Community Wireless Networks: Low cost broadband access and infrastructure

The CWRC Experience

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Abstract

This paper highlights the experiences of the Community Wireless Resource Centre (CWRC) since its inception in 2006. It begins with an introduction to the CWRC which arose out of the need to address the high cost of connectivity and then discusses the work of the CWRC to-date. The paper highlights achievements of the CWRC and the various challenges faced along the way. Finally, a summary is presented of CWRC research initiatives addressing some of challenges associated with low cost broadband, together with the future prospects.

Introduction:

The Community Wireless Resource Centre (CWRC) was established within the Department of Electrical Engineering with support from the International Development Research Centre (IDRC) in 2006. The CWRC arose out of the need to reduce the high cost of connectivity in IDRC-supported telecentres in Uganda, and to explore optimal connectivity models such as sharing the existing bandwidth with neighboring institutions via outdoor wireless networks. It was anticipated that by managing collectively the costs of connectivity at each Telecentre, more institutions could get access to Internet without heavy initial investments in satellite hardware and subscriptions.

The aim of this initiative was to make connectivity more affordable for Telecentres by implementing a communication infrastructure that is shared and managed by the community. Such concept is known as "Community Wireless Network", and it is based on the possibility for groups or communities to build self owned and operated networks. Hence, the projects would be in line with Uganda's rural communication development priority of "affordable communication services for all".

The general objective of the project is to provide or enhance sustainable Internet connectivity infrastructure, particularly in rural or under served areas in Uganda, by means of wireless technology. The CWRC would implement and support community wireless networks, train students and technical staff so as to build capacity in design, installation and maintenance of wireless networks, undertake research in the area of community wireless networks and document and share results widely.

Cognizant of the fact that affordable and equitable access to information remains a challenge especially in rural areas, the project would build on the various initiatives geared to improving internet access. These initiatives include the National Backbone Initiative (NBI), Rural Communications Development Fund (RCDF) and the Rural Electrification Programme (which also has an ICT component). The CWRC would provide a viable "last mile" solution to link subscribers up to the village level.

The CWRC Experience:

To-date, community wireless networks have been established at four telecentres in Uganda, namely, Kachwekano and Kabale telecentres in Kabale district, Nabweru telecentre in Wakiso District, and the Lira CPAR telecentre in Lira District[i]. Additional communication infrastructure in the areas includes cellular networks, TV and radio.

In general, all these networks are implemented in form of a star topology. The networks operate in the 2.4 GHz Wi-Fi band for both indoor and outdoor radio units. The telecentre acts as a hub as shown below;

A typical star-topology network implemented in Lira is shown below;
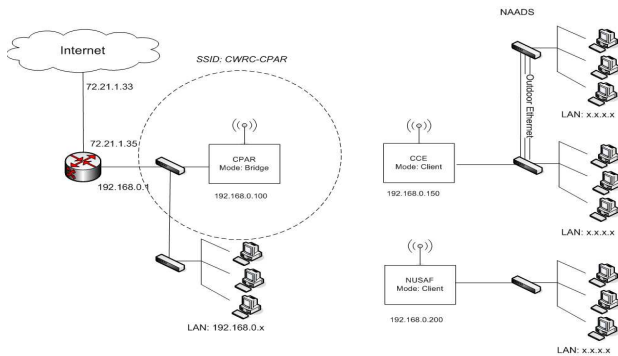
Typical network implemented in Lira, Northern Uganda in June 2007 by the CWRC; CPAR acts as a hub for CCE and NUSAF

There are nine clients (partners) in Kabale, four in Nabweru and three in Lira. This brings the total number of partners currently connected to the CWRC supported networks to sixteen. The clients contribute to internet costs on an equal basis and the subscription to the ISP is managed by the telecentre manager. The telecentre managers have been specially trained by the CWRC to provide technical support to the networks. Repeater stations were also used in Kabale to reach clients who were not reachable by direct line-of-sight. All the different networks supported by the CWRC have undergone varied experiences. Lira and Nabweru have a relatively flat terrain, compared to the hilly terrain of Kabale and there are generally low incomes at each of the four sites.

