FIRST MILE FIRST INCH

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Lack of access to communications and information services remains a major obstacle to the economic and social development of the rural poor throughout the world — nowhere more so than in Africa.

Sadly, technological solutions that have proved effective in developed countries are often beyond the means of remote, scattered and poverty-stricken communities. Thus in South Africa, Telkom's ambitious rollout of communications infrastructure in rural areas has all but stalled with some 850 000 lines having been disconnected.

In the face of this reality, a collaborative project known as First Mile First Inch (FMFI) is working to identify and develop models and low-cost 'shoestring' technologies that will overcome such impediments to progress. Specifically, FMFI seeks to address the needs of rural communities by implementing low-cost, affordable technolo-

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Taken from the headman's house, this picture shows Lwandile Clinic in the valley, surrounded by the rural village. The village is very widespread, and has no town centre.

Innovation succeeds in delivering improved heath care to rural poor

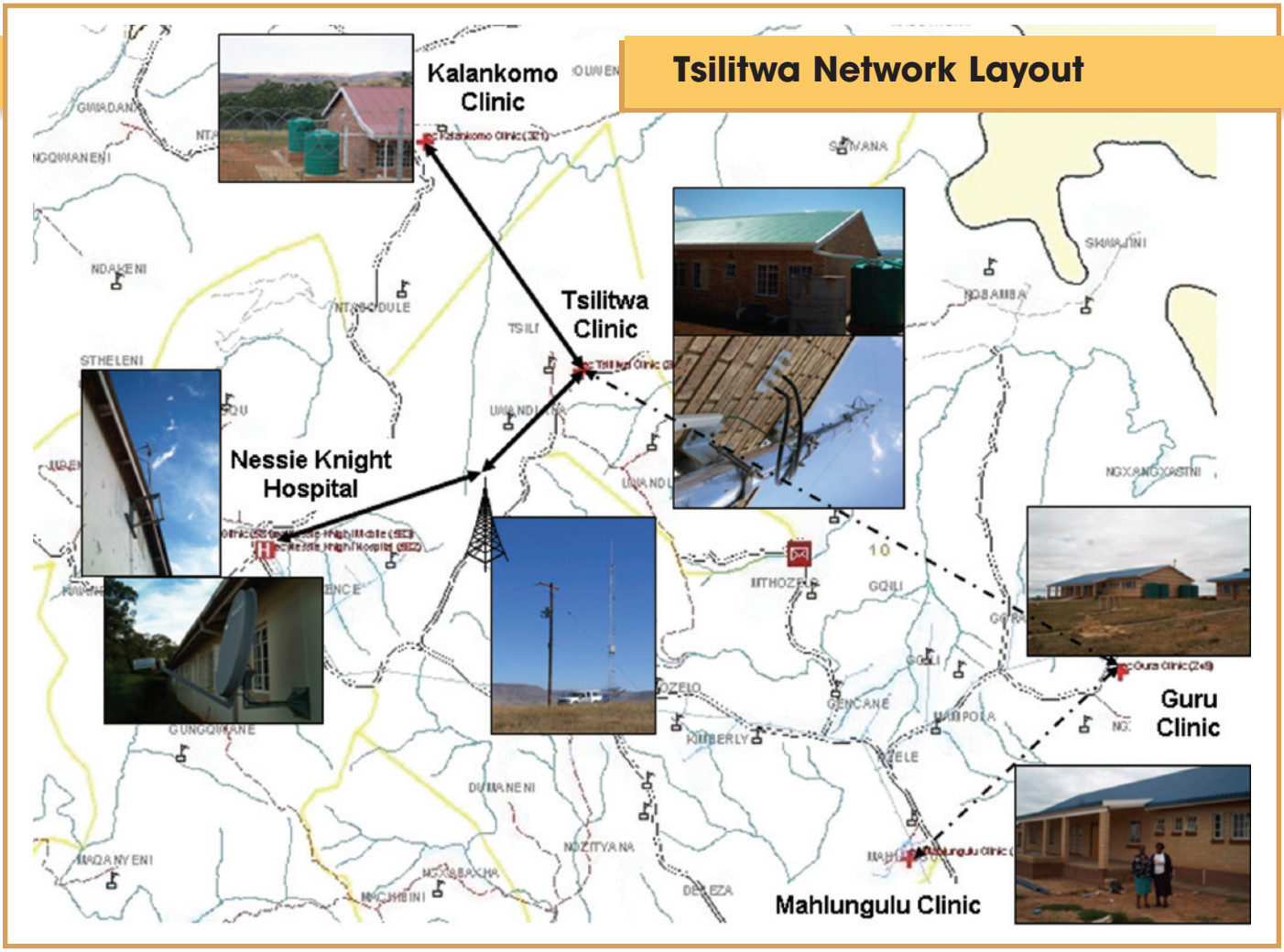
Disease follows inevitably in the wake of poverty. And because costly conventional technologies — and conventional wisdom — have failed to make the hoped-for impact on the lives of the rural poor, it is imperative that the potential for innovative low-cost solutions be fully explored and assessed.

