto et al., 2005). Hence, de-licensing of WiFi deployment is recommended by these authors. Chetty, Blake, & McPhie (2006) second this finding for South Africa, and propose this to be done in combination with de-licensing of VoIP - the sending of voice over packet switched networks, which traditionally was the domain of Internet traffic, also known as Internet telephony – which could further increase the value of wireless networks. Their argument is based on the need for further opening up of the market, which will, as they argue, lead to new opportunities for business development in rural regions.

6. Conclusions

Innovation is the key to providing access to Information and Communication Technologies (ICTs) in Africa. This paper describes some of the technological innovations that have been implemented in a variety of projects but what is equally important is the innovation in thinking. This requires a change in mindset, one that takes the viewpoint of the end user and shapes regulatory policy that empowers communities, and allows them to build demand for ICTs through community owned networks.

Decision makers need to adopt regulatory policies that support community owned networks as opposed to protecting the commercial interests of a few. That is not to say there should be an open market for spectrum but rather a selected distribution for health, education and community development. Technology is not the problem - it is the regulatory environment that prevents Africa bridging the digital divide.

Equally as important in innovating new technology is understanding how people interact with these new technologies and how their daily lives may be changed through such interaction. This requires developing qualitative research methods in order to get behind user needs and truly understand the relationship between the user and technology.

All of these projects are being implemented in deep rural areas and under very difficult conditions. To say there has been immediate success would be premature as many of the technical challenges still need to be ironed out. This is the nature of implementing technology in rural environments. Ongoing research will continue to monitor the journey taken by each project partner and seek to understand the associated behavioural changes of project partners and their resulting influence on project outcomes.

Equally important outcomes are the creation and growth of new partnerships with government, private sector, international aid agencies and organizations involved in technology research and development, and the publishing of reference book for "first mile" and "first inch" implementation in a rural Africa context due mid-2007.

Further research is necessary if we are to fully understand the opportunities in using wireless technology and license-exempt bands in Africa in order to achieve socio-economic objectives. There is a need to develop appropriate policies and regulatory environments in order to achieve harmonisation in the region and on the African continent.

Some specific areas for future research include:

- Research the opportunity for allocating license-exempt bands for health, education and community access
- Develop case studies and "good practices" from projects on the continent
- Investigate business models and exploring innovative solutions in order to achieve scalability and sustainability

Creating access to the Information Society is the key challenge facing Africa. The cost of access including telecommunication costs, licensing regime, and international bandwidth costs need to be drastically reduced in order to increase African participation.

References

[1] Neto I, Best M, Gillet S, 2004, "License-exempt Wireless Policy: Results of an African Survey" MIT, Cambridge, Mass.

[2] Neto I. 2004 "Wireless Networks for the Developing World: The Regulation and Use of License-Exempt Radio Bands in Africa, MIT, Cambridge, Mass.

[3] Lehr W, Sirbu M, Gillet S, 2006, "Wireless is Changing the Policy Calculus for Municipal Broadband" forthcoming in Government Information Quarterly.