A low cost, IP-based access loop for consumer telephony in rural communities

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***Abstract*— Discussion of a project exploring current wireless networking, and software telephony technologies, to provide consumer voice telephony in the rural setting. The project focuses on the use of open source, community developed software and off-the-shelf wireless networking hardware. The development platform will be the existing 'iLanga' system, a configuration of Asterisk software PBX, SIP express Router, Python Twisted framework, and OpenH323 developed by Jason Penton and Jonathan Hitchcock.**

***Index Terms*— rural development, open source software, asterisk software PBX, consumer access loop, wireless network, python twisted**

I. Introduction[1]

THERE is an impetus from the South African Government, the United nations, and many other non-governmental organisations for investigation and research in the area of rural communication technology, to bridge the so called "digital divide". The digital divide is characterised as the gap that exists in both the availability of electronic technologies to rural/underprivileged/previously disadvantaged groups, as well as the availability of skills to operate said technologies. By extending communication resources to people, their quality of life is improved, since more effective intra- and extra- community communication can occur.

The iLanga system[1], [2], [3], [4] already provides a comprehensive and economical software telephony infrastructure. This paper proposes that it should be to possible to extend the system further to provide consumer telephony at an economical cost. The project explores the deployment of an access loop that would benefit from the employment of the iLanga system, the dropping costs of off-the-shelf standardised wireless components, and access to cheap ip-phones.

Contact with the community in the Dwesa/Ncebe region in the Mbashe municipality in the Eastern Cape has already been established, to provide a test site for the project. Rhodes University already has a good relationship with the community, through work done by the Environmental Science and Anthropology departments.

II. requirements

There are a number of constraints (social/organisational, economic, and technical) which impact the form and deployment of the network. The network should be cheap (employing off-the-shelf components where possible), durable, flexible, reliable, remotely manageable/monitored and its components may need to be powered in isolation.

1) Social/Organisational constraints: Conradie, Morris and Jacobs[5] discuss key focus areas to successfully start bridging the digital divide, based on works by Mansell & When[6] and Burgelman, Nulens, & Van Audenhove[7]. The most significant focus areas are "(to) establish an ICT infrastructure or network that is reliable and affordable" and "introduce/develop ICT applications that are responsive to local needs".

2) Economic considerations: The total cost of ownership of any technology extends further than the cost of the initial commission of the equipment. Since the communities involved are underprivileged, sustainable deployment is not easily achieved. Poorly educated users, lack of facilities, and unfamiliarity with technological goods are primary hurdles, with project deserters (newly empowered people seeking employment/livelihoods elsewhere) and lack of internal fund generation as secondary.

It is important to provide people with tools to enable them to become economically active, and examine ways in which the costs (including skills) of consumer telephony can be supported. A possible avenue could be provisions for micro-service providers. Micro-service providers can provide access to telephony services to others, and derive economic benefit through sales of calling cards. Linked to a multi-purpose community centre which generates community income this should be a platform for economic activity.

The iLanga system already provides usage accounting, and dial-plan based costing model, e.g. when calls break out of the PBX there is user based call accounting, implemented via a credit system.

3) Technical considerations: Since the deployment will be in a rural and geographically dispersed setting there are a few factors to consider for the final network configuration.

a) Wireless network: The network will need to cater for a wide geographical area, with 5-10km between stations. The network must be robust and easily maintainable.

Since a standard data network will be deployed, there is room for later expansion into data services, and not simply voice services. Data services could be provided easily at a later date, relying on the already existing infrastructure.

b) Energy Considerations: The project will examine novel methods of powering network and user devices. The choice of

[1]This work was undertaken in the Distributed Multimedia CoE at Rhodes University, with financial support from Telkom SA, Business Connexion, Comverce, Verso Technologies, THRIP, and the National Research Foundation

technology used to provide end-mile and core network will be strongly influenced by how the devices can be powered, and if they can be powered without formal energy infrastructure.

c) Remote management: The network must be remotely accessible, to enable routine maintenance. Having remote access to the system will minimise the frequency that a skilled person will need to visit the deployment physically, thus lowering the total cost of ownership.

III. Implementation Tools

A. Multi-purpose Community centres

The multi-purpose community centre (MPCC) and telecentre approach have been used with varying success in roll out of information communication technologies (ICTs), according to Conradie, Morris and Jacob[5]. Multi-purpose community centres are usually schools or existing community centres which are fitted with ICT, and are provisioned for general public use. An MPCC/telecentre should form the centre of the deployment, to allow for centralised management of the network and its devices. The wireless extension to MPCC/telecentre is one approach to extending the footprint of the centre, and thus providing access to telecommunications to more people.

B. Wireless technologies

Wide-range networking (5km and upward), such as extending Wifi (IEEE 802.11), or using WiMax (IEEE 802.16) as the core network infrastructure, contrasted with other current wireless networking technologies.

C. LAMP - Linux Apache MySQL Python/PHP

The iLanga system already resides in a Linux environment, interacting with MySQL for data/configuration storage, and enabling user interaction through Python/Macromedia Flash interfaces. This environment allows for easy extension since the system already relies on database storage for user details and credit control. Extending the set of existing management tools is simply a matter of communicating with the MySQL and Python interfaces, allowing for a diverse range of possible configuration interfaces.

D. Community Forum

The deployment in the Dwesa/Ncebe region should provide a feedback mechanism for the project, and there is a need to communicate with the local people to understand what their needs and normal use of the telephony system will be, and react to their inputs.

IV. Progress

Initial testing of SIP based VoIP telephony over conventional 802.11b/g, and wide-range 802.11b/g network was limited in its success. When used in a conventional indoors wireless network, the quality of communications is indistinguishable from that provided by wired uplinks. When used on a wide-range wireless network that uses directional antennae to communicate with the root AP communication quality was highly variable; introduction of multiple peers to the network resulted in decreasing voice performance.

Further testing of network configurations is needed to quantify which configurations will have a significant impact on its performance, and if there are tools that can improve time division management of wide-range wireless networks.

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