Poverty and the rural remoteness of the Eastern Cape create a high dependency on public health services. Some 67% of the province's population lives in rural areas, where harsh weather, poor road and telecommunications infrastructure, and lack of public transport have a direct impact on the delivery of healthcare services. Conditions frequently make the referral of patients to institutions with more highly trained staff impossible, meaning that treatment in the community is the only available option.

As if these factors were not enough, the workload on healthcare staff is increasing as a result of the HIV/AIDS pandemic, with its concomitant requirement for specialised advice, consultation or second opinion.

An associated problem is that lack of access to training and continuing medical education severely limits health-worker development in rural areas, and this contributes to making work at rural health centres unattractive to

Tsilitwa Network Layout



healthcare workers, with a constant drain of these valuable professionals to urban centres.

Specialised care is scarce. There is only one dermatologist, two radiologists, two oncologists and one oral health specialists in the public service in the province.

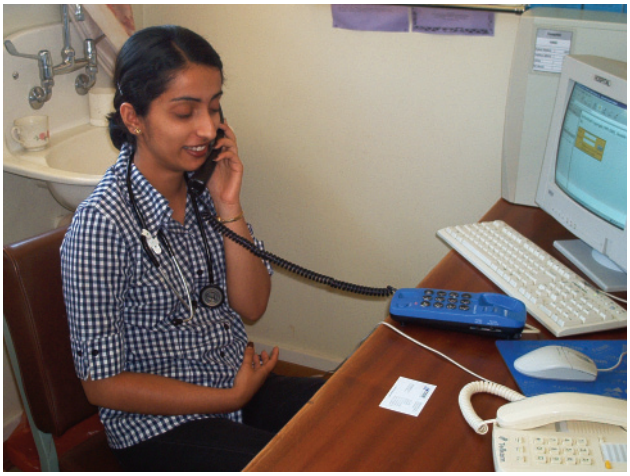
Despite all these drawbacks, two separate but related projects, the Meraka Telehealth Project and the UWC/UCT MUTI Telehealth Project, both located in South Africa's Eastern Cape Province, have demonstrated that innovative ICTs support cost-effective solutions that enhance healthcare among the rural poor.

Tsilitwa Telehealth Project

As part of the Department of Science & Technology's Innovation Fund project "ICTs in Support of Communities in Deep Rural Areas", a telehealth application was developed in Tsilitwa in 2001. The project involved the two communities of Tsilitwa and Sulenkama that are geographically separated by a hill, or kopje, preventing direct access between them, and requiring people to travel the 15km by a very poor dirt road where public transport is unreliable. The villages, some 100km north-west of Mthatha, are typical of the former Transkei area, having no electricity to homes, no running water and no telecommunications. The villages are spread out and inhabitants, who are mostly unemployed, number about 2000 in each village.

Community facilities in Tsilitwa included a prefabricated clinic and a technical school that, through the efforts of the headmaster, is electrified. The clinic ran on solar power until 2002, when it was electrified and a new clinic built in 2005.

ICTs are helping professional staff extend health service among Southern Africa's rural poor.



