Wireless Ghana
A Case Study

Prepared By

Community Based Libraries and Information Technology (CBLit)

www.cblit.org

Wireless Ghana

What follows is an in-depth case study of the **Wireless Ghana** project commissioned by and developed for the World Bank's **infoDev** group. This document has been prepared by a team of individuals working with Community Based Libraries and Information Technology (CBLit) at the Apirede Community Resource Center (ACRC), in the Eastern Region of Ghana.

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1. Introduction

1.1 General Detail

Network Name: Wireless Ghana – Akwapim Community Wireless Network

Location: Ghana, West Africa

Network Type: Community Wireless, Open, Mesh

Umbrella Organization: Community-Based Libraries and Information Technology (CBLit), Apirede Community Resource Center (ACRC)

General Demographic: Rural Villages, Underserved Areas, Low-Income, Developing Communities

Beneficiaries: School Children, educational institutions, church groups and small businesses

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1.2 Overview

Wireless Ghana is a project of Community-Based Libraries and Information Technology (CBLit), a non-government organization based in both Ghana and the United States. The Wireless Ghana project is a rural project. It was initiated at the Apirede Resource Center (CBLit's first Community Resource Center) in 2005 in response to the local community's requests for connectivity to help them break their isolation and move their children and community closer to the 21st century, and be competitive with their urban counterparts. Apirede is in the Akwapim[1] North district in the Eastern Region of Ghana. This district has seventeen towns and several villages with a total population of about 1.2 million people.

The project is being developed and managed by the Apirede Resource Center. The officers, volunteer staffing, and a variety of resources (Internet access, spare computer parts, etc.) are based

[1]Throughout this document we will refer to the local geographic district as "Akwapim," though it is also commonly referred to as "Akuapem."

at the Apirede Community Resource Center. Peace Corps Ghana has provided a teacher at the Apirede Community Resource center, Mr. John Atkinson, who is also acting as the Project Director for the Wireless Ghana project. They are able to do this because of the capacity they have gained by managing the center. The management committee together with the Chief and Elders monitor the activities/management closely to help create a professional environment, and professionally ensure that services/activities and orders are of quality and delivered on time.

The Apirede Resource Center staff has very quickly learnt the value of collaborating with other communities and that collaboration offers access to resources needed to help meet their challenges and achieve their agreed goals. There is a partnership between Apirede and Jumapo (the second CBLit center) and the wireless project is going to be extended there during the second phase of the project. Using the lessons learnt from the Apirede center, the Jumapo project would start operating on sound footing.

The Apirede center staff, having gained experience and confidence, is now also managing the HIV/AIDS program for the Ghana Commission for AIDS in the community surrounding towns and villages. The center recognizes the strategic location and the impact the wireless project could make in enhancing community health programs, education and economic and social activities.

1.3 Objectives

The Wireless Ghana project is committed to the goals set forth by CBLit:

- Promote a reading culture.
- Train rural schoolchildren and teachers in the use of Information and Communication Technology (ICT).
- Empower rural communities by providing access to information and breaking the isolation.
- Provide and use ICT to help increase direct participation in development and decision-making processes at local and national levels.
- Help to make Internet access in rural communities a reality.

1.4 Beneficiaries of the Project

The Wireless Ghana project will directly affect entire communities. Government organizations, public health services, educators, citizens and civic associations, business and the local economy are all potential beneficiaries of a community wireless network. Community wireless networks can serve as a local broadcaster to web cast town meetings, city council sessions, local speeches, or cultural events. Doctors can use the network to transfer information to patients with limited mobility as well as exchange patient information with other doctors, clinics, pharmacies, and hospitals. In this regard the Apirede community is working hard to complete its clinic which again

like the center will serve the surrounding communities. Local libraries will rapidly become a hub of free, open access to information. Wireless communication infrastructure promises robust job creation as businesses take advantage of lower barriers to market entry and the advantages of high-speed, low-cost communications[2]. A medium for communication and an available stream of information are two of the most empowering assets that a community can implement. The Wireless Ghana project is beginning to bring forth these achievable assets in its surrounding, rural communities.

1.5 Time and Scope - Major Project Phases

The project was initiated in early 2005. The first phase of the project is completed with ten nodes in the Akwapim Community Wireless Network providing ten points of connectivity to the Akwapim North district of Ghana.

