# INITIAL RESEARCH RESULTS ON AFFORDABLE COMMUNITY-OWNED INFORMATION NETWORKS IN SOUTH AFRICA

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## ABSTRACT

A Mesh Network is a network of computers that can communicate wirelessly with other computers in the Mesh or with any computer on the Internet. Mesh networking in communities allows people to build their own telecommunications infrastructure and it is becoming increasingly popular throughout the world. This paper discusses the potential benefits of, and obstacles to, using this technology in South Africa. The establishment of a local laboratory test-bed for this purpose is elaborated on. A community installation as well as a reference test bed is discussed. An affordable antenna design is reported on. Protocols and simulators under consideration are mentioned. References are included.

## INTRODUCTION

The mesh approach allows the network to grow organically without the normal structural restraints (like laying cables, digging up roads) of a normal network. Data is routed throughout the mesh network via each 'node' using whatever route is available. If a node becomes unavailable, then another route is found using the remaining nodes. A route to the Internet can be found automatically, by forming chains of nodes and passing the data along the chain. Its a bit like when driving in your car and you find they've closed a road. You check the map or follow the diversion signs and find a new way to your destination. The whole mesh is cooperative, organic and dynamically expandable.

## SUMULATIONS

Simulations are useful in predicting the behaviors of a network without having to spend the time and financial resources of actually building one. It is understood that the ultimate test would be to actually construct and install the network devices and replicate the experiments. The results would then be compared with those obtained in the simulations. Anomalies are then identified and studied. The simulation can then be modified to account for these anomalies. Some of the aims are to simulate mesh networks to, for example, understand VOIP performance over these networks. It is also useful to determine placement of Internet access gateways and the suitability of mesh networks for rural community access given varying terrain features. We have to choose a simulator that is customisable, well-known so that we can export or share models, easy to use, inexpensive, has a library of protocols, propagation characteristics, etc, and that could be tweaked for our requirements. Preferably it has to be able to incorporate terrain models as well. Some proprietary options we are investigating include Opnet and Comnet III. Open source candidates are NS-2, Ptolemy, OMNet++, CSim++, SimJava, and JavaSim. There is some confusion of packages here as Lund Institute of Technology (Sweden), Ohio State and University of Newcastle have all created packages called JavaSim. Ohio State seems to have the most advanced package that they have since renamed to J-Sim. There is also a general-purpose simulation language in Python called SimPy, which appears to be rather interesting, but without many add-ons at this stage. At this stage, Opnet, Ptolemy, SimJava and OMNet++ appear to be the best candidates for further investigation.

## PROTOCOLS

**We are investigating a number of existing mesh protocols for their suitability in the South African environment. A custom developed protocol might be required to meet the local requirements as these differ from those in first-world countries where protocols are usually developed. Some of the protocols being investigated are Mobile Mesh, Ad-hoc On Demand Distance Vector routing (AODV), Optimised Link State Routing protocol (OLSR), and Hazy Sighted Link State routing (HSLS).**

## LABORATORY TEST-BED

In order to test new theories and confirm results obtained by others, it is useful to have a physical configuration that resembles the actual scenario. As a first step towards establishing such a scenario, we have created an indoor-test bed with hardware that closely resembles that which would normally be installed in a community network. The current test-bed consists of a 2-dimensional array of WiFi-enabled single-board computers [figure 1]. 49 computers are dispersed along this matrix. In addition to the WiFi, each box also has Ethernet capabilities. This allows for out-of-band communication with the box. Using this communication channel, firmware can be upgraded and wireless traffic statistics can be downloaded from each box without interfering with the traffic being measured. The spacing between the boxes is such that with minimal power settings and an appropriate antenna, communication between the boxes can be limited to adjacent boxes if so required. This allows us to simulate the so-called hidden node problem as well as other interesting problems.