The village of Sulenkama had more infrastructure, boasting a 200-bed community hospital, the Nessie Knight, served by one doctor. The hospital had electricity (with generator back-up) and 3 DECT telephone lines. However, the telephones usually did not work and hospital personnel relied on personal cell phones to call Mthatha for an ambulance.

MUTI rural telehealth system

"Muti", the Xhosa word for medicine, has given its name to a research effort by computer scientists at the Universities of the Western Cape and Cape Town with additional collaboration from the University of Waikato, New Zealand, to provide a rural telehealth system for hospitals and clinics in a remote rural part of the Eastern Cape. Like the CSIR system, MUTI operates over a long-range WiFi network. Unlike the CSIR solution, MUTI operates in both real-time and store-and-forward modes to cope with (a) unreliable power supply, (b) extreme demands on healthcare professionals' schedules.

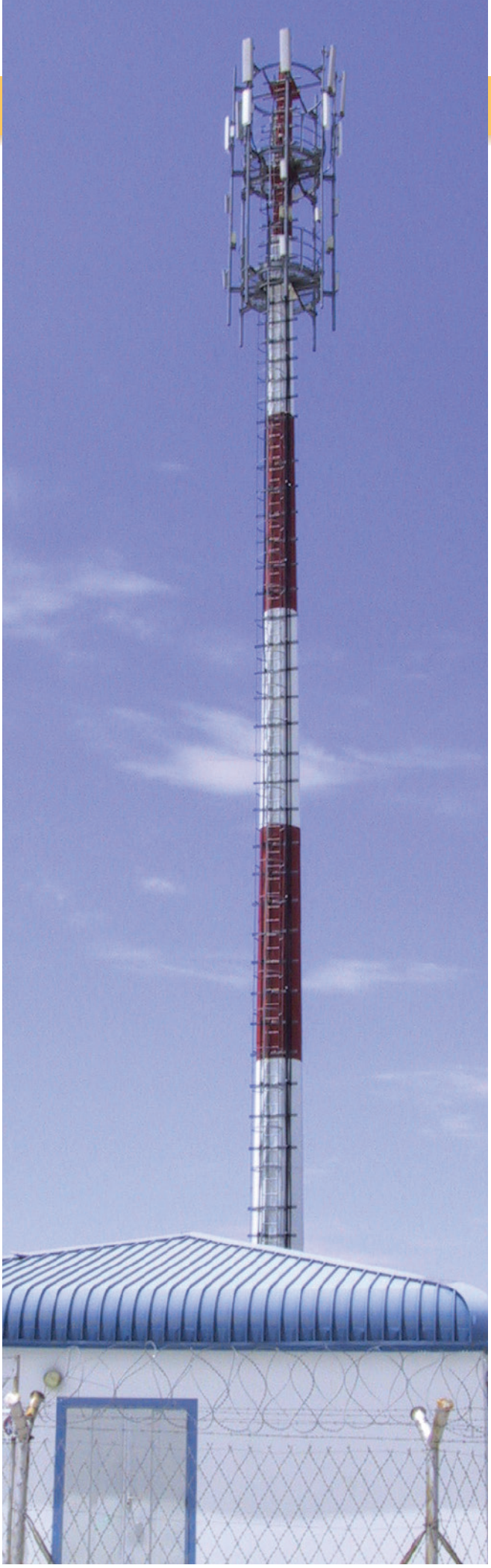
The project team has been iteratively evolving MUTI for more than four years. It enables nurses and doctors to use a wireless IP-based communication system to conduct patient referrals, request ambulance services, order supplies and generally keep in contact with one another. The communication applications run on both laptops and WiFi-enabled cell phones. The primary community-oriented goal was to prevent unnecessary travel by sick patients from the clinic to the hospital, as transport in these poverty-stricken and geographically dispersed areas is irregular and expensive. Additionally, the team hoped that the system would enable nurses at the clinic to learn how to treat a wide range of problems locally by consulting with doctors they normally do not come into contact with, while reducing the workload for doctors at the hospital.

