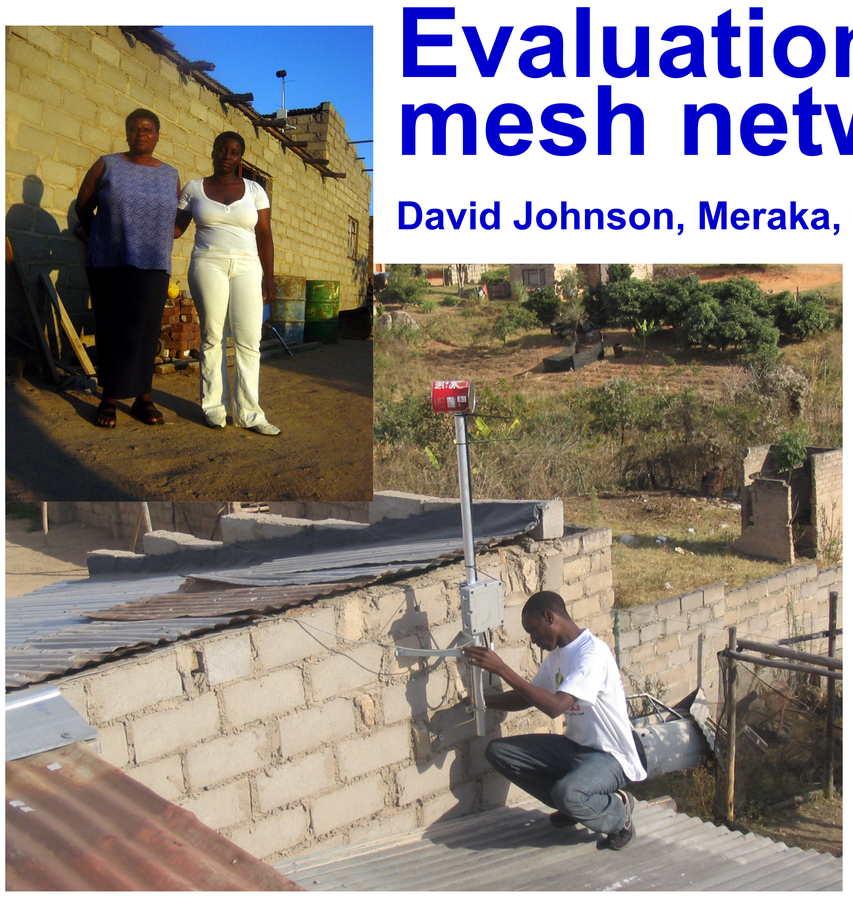
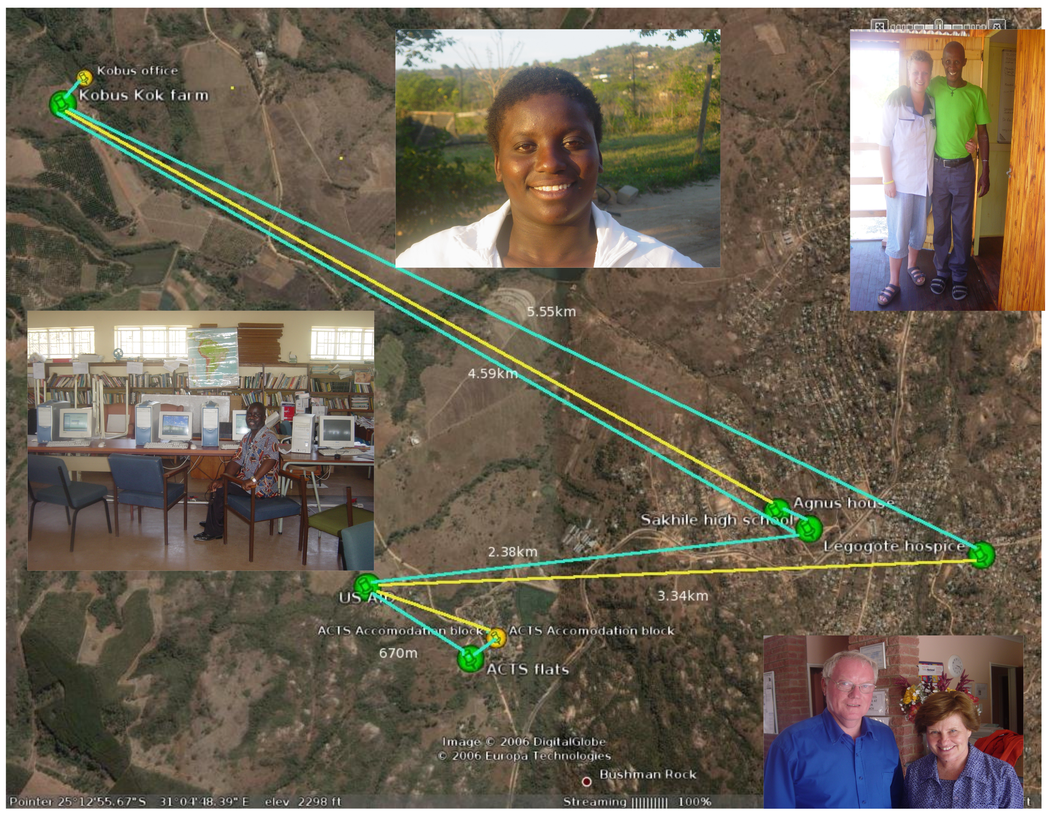
Evaluation of a single radio rural mesh network in South Africa