## COMMUNITY INSTALLATION

The Meraka Institute's first Cantenna[1] installed in a rural setting was mounted onto the house of a health worker from Peebles valley, near White River in Mpumalanga, on 6 July 2005. This Cantenna is made from a metal can [figure 2,3], such as a coffee tin, and a section of bicycle spoke soldered into a special connector that can connect to another point with a similar antenna up to 5km away. The project in Peebles Valley is one of 10 sub-projects in the First Mile First Inch (FMFI) project being funded by the International Development Research Centre (IDRC). The Meraka Institute is in charge of the technical development as part of its Community Owned Information Network (COIN) initiative under the Wireless Africa project banner.

These small, self-constructed antennas, which are made from locally available material, are connected to a low-cost WiFi card plugged into a computer. A small wireless router is placed in a weatherproof casing on a pole to which several community members could connect and form a community mesh network. This mesh networking technology allows the wireless installations to automatically configure themselves to find the optimal routes through the network and very little configuration is needed to set them up. This technology has also enabled the local high school that uses the more costly omni-direction antenna, to gain Internet access through its computer centre.

Mdluli's house was given priority on the premise that she works at the Aids care training and support (ACTS) clinic in Peebles Valley. The clinic cares mostly for HIV/Aids patients from that area and surrounding villages and townships. The Cantenna will allow Mdluli to do internet-based research on HIV/Aids and other health matters. She will also be able to make Voice over Internet Protocol (VoIP) calls to health workers across the country. Peebles valley, also known as the Masoyi tribal area is a poor community of some 220 000 people where it is estimated that 33% of the sexually active population is HIV- positive.

Training will be carried out to teach the community how to construct their own Cantennas, set up a wireless router, and connect it to a computer. The following explains portions of the community installation [figure 2]. The VSAT satellite feed comes in at the ACTS AIDS Clinic. The clinic it is the logical centre of the network where the servers will be kept. This is also the site with all the medical experts. Health workers in the mesh would want to connect to make use of their expertise. Many of the doctors and other staff at the ACTS clinic want to stay in touch with the world. For this reason the clinic staff houses will be connected to the network. The farmers making use of the network will cross-subsidise the poorer part of the community. A computer lab at the school will be connected to the mesh. The intension is to maximise local content on the network. For example, we will store the well-known Wikipedia on the ACTS server for access by the community. ACTS staff houses will get priority when installations are done. We are hoping that the staff will use this link to further research AIDS. The Hospice will connect back to ACTS. A VOIP connection back to the ACTS clinic will save on telephone call costs. The cell phone bill between the hospice and the ACTS clinic often exceeds R3000 per staff member.

## REFERENCE INSTALLATION

A reference installation [figure 5] allows for the testing of protocols and equipment under realistic conditions. Once simulations and tests conducted on the test bed have shown promising results, the reference installation is used to conduct further tests. Only when we are confident in the results obtained in the reference test bed, are the improvements made available to the community networks.

## CONCLUSION

Although this project is still new, we have already identified issues that need to be addressed in order to make it a success. Probably the most challenging is the current legislation that limits the provision of telecommunication infrastructure. One of the aims of the project is to demonstrate the benefits of allowing communities to provide and maintain their own infrastructure [figure 6]. We hope to influence legislation this way. Another challenge is to demonstrate to the communities the advantages of owning their own communication infrastructure, and maintaining it using resources available locally. A challenge of lesser importance, and which will eventually disappear, is that of supporting remote installations in rural areas. These installations are currently supported from our offices in the Gauteng province, necessitating long hours on the road to reach a single installation.

## REFERENCES

[1] "How To Build A Tin Can Waveguide WiFi Antenna", accessed 22 August 2005, URL: http://www.turnpoint.net/wireless/cantennahowto.html

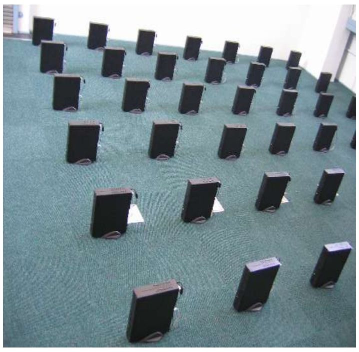

*Figure 1 Laboratory test-bed*

*Figure 2 A view inside the homemade antenna. Note the radiating element.*

*Figure 3 Community members are used to install the Cantennas. The Cantennas will connect rural areas like these to the world.*