The team gained the approval of local community leaders and both regional and provincial Department of Health managers. However, at the time of project inception, Voice over Internet Protocol (VoIP) was illegal in South Africa. This was overturned by the national regulatory agency, the Independent Communications Authority of South Africa (ICASA) in March 2005. The WiFi network, however, is still legislatively problematic. An umbrella goal of the project is to influence national policy to "open up" these technologies for empowerment of disadvantaged people across the country.

Project challenges

Challenges encountered in both projects included:

- Frequent and sometimes lengthy power outages;
- Damage to equipment from theft, vandalism and even lightning strikes;
- High turnover of hospital doctors
- High maintenance required of the repeater site between Tsilitwa and Sulenkama
- Regulatory barriers: the lack of telecommunications infrastructure indicates WiFi as a potential solution to meet the needs of rural connectivity. However, use of WiFi in the 2.4GHz ISM band (which is licence-free internationally) is forbidden where it cuts across public boundaries and where the power emission of the antenna exceeds 100 mW.



Mobile covers 90% of the country and existing infrastructure can be used for community mesh networks.

Implementation process at Tsilitwa

Infrastructure implemented in the first phase of the project included a Mult-Purpose Community Centre) at Tsilitwa and Sulenkama; a PC network at the Tsilitwa school, a WiFi network connecting the Nessie Knight Hospital and the police station with a number of sites in Tsilitwa, including the clinic, school and the MPCC.

Both sites were connected by means of VoIP. The Tsilitwa Clinic was also linked to the Nessie Knight with a web-cam to facilitate teleconsultation between the clinic sister and the doctor. Email was piloted at the clinic using a GSM (cellphone) modem as cellular coverage was introduced in the area.

The clinic sister was provided with a digital camera to take photographs of patients with skin disorders or wounds. For a year the images were sent via GSM to a specialist in Mthatha for diagnoses and advice, with good medical results.

The MEC visits Tsilitwa

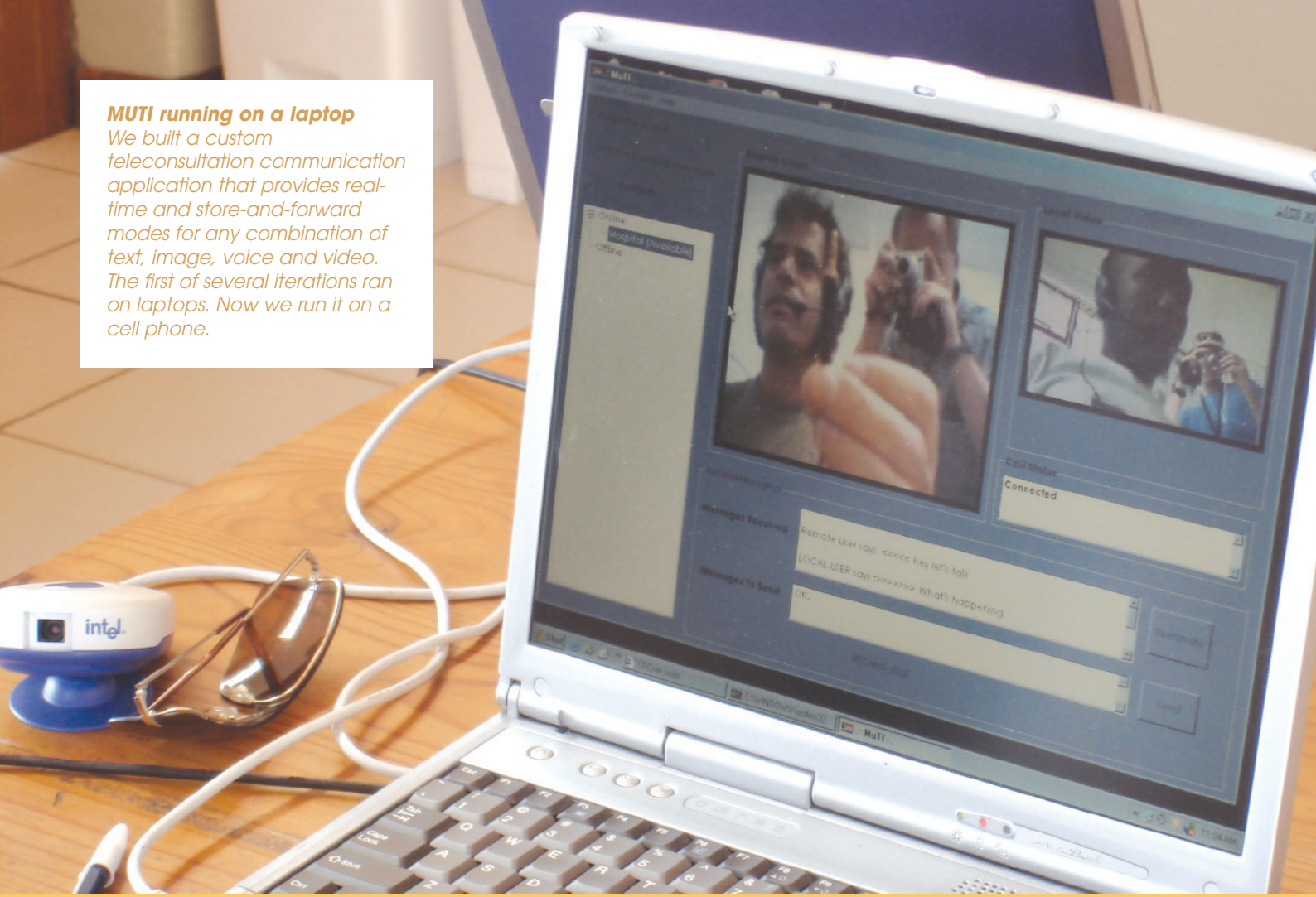
The value of the installation was highlighted at an early stage when the Eastern Cape Member of the Executive Committee responsible for health, Dr Bevan Goqwana, visited the project on World HIV/AIDS Day in December 2002. He was able to diagnose a patient from the Sulenkama hospital using the technology. The MEC subsequently requested that more clinics be connected using the technology.