To serve a wider area, phase II of the project, will be executed between September 2006 and September 2007 and will specifically address:

- Strengthening of the network infrastructure with a backbone of high-power, low-fault "central" nodes and a cost-priced VSAT solution;
- Expanding the network from 10 to 20 nodes by providing new access points to 5 secondary schools;
- Adding and maintaining nodes for small businesses, organizations, community groups and churches that can purchase their own equipment;
- Bridging current volunteers to part-time employees to achieve a stable workforce, well maintained and sustainable network;
- Hosting a conference on Community Wireless Networks in Ghana to address the applications of wireless networking technology through parts of rural Ghana.

In Phase III of the project, from September 2007 through 2008, the Wireless Ghana team will assist in the implementation of community wireless networks throughout the various regions in Ghana, particularly those with a CBLit presence. (CBLit's next centers will be in the Ashanti and Western regions). The pilot project, the Akwapim Community Wireless Network, will serve as a model in the implementation of these networks.

1.6 Sponsors

[2]Meinrath, Sascha. "Social Benefits of Community Wireless Networks." Free Press. Editor, Robert W. McChesney. Online. Internet. Thu, May 11, 2006. <http://www.freepress.net/wifi/social_benefits.pdf>.

The initial phase of the project has involved grass-roots development efforts with various local and international partners. Wireless Ghana has been assisted with funding, software-support, and know-how.

Phase I support has been given by:

- Community Based Libraries and Information Technology
- The Apirede Community Resource Center
- Peace Corps Ghana
- Champaign-Urbana Community Wireless Network
- MyGhanaOnline.com
- Ghana Educational Services
- Akwapim North District Council
- TakingITGlobal
- The Information for Development Program
- Student World Assembly

Additionally, there are a number of individual donors who helped initially fund and advise the project, as well as the schools and community organizations that have built network nodes throughout phase I.

2. Public Private Partnership Model, Organization, and Leadership

The Akwapim Community Wireless Network is a Community Wireless Network executed and maintained by a small group of volunteers. These volunteers also work in the Apirede Community Resource center established by CBLit. Rural communities in developing parts of Ghana use the network for information and communication purposes. The model of a Community Wireless Network is by definition one of varying organization and overlapping leadership roles. In this section we set out to show how members of the project go about working alongside one another, and how they go about working with the members of the communities they serve.

2.1 Staffing / Volunteers

There are 3 team members on the ground in Ghana that work on a day-to-day basis to extend and support the Akwapim Community Wireless Network.

Boateng Ebenezer: The Chief Technology Officer for the Wireless Ghana project, Boateng Ebenezer has a background in troubleshooting hardware setups and software installations. He is particularly adept at finding solutions to problems with failed hardware that result from sporadic, fluctuating power sources.

Title: Chief Technology Officer (CTO)

Qualifications: 4-Year Degree in Computer Hardware Support

Everyday Duties: Fixing broken machines throughout the network; viewing key network metrics that define the usability of the network's major nodes; monitoring network abuse; building servers that enable new services onto the networks.

Interdependence between Staff: On an average day the CTO may consult with the Projects Coordinator and/or the Director to procure funds in order to fix broken machines or installations that arise on the network. He might consult with the Projects Coordinator to discuss how people are using the network and how they can be best served. He might consult with the Project Director on new technologies that will improve network efficiency.

Gideon Amoah: The Projects Coordinator officer for the Wireless Ghana project, Gideon Amoah has a background in software implementation and ICT education. His duties are heavily involved with bringing technology to the layman and clearly communicating those technologies in a non-intimidating language and in their technology free environment.

Title: Projects Coordinator

Qualifications: 2-Year Degree in Software Basics and Education, Certificate in Network Administration

Everyday Duties: Teaching network users how to use the network; collecting fees to pay for Internet access; informing potential users on the details of joining the network.

Interdependence between Staff: On an average day the Projects Coordinator may consult with the CTO and/or the Director to add a new node or set of users to the network. He might consult with the CTO to discuss how members of the community can get more and better use out of their resources on the network. He might consult with the Project Director on methods for documenting and communication about the project.

John Atkinson: The Project Director for the Wireless Ghana project, John Atkinson has a background in engineering, programming, and interface design. His strengths lye in making innovative uses out of technology situations in which there are a lack of resources.

Title: Project Director

Qualifications: 4-Year Degree in Mechanical Engineering, 3 Years of experience in Programming and Interface Design

Everyday Duties: Finding technologies that will be both helpful and possible for the network; compiling customized routing software to power network nodes; monitoring network health, status, and abuse; sharing and communicating the project with outside agencies for mutual benefit.

