Socio-Economic Aspects of Voice-over-IP Technology in Rural SA

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Abstract- This paper describes work in progress towards developing a business case and preliminary design for an 802.11-based mesh network in the remote rural community of Mankosi in the Eastern Cape province of South Africa. Aside from the technical challenges to building the network to be sustainable in the long term, this network needs to generate some revenue. Hence, there needs to be a business model that has revenue generation potential. This study will explore the economical and social aspects of voice over Internet-Protocol as a service for this community. After talking to the village leaders, we learned that there is a demand for telecommunication services and that most of them were interested only in telephony service. Very few villagers were interested in or had any knowledge about the Internet. We also learned that most of their cellular phone calls are local within the Mankosi community. This allows us to deploy an experimental local telephony service; a perfect opportunity for a low-cost and low-costing inverse mesh infrastructure that can easily be connected to breakout and Internet services in the future.

Index Terms— Converged service: Voice over IP, Limited range communications: ad-hoc WiFi, Core network technologies: mesh network topology.

I. INTRODUCTION

This paper presents work in progress toward the realisation of a sustainable business model for rural telephony in the remote rural community of Mankosi, located in the Eastern Cape province of South Africa. The community has difficult geographical terrain and scattered population, lacks basic necessities like electricity and tarred roads, and is situated at a distance of 70km from Mthatha.

During a number of informal interviews with the village leaders, we learned that there is a demand for telecommunication services and that most of them were more interested only in telephony service and not Internet. We also learned that most of their phone calls are local within the Mankosi community. This prompted us to deploy an experimental local telephony service; a perfect opportunity for an inverse mesh infrastructure that can easily be connected to PSTN and Internet services in the future.

Research has shown that rural communication, particularly in developing regions, has been a topic of interest for quite some time [1-11]. Recently, there have been many attempts in deploying community-based wireless mesh networks offering different services in developing regions and around the world, for example Bo-Kaap Mesh Network [1], Peebles Valley Mesh [2], Linknet [3], and Dharamsala Community Wireless Mesh Network [4].

IEEE 802.11-based wireless mesh networks are suggested as a cost-effective alternative for providing last-mile connectivity to rural areas, particularly those in developing regions [5,6]. It is for this reason that we considered using an IEEE 802.11-based mesh network with voice over Internet Protocol (VoIP). We believe that cheap telephony is the key to rural communications and that it should not be looked upon as a commercial service but as a developmental tool. Despite almost ubiquitous coverage, rural cellular networks are just too expensive for people to use so they resort to callback tactics and avoid making costly calls [7]. Because of mobile penetration, although scarcely used, voice is also a service that many people, especially those living in rural areas, can immediately relate to, unlike Internet, email and instant messaging.

A key objective of this study is to explore ways in which VoIP technology may help close the digital divide and improve the livelihoods of rural individuals, families and communities at large.

Despite the broad recognition that Information and Communication Technologies (ICTs) are key to social and economical development in rural areas, poor non-existing basic ICT infrastructure for telephony and Internet, low distribution of electricity, and difficult topological conditions are widening the digital divide. Such disadvantages degrade both social communication and business advancement, and isolate rural communities from the rest of the world [8].

Provision of telecommunication services to rural areas presents a unique set of technical and non-technical challenges, most of which are captured in [9] and [10]. Furthermore, from a telecommunications service provider's point of view, the risks involved in connecting rural communities are very high since the user density and customer payment capacity is low [11].

II. METHODOLOGY

This study focuses on building a sense of community ownership of both the network and the business model because doing so is imperative in assuring the success and sustainability of the network. We work in partnership with the Mankosi tribal authority and a local NGO called TransCape.

We follow the existing local procedures to work hand-in-hand with Mankosi community processes. This procedure consists of first having a private meeting with the Headman and his advisers to describe the idea, its potential positive and negative impacts, and if they like it, to ask for permission to work in the community. For this study, such a meeting was arranged by one of the authors, who was born in the community and has lived there ever since.

After being granted permission to work in the community, a second meeting was held (arranged by the headman) with his advisers and sub-headmen from the dozen villages within the community. For this network to be more relevant to the community, specific informational needs of rural individuals and the community at large were discussed. It was agreed that the community choose ten places to locate mesh nodes according to the technical, security and social constraints discussed in the meetings.

Initial usage of the network is envisioned as follows: the headmen and sub-headmen will call each other rather than walking long distances to communicate about tribal matters more efficiently. Local community members will also be able to use the VoIP network. All end-users will pay a small fee (yet to be decided). This is very different from standard Village Telco rollouts where local VoIP is typically given for free, and charges only made for breakout and/or Internet. Regarding the business model, it was agreed that the community will define the rates and will provide a mechanism for collecting money from end-users. The rates charged will provide the means for its maintenance and operational costs, carried out by a small team of local technical support and operators that we will train.

The proposed network will be installed by the locals, after being trained in basics of wireless networking, VoIP, dimensioning of solar system, and the billing system as a way to increase local buy-in of the network.

III. MANKOSI COMMUNITY NETWORK DESIGN

This project uses a low-cost Wi-Fi device called a mesh potato (see www.villagetelco.org). A mesh potato is a wireless router capable of running a mesh networking protocol with an Analog Telephony Adapter (ATA). This allows the use of a traditional telephone, also known as a plain old telephone service (POTS) phone. It runs on any DC voltage from 10V to 40V, or any AC voltage from 110 to 250VAC via a wall-plug type power supply. Since the ten community mesh sites have no power, we have designed a solar power system with a dual battery bank and will use power over telephone line (PoTL) to power the unit mounted on the side of a homestead. The power system comprises one 140W solar panel and two 105 Ah deep cycle maintenance-free batteries. The reason for over dimensioning the power system lay in the trade-off to provide extra electricity in the houses of the operators, who are going to allow everybody from the community to enter their households to make calls.

We have a monitoring server running Ubuntu OS that houses a billing system (a2billing), a network management system (Nagios) and the software for incidence tracking (Request Tracker for Incidence Response). All this is open source software, so further reducing CAPEX. This will be installed at TransCape's headquarters where there is Eskom power and a large battery backup system.

The community has selected the households to install the nodes of the network. Most of the nodes are mesh connected to more than one node so, if one node goes down, there will be no major consequences on the rest of the network.

As noted before, the solar system is over dimensioned to power the mesh network and its contribution to the CAPEX of the project is the highest, around the 55%, followed by the Wi-Fi equipment at 15%. Together with transportation, civil infrastructure, training and tools, CAPEX of the project totals 99000 ZAR. To approximate the OPEX, some historical knowledge of the network is needed to predict the failures and the cost of reparation. The long term financial sustainability of the network depends on the revenue obtained from its use. The Tribal Authority will decide the price per minute after the first 6 months of operation of the mesh VoIP network so that it benefits community members and allows for financial sustainability. This period will provide real data on usage and operation of the network which will allow a more accurate prediction of costs and enable a more informed decision from the Tribal Authority.

CONCLUSION

According to the reviewed literature, it is clear that more research still needs to be done for the rural village telco idea to take off. The more real world testbeds are deployed, and documented, the better we will understand how non-technical challenges affect sustainability of ICTs. The innovative participatory network design described and the proposed micro-revenue model will provide more insights about how rural community-driven wireless mesh networks could sustain themselves once external funding is gone.

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