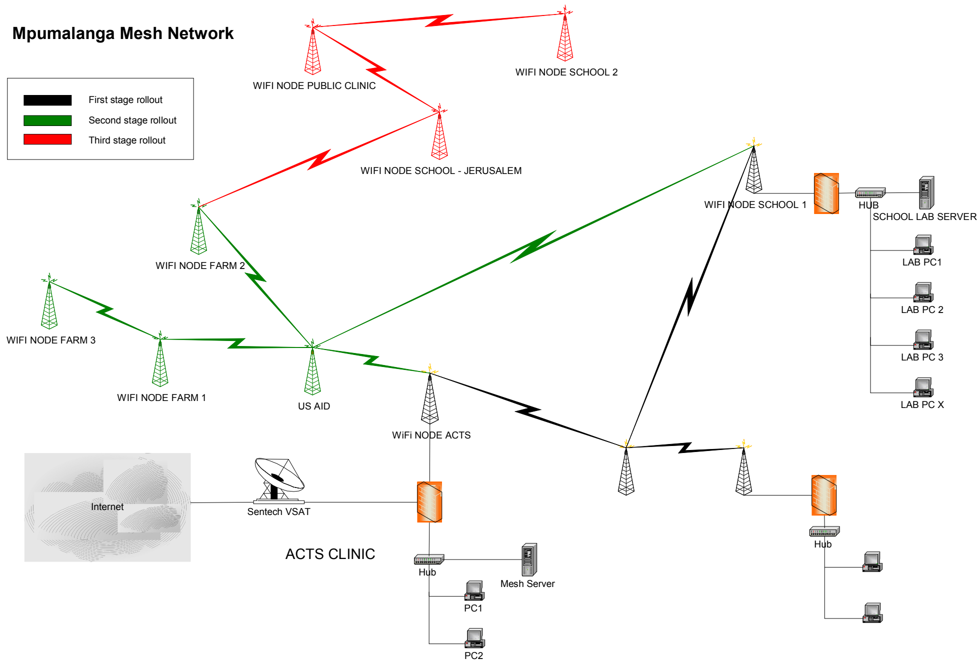


*Figure 4 The Mpumalanga network*

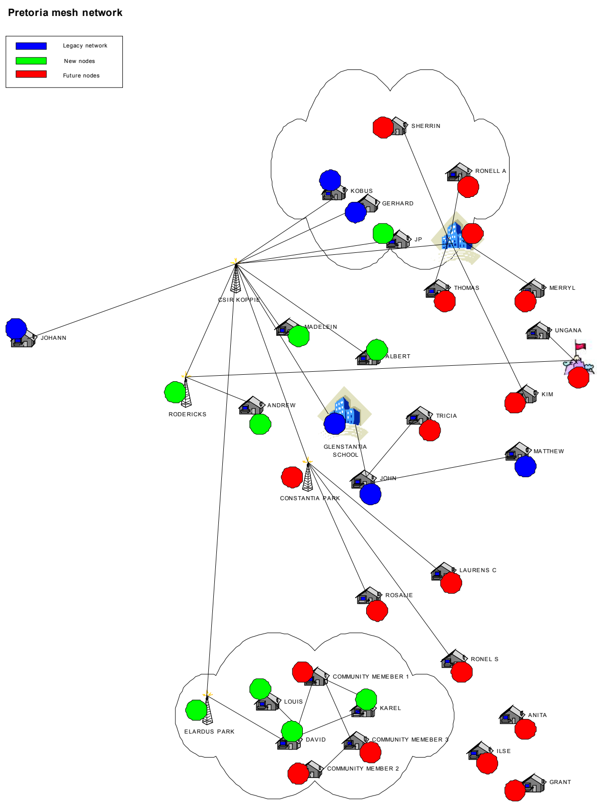


*Figure 5 The reference network*

*Figure 6 Empowering: Training to enable the community to install their own Cantennas is a priority*


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