Interdependence between Staff: On an average day the Project Director may consult with the Projects Coordinator and/or the CTO to discuss new technologies and their feasibility within the network. He might consult with the Projects Coordinator to discuss how people are adapting to the resources the network is bringing them. They may also discuss fee collection issues. The Project Director might consult with the CTO on the health and status of machines powering the network and how they can be backed-up, made more efficient, and strengthened.

While we all have somewhat specialized duties, often we find ourselves doing a little bit of everything. We all perform the following duties on a regular basis:

1. Travel to network sites and perform maintenance responsibilities
2. Recruit and inform organizations that want to join the network
3. Search for ways to improve the project from administrative, technical, and social viewpoints

2.2 Community Leadership – Roles and Exchanges

Within our rural town setting the community roles of leadership are diverse, but the main players are Chiefs, District Assemblymen, Member of Parliament and Ministers. As a project heavily entrenched in the local community we find our ties to have reached the level of the Chief, who is highest form of localized authority in any single town, and the District Assemblymen, who spend a good portion of their time working locally in the towns and villages of the Akwapim North District.

Ministers and Member of Parliament are much more powerful leaders, but their influence is more regional and/or national. They work in cities and are not a frequent part of rural community life.

Chiefs in the towns of Apirede and Adukrom have shown continual support for the Wireless Ghana project, without which we would be shutdown. The chief in Apirede frequently visits ACRC to meet with its board of directors and view progress of the all of the center's activities, including the wireless project. This interaction, by extension, has allowed him to understand the role of libraries, technology and therefore made him appreciate the effects on his community and neighboring towns and villages. These interactions have made the most powerful man in town a convert to the impact of technology on communities and businesses and a willing champion of the wireless project. Because they see and have experienced the impact of technology, these chiefs are actively engaged and are seeking space for us on telecommunication towers in nearby villages and town. It is our observations that for these projects/activities to be successful in the rural areas, a strong champion in the chief or the elders is needed. This is also important because most of these areas have not seen or managed projects of such scale – in case of Apirede a Resource Center with four major core components (Library, Women Center, Children Center, ICT Facility) and in addition the wireless project.

Like the chiefs and elders, the Akwapim North District Assembly has also realized the transformation in the areas with access to communication. The Assembly is working with Wireless Ghana to allocate funding for network nodes in libraries and community centers, in the nearby towns of Abiriw and Dawu. Abiriw and Dawu are located between Apirede and Akropong, well within reach of the wireless network (See Map 4.1.1 in Section 4).

Some key community leadership has come from outside of the local community to express interest and give support. The CEO of MyGhanaOnline has given Wireless Ghana their web hosting services, as an effort and example of promoting volunteerism, non-profit and community-driven work in Ghana. The website has been an invaluable tool in sharing and communicating community wireless networking ideas, for mutual benefit, with similar projects worldwide. The Ghana Educational Services has been a supporter and has provided logistical support in the building of network nodes in the Akwapim Community Wireless Network. Their support of Wireless Ghana's activities in senior secondary schools is a driving force for phase II of the project, which will address building nodes for five cooperating schools in the Akwapim North district.

2.3 New Nodes - Community Contracts

When a new node is built a new contract is made with an organization in one of the communities served by the network. Typically nodes are built and installed by the volunteers of Wireless Ghana. We support the idea that organizations start building and installing their own nodes but the current state of the technology in place is complicated for the non-technical people. Therefore, Wireless Ghana team writes a contract for potential node users that allow them to obtain access to the network. A typical contract can be seen in Appendix A. It informs the node user of the cost of the startup equipment, the timeline for installation, and the cost of Internet services on the network.

The cost of a typical installation is about USD $500. This covers all of the equipment and installation expenses necessary to mount an antenna on a rooftop, run cables indoors, setup an indoor router, and connect personal computers to the router. Nodes are guaranteed to be installed within two weeks, depending on the availability of equipment that must be imported.

One thing that is not addressed in the contracts is a maintenance service agreement. Currently minor maintenances are performed free-of-charge and the teams available to do so. Most times, maintenance is something very simple but because *volunteers* perform the maintenance, as there is no full-time staffing, often it can take weeks to fix a minor issue.

3. Project Financing Approach

The Wireless Ghana project started with next to no capital. We used a small amount of personal monies to buy some wireless equipment and play around with it. After hundreds of tests with antennas in different locations we were able to bridge a 5km link. When we were able to prove that the technology was possible we were able to attract the first organization to purchase a node. Our startup costs were mainly aimed at proving the viability of our venture. As a community wireless network we started with two nodes, the bare minimum of a network, and have steadily expanded one at a time throughout the first phase of the project.