The success of the implementation led to significant expansion of the initial project. In 2003, funding was obtained from the World Bank Development Marketplace for the expansion of the network to other clinics in the region. At the beginning of 2004 the Department of Public Works embarked on a building programme in OR Tambo District Municipality for the construction of new clinics. At the project site in Tsilitwa this meant demolishing the old clinic, and transfer and re-installation of WiFi equipment to the new clinic, which resulted in a whole new set of challenges being presented to the project team, including the redesign of the existing network to focus on connectivity for health to a number of clinics in the area.

After RF equipment was erected, the link between Tsilitwa clinic and the hill and Tsilitwa to Kalankomo clinic was tested successfully. The team then tested the line of sight to Guru Clinic, but establishing a reliable link proved problematical and the final network included Nessie Knight, the hill in between Sulenkama and Tsilitwa, and the Tsilitwa and Kalankomo Clinics.

Though Guru Clinics could not be connected to the network, an antenna mast had previously been erected and an enclosure box fitted to house the WiFi equipment. The decision was taken to complete the installation by installing the power cabling, trunking and LAN point to provide a PC for the clinic. This would at least introduce the clinic staff to e-Health, and connectivity

ICTs can deliver the right information at the right time to the right person



MUTI running on a laptop
We built a custom teleconsultation communication application that provides real-time and store-and-forward modes for any combination of text, image, voice and video. The first of several iterations ran on laptops. Now we run it on a cell phone.

might be provided by some other means, such as 3G, at a later stage.

While the pioneering tele-dermatology project was considered successful, the unacceptably high cost of GSM prevented further use of this technology. Subsequently, an application has been made to the Universal Service Agency for sponsorship of a VSAT to provide Internet and email connectivity to the Sulenkama/Tsilitwa cluster. This was imperative for the tele-dermatology application to resume.

MUTI Implementation

The project team built the first version of MUTI in 2004 for the Nessie Knight Hospital at Sulenkama and the Tsilitwa Clinic, where the CSIR-funded network was already in place.