Challenges:

A number of operational and research challenges that have been encountered include the following;

1. The partners are not sensitized for instance on the ways of managing bandwidth to reduce on the cost of bandwidth. Much more bandwidth than had been anticipated is currently consumed, with Kabale consuming up to ten times more.
2. Breakdown of equipment is a major challenge for these wireless networks. This could be due the harsh environment or lightning. A case in point is the network in Kabale, whose central hub was destroyed due to lightning, rendering the network dormant. Worse still, there is limited local supply of wireless equipment.
3. The clients are currently not convinced about paying the same flat rates. The differences in user behavior mean that their bandwidth usage is different; hence they should pay different rates. This presents an administrative challenge to the telecentre manager.
4. The remuneration of the telecentre managers who maintain the networks is still not clear. They depend on "handouts" from the clients. This of course is not a sustainable way of running these networks.
5. There is a high turnover of the CWRC project staff. The CWRC continues to attract good graduates of the electrical engineering programme. In addition to there not being a salary structure of the CWRC, the offer for a graduate engineer starting at the CWRC is not as competitive, in comparison with the big telecommunication companies.

Solving the challenges through Research Initiatives:

The CWRC is currently involved in research initiatives to solve some of these challenges. The Wireless Africa (WA) project is one of such initiatives[ii]. WA aims at implementing low cost, affordable technologies and applications that result in the high use, potential revenue and/or dramatic cost-savings. This initiative will result into the implementation of appropriate business models for sustainability of telecentres.

The MP/ Scientists pairing scheme managed by the Uganda National Academy of Sciences (UNAS) is another initiative that attempts to expose policy makers to current technology trends and also enabling scientists to appreciate policy and the law-making process. This has a tremendous impact in enabling research groups like the CWRC to influence policy. For instance, this could create an enabling environment to make ICT equipment more locally available.

The CWRC also contributes to capacity building in the Department of Electrical Engineering through industrial training. So far, nine students have been taken on by the CWRC since its inception. These students are equipped with skills in wireless networking. Five of these students have gone on to do their final year research projects/ dissertation

under the supervision of the CWRC and two students have further stayed on as Research Assistants with the CWRC after completing their undergraduate studies.

The CWRC will address a number of bandwidth-related challenges for community wireless networks through a grant from the Millennium Science Initiative (MSI) project, managed by the Uganda National Council of Science and technology (UNCST). The MSI project will involve supervision, mentoring and training of sixteen (16) students and will address questions like;

a) How can traffic shaping be implemented in a "static" – as opposed to an adaptive wireless environment so as to ensure latency and congestion management as well as fairness within the network?
b) In the case of adaptive bandwidth schemes, what key factors should be actively monitored in order to determine and quantify the "extra" bandwidth utilized by a user?
c) What is the impact of the propagation environment on the viability of adaptive bandwidth management?
d) What impact does cognitive radio technology have on the number of users that can be hosted on a single cooperative network employing an adaptive bandwidth strategy?
e) What policy recommendations can be provided to improve the capacity of wireless technologies in the provision of diversified services and value addition – even in the presence of licensed users?

This research will provide tangible ways of implementing traffic shaping on a wireless network, so that clients are charged based on the bandwidth consumption.

Future Trends:

The networks supported by the CWRC have been operating for almost two years. During this time, the CWRC has held several workshops geared towards capacity building at the telecentres. Many participants have taken part in these workshops, notably telecentre managers and electrical engineering students from the Faculty of Technology.

The workshops included both theoretical training as well as hands-on practical training.

The telecentre managers, who have been technically equipped by the CWRC, are responsible for the maintenance and troubleshooting of any network issues that may arise from the community wireless networks. If the Telecentre managers cannot handle the technical issue at hand, then the CWRC can intervene.

The CWRC will set up a technical team composed of the students and staff in the Department of Electrical Engineering, telecentre managers and technical personnel at the telecentres to handle technical issues arising from the established networks. In this way, the sharing of knowledge will bring a two-fold benefit; (i) arriving at sustainable solutions for the Telecentres and (ii) enhancing capacity building in the Department of Electrical engineering.

The CWRC also has a mailing list subscribing the Telecentre staff, the staff in the Department of Electrical Engineering, the training students under the CWRC, and other stake holders in the public and private sector. This means that all the technical issues are discussed and appropriate solutions arrived at. We believe that in this way, sustainability of these Telecentres is achievable.

The CWRC will carry out further research and continually provide technical support to these telecentres. The research will continually address other upcoming issues such as bandwidth management, which is currently a key challenge to the Telecentres being supported by the CWRC. The CWRC will strive to have the telecentres achieve autonomy and sustainability while at the same time continue to build capacity in the Department of Electrical Engineering, Faculty of Technology, Makerere University.

References:

i CWRC Network Implementation and Training, http://cwrc.it46.se

ii Wireless Africa, http://www.wireless-africa.org/