While the cost of starting up the wireless network was minimal, without the existing resources in place there would be no Community Wireless Network. The service that attracts people to buy a node on the network is Internet access. That came from our umbrella organization. Community Based Libraries and Information Technology is the facilitating NGO that supports the everyday logistics of Wireless Ghana. The offices, volunteer staffing, and a variety of resources (Internet access, spare computer parts, etc.) are based at the Apirede Community Resource Center (ACRC), CBLit's initial, flagship community resource center. Wireless Ghana is heavily attached to CBLit and ACRC. The existing resources at ACRC have made the Wireless Ghana project possible.

Having proven the possibility of the project with the existing resources a main financial obstacle to expansion is the cost of adding a node. We saw in the previous section that each node cost roughly USD $500 to build and install. Imagine if everyone in developed countries had to pay that much money, directly, in order to obtain access to communication and information. In Ghana's rural villages that amount of money is a high price to pay. It is out of the reach of most individual and explains why the majority of the network nodes are owned by larger organizations.

The largest obstacle, however, in the financial approach, is the service fee for access to the Internet. It is one thing to pay a high price for a one-time installation of equipment, but when those high prices are a constant expense there is a real obstacle toward progress. It is this problem that the idea of an open network, where anybody can competitively offer services, attempts to address. In the next section we will look at how Satellite Internet services in remote, rural areas are nearly unusable due to their exorbitant costs, and how that is not only a function of the technology, but also of the local policy.

3.1 Financing Access for Service - Internet

A major drawback to telecommunications access in developing countries is the cost of services. The backbone for services, chiefly Internet access, in a developing area with limited-to-no existing communication infrastructure, is often a satellite feed. Satellite feeds are expensive, both in terms of the one-time investment in equipment and the continuing service, as compared to most landed forms of access (DSL, Cable, telephone line). Prices for satellite access in developed nations are significantly better, but often those ISPs are reluctant to work in places like West Africa, for fear of financial instability. Table 3.1.1 outlines the fee structures of an ISP in Ghana, Accelon, versus those of an ISP in Serbia and Montenegro, VoySat. These prices are a snapshot from February 23, 2006.

Table 3.1.1 Satellite Internet Fees Structures – Shared Access - Ghana vs. Serbia

Serbia – **VoySat** *$USD*	*Ghana* – **Accelon** *$USD*	*Bandwidth* – ***Internet Speed and Capacity (down/up)*** *kbps*
n/a	450	***128 / 32 (slowest)***
n/a	750	***256 / 64***
203	1500	***512 / 128 (average)***
407	n/a	***1024 / 128***
623	n/a	***1024 / 256***
755	n/a	**2048 / 256 (fastest)**

From Table 3.1.1 it is clear that broadband Internet access is much more readily available in Serbian than in Ghana. The one directly comparable commodity, bandwidth at 512/128, an average speed comparable to DSL in the United States, is 7-8 times more expensive in Ghana than in Serbia Montenegro. Buying service directly in Ghana is generally much more expensive and the services tend to offer considerably less in terms of the quantity of product.