MUTI v1 provided synchronous voice, and asynchronous (store-and-forward) text, voice and images. The team ran MUTI v1 on laptops (not the PCs installed by the CSIR) chosen to maximise battery life. The user interface was not very user friendly, and made it difficult to train the nurses to use the software. However, even when they did use the software, the doctor hardly ever answered because the laptop (as well as the CSIR PC) was locked up in a room in the hospital. The doctor was alone, and rarely had time to answer calls.

The project team paid a great deal of attention to the human computer interface with a user-centred development approach to deal with the WiFi network as the First Mile, and the human computer interface as the First Inch. They wanted to learn how to develop a usable and sustainable system that fits into the social context of its usage.

Based on the feedback from the Sulenkama/Tsilitwa experience, the MUTI team continued to develop the MUTI system in 2005. First they built their own WiFi network at a new site: Canzibe Hospital and Lwandile Clinic, in the Libode district.

This rural wireless network connects Canzibe Hospital and Lwandile Clinic, which are roughly 20km apart. The wireless links used enhanced (for longer distances) 802.11b links at 2.4 GHz. Because the hilly terrain prevents line-of-sight, they needed to build two intermediate relay stations. All four units use a low voltage WRAP PC router-board, essentially a "biscuit" PC that runs an open source Linux operating system that handles all of the routing.

MUTI v2 rounded out the synchronous and asynchronous communication to three modalities: text, voice and video. The interface was slightly improved, but still was not very easy to learn or use for the nurses. The doctors, on the other hand, were able to point out numerous deficiencies, but were still able to use the system. Because the clinic has no other form of communication, they used the real-time voice and video functions the most.

Feedback from MUTI v2 in 2005 and early 2006 indi-

Sweet, but Elusive, Scent of Success

For Sister Patricia Madikane, the only trained medical professional at the Tsilitwa Clinic, the experience of the tele-health system has been, in retrospect, a mixed blessing of delights enjoyed but then denied. "When the whole system was working, it was wonderful," she says, "and I'm sure it has even helped to save lives."

Sadly, however, an important element of the innovative ICT solution pioneered at Tsilitwa, the tele-dermatology system, though successful has had problems with the power and maintenance of the repeater site.

"This was so valuable," says Sister Madikane. "For example, we once had a patient come to us with a terrible skin disease that caused her awful problems. She lived most of the time in Johannesburg, but had not managed to get effective treatment there. I took photographs of her and sent them to the dermatologist at East London. He advised us on a course of treatment which we began with very good results. The patient has now returned to Johannesburg, but I understand she is continuing with the treatment we started here."

Sister Madikane has been told that funds are being sought to re-establish the tele-dermatology system using a VSAT satellite link, which would have lower running costs that the cell phone.

She sighs with the patience that is a necessary virtue in those who work among the rural poor. "Yes, it would really be very good to have the system working again," she says. "so that we can help our patients more than we able to do now."

cated that nurses were not using the asynchronous functionality purely because of the interface difficulties. Doctors would answer synchronous calls when they could, but were busy, and the system had only a single laptop.

Accordingly, the MUTI team decided to port the store-and-forward portion to a WiFi handset. This is MUTI v3. The user interface is greatly improved and resembles SMS. The nurses are already familiar with SMS on cell phone handsets, and find the handset much less intimidating than the laptop PC. Power is still a problem, however, in that the handset consumes the battery rapidly when the WiFi is turned on. The MUTI team software attempted to manage that by automatically turning it on and off when needed. The handset still functions as a normal GSM phone, and the nurses can either use that, or the MUTI v2 system on the laptop to make a voice call. The data shows that they use the MUTI system more often than the cell phone.

Conclusions

The store-and-forward functionality was a good fit, though, because of technological restrictions on cell phones (to protect the voice revenues of cellular service providers), the team was not able to port the real-time components of the system. All of the peripherals from the laptop (microphone, headphone, camera, video and even Bluetooth and WiFi) are all neatly integrated into a cell phone device. Because cell phones are already integrated into everyday rural South African life, the cell phone is an attractive component for the First Inch. The battery life, however, remains an issue.