David Johnson, Meraka, CSIR, Pretoria, South Africa

IDRC CRDI





Abstract

This project was part of the "First Mile First Inch" project funded by the IDRC and looks at social and technical innovation on service delivery models in different contexts of communities with low-density telecommunications.

This paper evaluates the ability of a low cost wireless mesh network to provide Internet access to a rural area in South Africa with limited broadband connectivity. The network was installed in a mountainous area with a wide range of distances between nodes ranging from long range 5.5km links to short hops between buildings of only 30 to 50m.

Due to this combination of distances, a mix of unplanned node placement with omni-directional antennas and planned nodes using directional antennas was used. The current network consists of 9 nodes spread over an area of about 15 square kilometers. There is electricity at all the sites but power outages are common, occurring at average intervals of one outage in 7 days, lasting between 3 and 24 hours. The network provides a good service to the satellite based Internet with throughput rates ranging between 300 kbps for 4 hops and 11000 kbps for 1 hop and an average throughput rate of 2324 kbps.

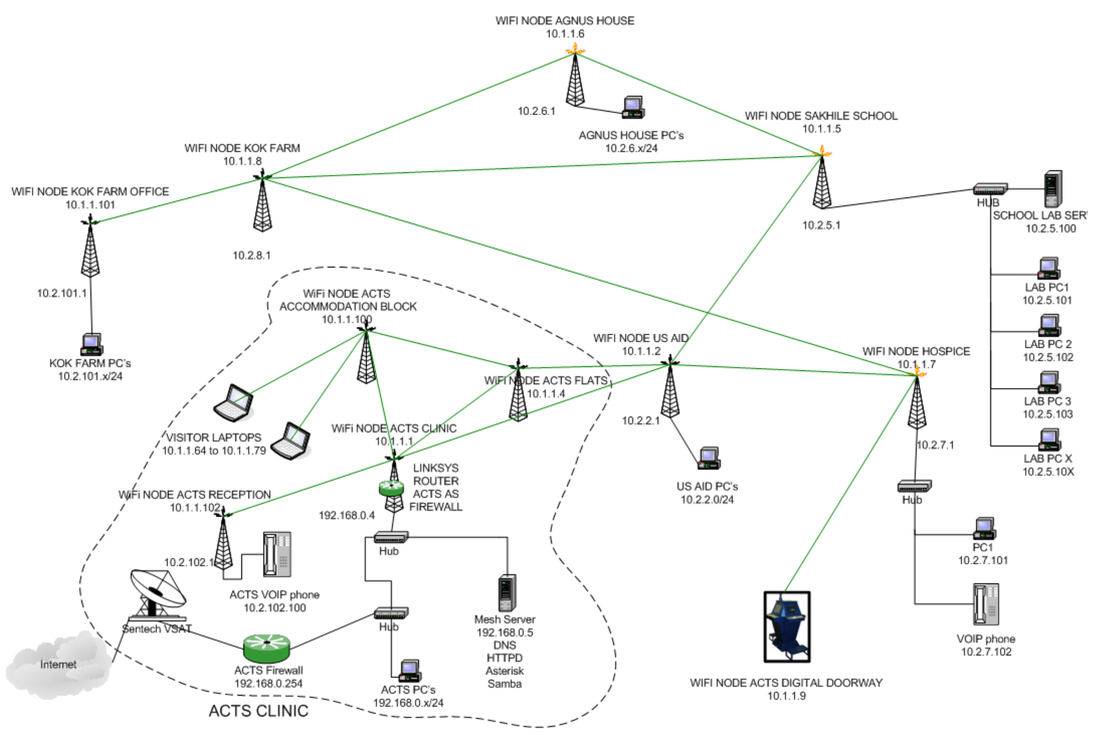
The paper evaluates the performance of the OLSR routing protocol being used in the mesh network as well as giving an overview of usage patterns and social behavioural patterns of the users. The users range from first time users in poorer areas of the network to fairly accustomed