3.2 Outlook for the Future

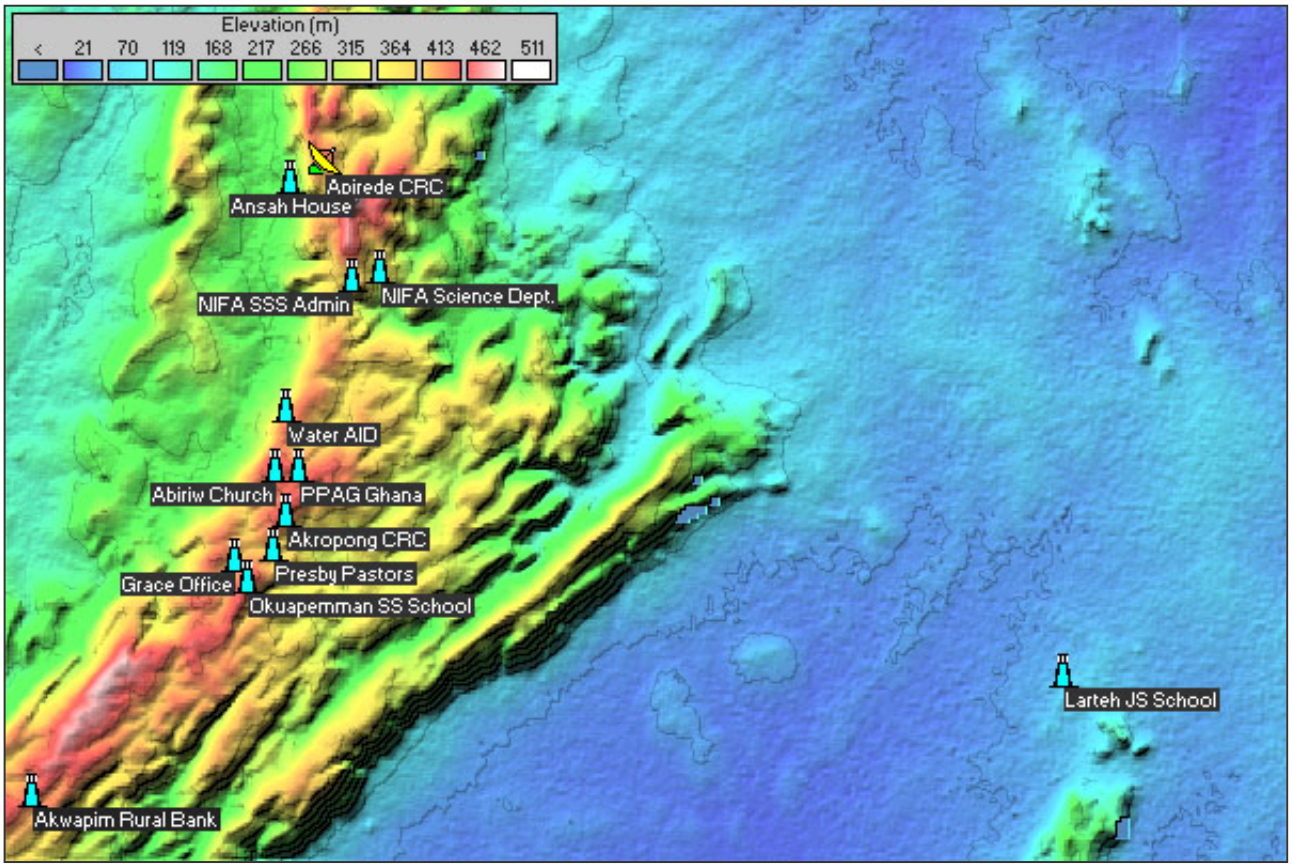
In order to continue our work and expand the project into more rural, underserved areas we have developed a budget for the second phase of our project. Appendix C gives an overview of the major expenses we foresee in doing that work. This budget is addressed toward foundations that allocate grants.

4. Project Technology

4.1 Template for Network Architecture - Applied Technologies

The Akwapim Community Wireless Network is an open-architecture mesh network that uses cost-priced WiFi technology and open-source software to share Internet access. The network currently has over ten nodes, and spreads out over a 20km range, offering connectivity to schools, businesses, and community activity centers throughout six towns in the mountainous Akwapim North district of Ghana's Eastern Region. Figure 4.1.1 maps out the existing nodes on the network.

Figure 4.1.1 Topographical Overview – Akwapim Community Wireless Network



The CUWiNWare software, from the Champaign-Urbana Community Wireless Network, implements the mesh network. It has advanced algorithms that determine the best path for an “Internet” signal to travel to get through the network, from point A to point B. It is an "organic," open-architecture platform, in that a node can enter or leave the network at any time, without any changes needing to be made to the other nodes.

Each node has an antenna and a router, and various cabling. The antennas vary in size and structure with application; highly depending on each proposed connection. Figure 4.1.2 depicts a typical antenna installation. The routers are built from desktop computers and wireless cards; they

are nearly all identical. Figure 4.1.3 shows a router being used at the Akropong Community Center.

Most routers are constructed out of old computers and new wireless cards. Most of the nodes are made from Dell OptiPlex units and D-Link DWLG520 WiFi cards. The computers used do not need hard drives and therefore are well suited for work in developing countries. CBLit has many computers lying around due to a broken hard drives; the result of an unstable electricity supply. These are used to build-out the network.

Figure 4.1.2 Antenna for Okuapemman Senior Secondary School

Figure 4.1.3 Low-Cost Network Node at Akropong Community Center

The wireless implementation is standard IEEE 802.11b, running in ad-hoc mode. Due to the emerging widespread popularity of this technology in the consumer marketplace, it is easy to obtain and use off-the-shelf WiFi equipment. Some of this equipment is now available in Ghana, though in the beginning there was a need to import equipment from the United States and Poland.