Despite the demonstrated success of the project, a continuing problem is the issue of a licence for the use of WiFi. It is interesting to note the changes taking place in the regulatory landscape with respect to WiFi. At the African WiFi Conference in 2004, a representative of the Independent Communications Authority of South Africa (ICASA) indicated a willingness to assist with facilitating the use of WiFi in tribal lands. Further, The CSIR has met with the Regulator to discuss issues of tribal and contiguous land and municipal PTN licences. Following this the CSIR is currently developing a strategy for use of WiFi in the Eastern Cape for health and education.

A positive sign is that in 2004 the Minister of Communications awarded a licence to four black economic empowerment (BEE) companies to operate telecommunications services in under-serviced areas. These Under-Serviced Area Licencees (USALs) have been funded for a period of three years through the Universal Service Agency.

Lessons Learned

- Telehealth applications can be commissioned in deep rural settings to link clinic sisters to health specialists for diagnosis, referral and teleconferencing.
- An effective telehealth solution depends on the commitment of the entire chain of command in the health environment to use it from clinic to specialist.
- Successful pilot projects in the telehealth environment will lay the foundation for replication and commercialisation.
- To introduce a telehealth solution effectively and ensure it is

used ,it is necessary to facilitate individual use by the clinic staff, the hospital doctors and upwards to the district and provincial level personnel.
- Capacity building for effective use of ICTs in health needs to be structured to include clinic staff, hospital personnel, specialists and administrators.
- Ongoing support must be provided at the local level to facilitate the integration of ICT activities into established health routines for diagnosis and referral
- When backbone connectivity is in place, community-based initiatives can provide affordable access to ICT resources through WiFi connections operating in the 2.4/2.6 GHz range.
- It is necessary to exceed the power output regulations for WiFi or to jump to a higher frequency in some instances, to be able to connect distant rural sites.

Recommendations for Policy Brief

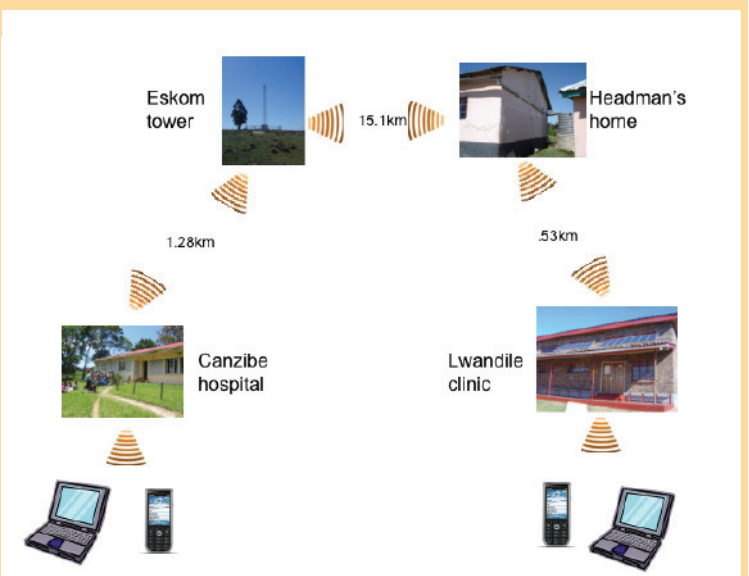
This policy brief highlights some of the critical challenges to be considered in order to achieve community access thereby helping build an Information Society and contributing towards the Millenium Development Goals.

Although the backbone connectivity was not a key research component of this project, in order to understand the First Mile it is necessary to consider the whole value chain of communications.

In all 10 of the FMFI projects undertaken in Angola, Mozambique and South Africa, cost was identified as the key barrier to community access. The cost of VSAT ranged from USD2000 pm in Angola, USD1000 pm in Mozambique to USD500 pm in South Africa. The FMFI project partners had to find innovative ways to deal with these costs and create cost-sharing business models to achieve a level of sustainability.