Mesh design

The network was built to explore a least cost 802.11 mesh network to supply Internet connectivity, being supplied to an aids Clinic. This connects to surrounding schools, homes, farms and other clinic infrastructure through the mesh network. The Aids clinic, which is a non-governmental organisation (NGO) funded by a pharmaceutical company social grant, has brought hope to over 700 patients in the area over the 4 years it has been running. The VSAT Internet connectivity, which is provided free of charge by a sponsor, is usually underutilized every month, with clinic users only using approximately 60\% of the available bandwidth each month.

The satellite link provides 2GB per month at a download rate of 256 kbps and an upload rate of 64 kbps. Once the 2GB capacity limit is reach the Internet connection is cut off until the beginning of the following month and no spare capacity can be carried over to the following month. This spare capacity is shared to users in the mesh network, free of charge but has to be carefully managed by a firewall to ensure that their usage does not effect the clinic's Internet availability.

Linksys WRT54G wireless routers, which are single radio 802.11 b/g routers capable of being re-flashed with a completely new operating system, were chosen becuase of their low cost. They have a 200MHz CPU on board and use flash based memory with no fans or other moving parts. These devices are designed for indoor use but modified for outdoor use by repackaging the electronics so that it can be mounted on an outside mast.

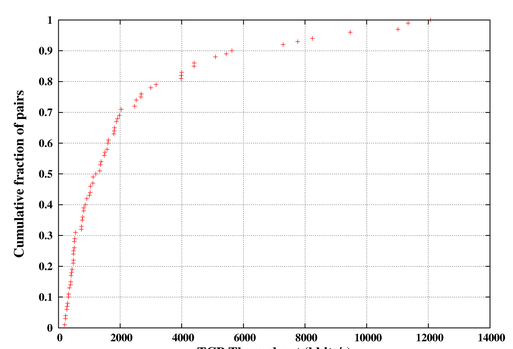


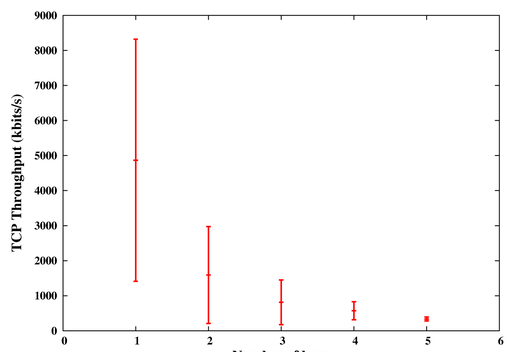
Network services

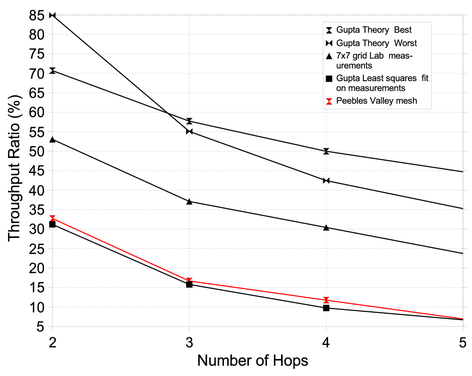
- Local copy of Wikipedia is available on the server to save on Internet traffic.
- Asterisk gateway is installed on the network to allow users to make free local calls.
- Local Linux Unbuntu repository is updated every 6 months to allow users to add new software without using the Internet.
- Media Wiki is available on the local server for users to build their own web content.