In order to provide Internet connectivity to all the nodes, the open-access architecture nature of the network allows an uplink to the Internet to be placed at any of the nodes. This is a key to its flexibility as it expands. Currently there is a VSAT at the Apirede Community Resource Center providing a 128/32 (downlink/uplink) kbps link. In phase II a cost-priced VSAT solution would be added to provide true broadband speed (512/128 kbps). The increased bandwidth will permit more people to connect, and thus allow the expansion of the network to 20 nodes. The open-access nature of the network means that anyone who has a node can offer services, such as Internet connectivity.

The “open networking” goal of the CBLit’s Wireless Ghana pilot project, the Akwapim Community Wireless Network, is to develop a truly open-access network where services (Internet access, voice over IP, video applications, etc.) can be offered by anyone, anywhere on the network, and where content can be created by anyone and shared.

4.2 Technical Problems

The main technical problems afflicting Wireless Ghana are threefold:

- Enormously expensive cost of buying satellite bandwidth in Ghana[3]
- Lack of a steady, reliable power supply from the Electric Company of Ghana
- Lack of capital to secure cost-valued consumer and professional electronics equipment into the infrastructure of the network, thus making it a reliable resource to the community

The solution to these problems, which are all financial in nature, has been to add equipment slowly, as the funds become available and obtain the equipment from developed nations. The center now has very basic uninterruptible power supplies on the two nodes that comprise the networks backbone. One of these nodes has an amplifier to strengthen its WiFi signal.

All antennas, most cables and connectors, and the amplifier have been purchased from the United States or Poland. The initial batch of WiFi radios were shipped from the United States. The WiFi radios are now available locally, though at a much increased cost.

Our highest technical priorities for our next phase of work, Phase II, include:

- Securing a cost-effective VSAT solution that will scale with the network. This has been difficult because access to telephone communication is limited and expensive. Many of the companies that offer the services needed are not seriously working in West Africa[4].
- Building durable, sustainable masts for the antennas (a lesson being learned in Phase I): This is possible in Ghana, though quality materials are hard to come by and generally very expensive. Where masts have to be built, investments have been made in quality steel workmanship. If the center is able to build a mast in Abiriw, or obtain co-location with SpaceFon (a multi-national cell provider), who operate a mast in the Akwapim region, that would reduce the need to build smaller masts at end-user locales - putting an antenna on a 70m mast would make it accessible to a majority of building tops in Akwapim. Co-location, though, will likely be outside of CBLit's limited finances. However, effort is being made to have access to these masts through the government channels that operate them.
- Implementing uninterruptible power supplies into the backbone nodes, specifically at the satellite location and on the omni-directional feed antenna in Abiriw (see Figure 3.1). These have to be capable of powering a node for at least 8 hours of continual downtime, which is typical of the electricity supply here. This will alleviate the damage to equipment and network downtime resulting from the current power supply.

[3] See section 3.1
[4] See section 3.1

5. Benefits to the Community

5.1 Educational Benefits

The Wireless Ghana project believes the use of computers to communicate and to access stores of information is a viable weapon in the fight to create a reading culture and to surpass conditions of poverty. The general ability to read and write is becoming less of a problem in Ghana, but the ability to use those skills for effective communication in a global marketplace is a different story. The lack of a reading culture in Ghana is a problem that needs innovative attentions and solutions.

The center in Apirede was established only eighteen months ago, and Jumapo, the second center, is barely a few months old. Therefore the statistics available show the number of children and adults using the center and the interest in technology. How the use of technology has affected their school work would take sometime to measure.

However, a few observations have been made. CBLit is witnessing changes in the two pilot communities, especially the one in Apirede. Evident is the excitement and awareness by most of the citizens of the benefit of technology and information exchange and its effect on their children's education. Parents are trying to understand ICT and urging and encouraging their children to use the center and its facilities because they see some children are showing results.

Figure 5.1.1 Junior Secondary School Students at Apirede Community Resource Center

Figure 5.1.2 Streets of Jumapo – One of the Communities Wireless Ghana Is Working In

The Wireless Ghana project brings educational benefit in various ways, but centrally through connectivity. By providing access to the Internet communities are exposed to vast collections of information and literature in various languages. And by using the Internet to find information communities begin to realize the immediate economic gains that come from such information. A school student can go online to read the texts of ancient Greece, and a farmer can search the Internet for tips on better rural agricultural processes.