The solution was found in sharing and distributing bandwidth to other users on a cost recovery basis. This was done through the use of wifi connecting the VSAT/Leased line at the hub to other users within a 20km radius. An extension of this configuration was found particularly effective in the deployment of mesh networks. These solutions however, presented new challenges and require the following issues to be considered for policy:
- Liberalising the regulations around the use of 2.4 GHz band for social objectives.
- National ICT initiatives in education and health
- Building partnerships with existing infrastructure owners to secure equitable access to ICT infrastructure and resources.
- Making provision for resource and cost sharing of ICT infrastructures.
- Government sponsorship of community connectivity and the potential use of Universal Access Funds in this environment.
- Implications of PLC and municipal ICT networks.

To maximise the use of the regulatory principles established in the FMFI context would involve escalating the regulatory debate upwards to the Communications Regulators Association of Southern Africa (CRASA) to have an impact on a broader audience than the three target countries as well as to CIPESA (East and Southern Africa) and ACRAN - African Communication Regulation Authorities Network.



The hilly terrain and lack of line-of-sight between the hospital and clinic required two intermediate relays for the network. Each node costs about R4000, with a bit more for the solar sites. Either solar or mains charge a 12v 96aH battery. All network hardware was purchased locally in South Africa.

The organisations involved in this project are the University of the Western Cape, the University of Cape Town, the CSIR Meraka Institute and IDRC CRDI.

First Mile First Inch

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gies and applications for Internet access and connection to the global information society that result in high use, potential revenue and/or dramatic cost savings for institutions and end users, and expanded use of Communication Technologies (ICTs) in remote African locations.

The FMFI project is a comparative study of Information and ICTs in different low-density contexts, across different projects in a number of countries.

This is a network project funded by the IDRC, a Canadian Crown corporation that works in close collaboration with researchers from the developing world in their search for the means to build healthier, more equitable, and more prosperous societies (*http://www.idrc.ca/*). The collaborative network was coordinated by the Meraka Institute of the Council for Scientific and Industrial Research (CSIR) in South Africa and 12 project partners in Angola, Mozambique, Namibia and South Africa. As such, the project comprises an in-depth exploration of five key objectives:

- Innovative First Mile and First Inch solutions
- Changed behaviour in use of ICTs
- Cost and benefits of solutions
- Scalability and replicability of technologies
- Influence on policy and regulations.

The approach taken by FMFI is essentially to foster "bottom-up" collaboration to achieve sustainable technical innovation that is scalable and replicable.

First Mile refers to the links between the access devices and the local access providers, and involved such connectivity technologies wireless (WiFi), wired Ethernet, powerline technologies, Bluetooth, narrowband HF/VHF/UHF, and mesh networks employing any of these technologies.

First Inch refers to the applications and access devices (PCs, thin clients, handheld Personal Digital Assistants (PDAs) and cellular devices). Importantly, this component of the project addresses the fact that it is often not enough simply to place technology in the hands of users; instead, the technology must be adapted to the local environment. Further, the users require training and education on the technologies.

Among the barriers to development of innovative solutions are that:

- First Mile technologies are frequently cutting edge and not yet supported by telcos that remain committed to older technologies servicing mass markets (a major reason why their existing business models have not worked for the rural poor); and
- Many countries have telecommunications policies that inhibit the use of First Mile technologies and require licensing.

As regulatory policy should support community development, not hinder it, the successful implementation of First Mile technologies that demonstrate real benefits the poor can influence governments in the development of regulatory policy.

Importantly, the challenges are not merely technological, but social and cultural. Success therefore depends on addressing all of these issues and in order to do this the project has adopted an Outcomes Mapping methodology, which focuses on changes in the behaviour of people, groups, and organisations involved with the programme.

As President Thabo Mbeki said at the launch of the National Research and Development Strategy in January 2002: "We have to ensure that as many of our people as possible master modern technologies and integrate them in their social activities including education, delivery of services and economic activity."

The First Mile First Inch (FMFI) project is a paradigm shift from the traditional "last mile" and "last inch" thinking representing a more bottom-up grassroots approach to innovation and focusing on the end user.