- Local Samba server is available where files such as windows updates, virus updates and commonly downloaded files can be stored to avoid download duplication.
- A transparent proxy server is used on the server to help minimize Internet usage and to filter out expensive automated downloads such as Windows updates.

Technical results

- Throughput rates ranging between 300 kbps for 4 hops and 11000 kbps for 1 hop and an average throughput rate of 2324 kbps.
- Average hop count in the network was 2.21.
- Average delay between any two nodes was 5.57 ms in an unloaded network.
- Cost savings of about $400 per month were achieved by installing VoIP phones which use the mesh between hospice and clinic instead of GSM.
- Most throughput degradation was due to multi-hop and drop-off matched Gupta's indoor experimental results well.

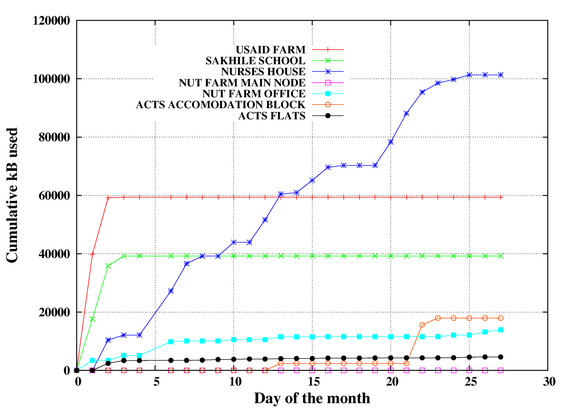


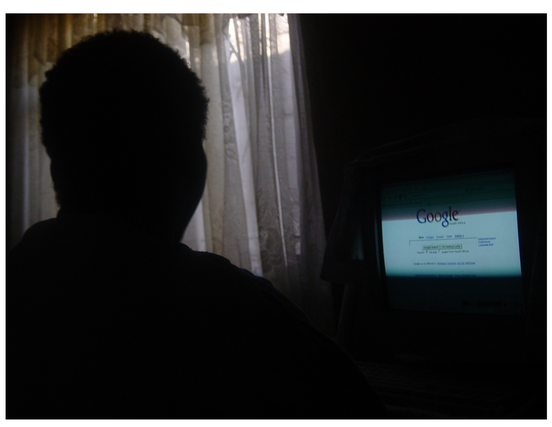




Social observations

- First time users of the Internet had little conceptual understanding of what type of Internet usage consumes large amounts of bandwidth.
- First-time Internet users were easily fooled into believing they had won huge sums of money by Internet scams.
- Up-time in the network was often severely hampered by users unplugging their equipment.
- Instant messaging tools such as Skype have proved to be a very valuable helpline for inexperienced users in the network. Users would often message more experienced users in the cities.
- General trend for rural users to move from purely web based Internet usage to person-to-person communication over first few months of usage.
- Younger generation need no formal computer training to become computer literate.
- Installing a wireless network brings many employment opportunities - 2 previously unemployed people were employed in the formal sector as a direct result of this project





Contact information at CSIR, South Africa:

David Johnson (Senior Researcher, Wireless Africa)
Tel: +27 12 8414266
email: djohnson@csir.co.za
website: http://wirelessafrica.meraka.org.za or http://www.fmfi.org.za

meraka INSTITUTE
African Advanced Institute for Information & Communications Technology