5.2 Social Benefits

The social transformation is clearly evident and people who have never been allowed to manage projects of such scope can see the results of their effort. On display are citizen's confidence, the willingness and ability to do things for themselves. Citizens are looking beyond narrow agendas and entrenched traditional bureaucracy, toward vision and open-minded approaches.

Citizen's realization of the sense of ownership of the project has been a central driving force toward progress. Through inclusion of rural perspective and reality, and by making the citizens manage the project themselves, there has emerged a "can do" attitude and the tenacity to make the project a success.

The community is learning quickly the value of collaborating with CBLit and other communities to achieve their agreed goals and that collaboration offers access to resources needed to help overcome their challenges.

The women who at the beginning of the project were seen only in the background are now articulating their needs and those of their children, providing suggestions and getting the men to accept constructive criticism. The economic gains from the women center are certainly empowering them. This empowerment is important because their participation is needed in the fight against poverty and the education of children.

A few statistics throws light to what is happening. The Computer Center trains teachers and children from primary grades through high school (SSS) as well as adults in introduction to ICT to help break the isolation and make them competitive. From October 2004 to March 2006 one thousand, seven hundred and twenty-one (1,721) school children and one hundred and twenty-eight (128) adults have been given introductory classes. Access is also provided to the Internet (Internet Café) and Games Room. During the same period, three thousand, and sixty-five (3065) people from the community and neighboring communities have used these two facilities. Also organized by the ICT center is the **Film/Video/Media Room.** Films and videos are screened from their impressive video library of educational cartons for children and tapes on health, sanitation, childrearing and parenting and governance for adults.

5.3 Business Benefits

Communities are signing up to obtain help and get access to the wireless Internet services. The problem is CBLit's lack of resources to move quickly to satisfy demand. Small businesses, organizations and churches are aware of:

- Large amount of literature available to them, exposure to vast collection of information and eventually the economic gains that come from such information in the language of instruction

- The immediate economic gain from becoming literate;

- A small project managed by a dedicated staff providing close attention;
- A program that is responsive to their expressed needs.

5.4 Equitable Access Targets

A description of how the technologies proposed by the Wireless Ghana project will promote equity of information availability to different demographics of the Akwapim-North district, including individuals of all ages, from both the public and the private sector.

Any individual, organization, or agency is encouraged to build a node for his or her own access. It is the intention of the project to provide nodes to schools as well as offer connectivity services to private enterprise. Through these connectivity efforts Wireless Ghana is reaching thousands of individuals in the local communities. Table 5.4.1 lists key demographics and the means by which they are served by Wireless Ghana's Akwapim Community Wireless Network.

TABLE 5.4.1 Tactics for Inclusion of Equitable Access Targets

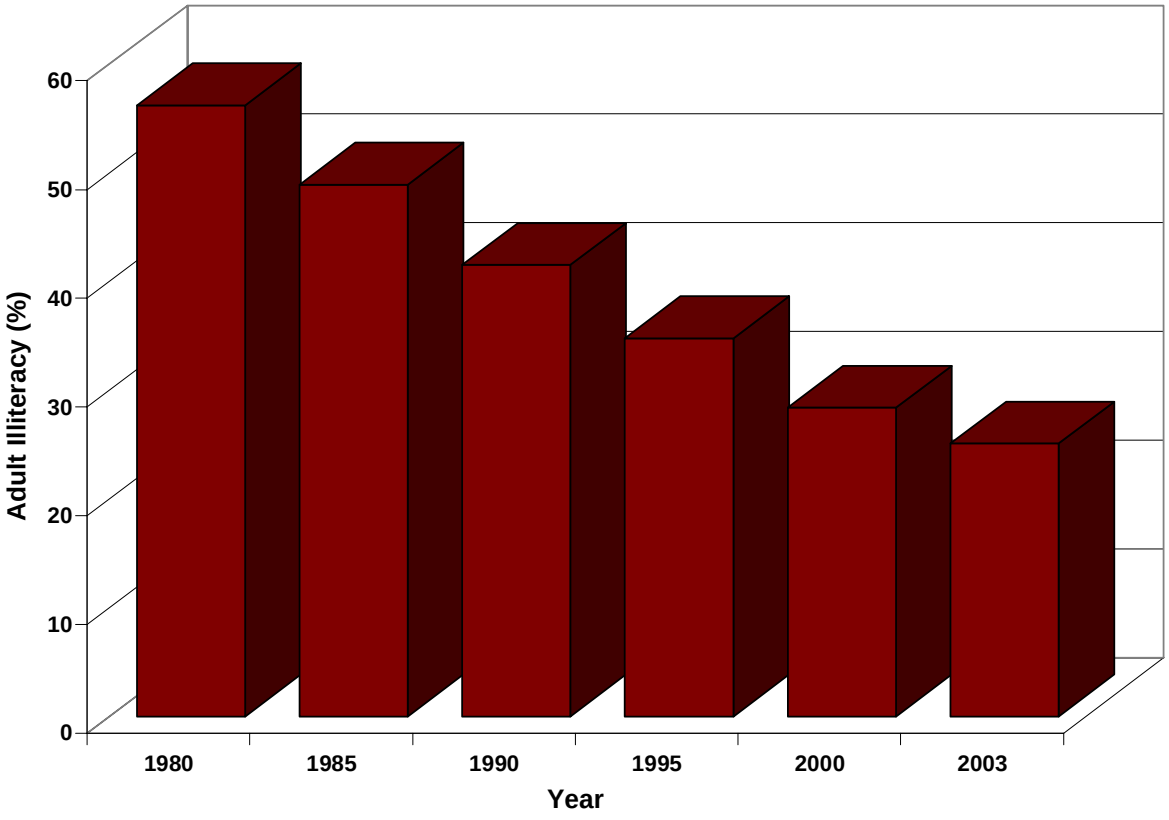
Equitable Access Target	*Tactic for Inclusion*
Public school teachers	Internet connectivity and educational software (typing, word processing usage, spreadsheet usage) in administration buildings.
Parents public school students	Access to information at the Internet cafes run by the community centers, on a pay-per-minute basis.
Public school students	Student computer labs will be outfitted with Internet connectivity and educational software (typing, word processing usage, spreadsheet usage).
Private school students and teachers	The availability of information from Internet cafes run by the community centers will empower private school affiliates.
Other public school educational personnel	Via Internet-connected terminals in the classrooms and administration buildings all public school personnel will have some access to information technology.
Other interested parties including, but not limited to, home schools, business owners and managers, government officials and office personnel	The availability of information from Internet cafes run by the community centers will empower private school affiliates.

6. Society and Economic Factors: Why this Project?

The Wireless Ghana project proposes that the use of computers to communicate and to access stores of information is a viable weapon in the fight to build a reading culture. The general ability to read and write is becoming less of a problem in Ghana, but the ability to use those skills for effective communication in a global marketplace is a different story. The lack of a reading culture in Ghana is a problem that needs innovative attentions and solutions.

Over the past 20 years there has been a decline in illiteracy in Ghana. This progress can be seen in Figure 6.0.1. Current levels are half of what they were in 1980.

Figure 6.0.1 The Decline of Illiteracy in Ghana.
Source: Globalis Maps – http://globalis.gvu.unu.edu/



Looking at Figure 6.0.1 we can project that in 2006 it is likely that well over half of Ghanaians have the ability to read and write at an acceptable level[5]. A major factor in the progress of literacy

[5]Qualifications for UNESCO data: Adult illiteracy (rates for adults above 15 years of age) reflects both recent levels of educational enrolment and past educational attainment. In so far as possible, data refer to the proportion who cannot, with understanding, both read and write a short simple statement on everyday life.

has been the effort of the local government, through agencies like Ghana Educational Services, to get children enrolled in Primary schools.

But what this statistic does not show us is the practice of reading and writing skills on a daily basis. It may be true that a majority of Ghanaians can demonstrate a form of literacy (write a short paragraph about their daily activities), but this majority is not using these skills with regularity. People do not have books; very few people read the very few newspapers; access to libraries, computers, and the Internet, humanity's pool of information, are limited to non-existent in rural areas. In short, reading has not been adapted into the culture, nor has it had a chance to be. There is theoretical literacy, but a *practical illiteracy*.

Two driving factors of *practical illiteracy* are a lack of access to affordable communication and a lack of access to information. In Ghana both of these factors exist. Figure 6.0.2 and 6.0.3 compare two indicators of economy that are directly related to illiteracy: access to telephone lines and access to the Internet, within Ghana and its neighboring West African countries with that of the United States.

Figure 6.0.2 Main Telephone Lines per 100 Inhabitants, Ghana vs. U.S.
Source: UN Common Database (UNESCO estimates)

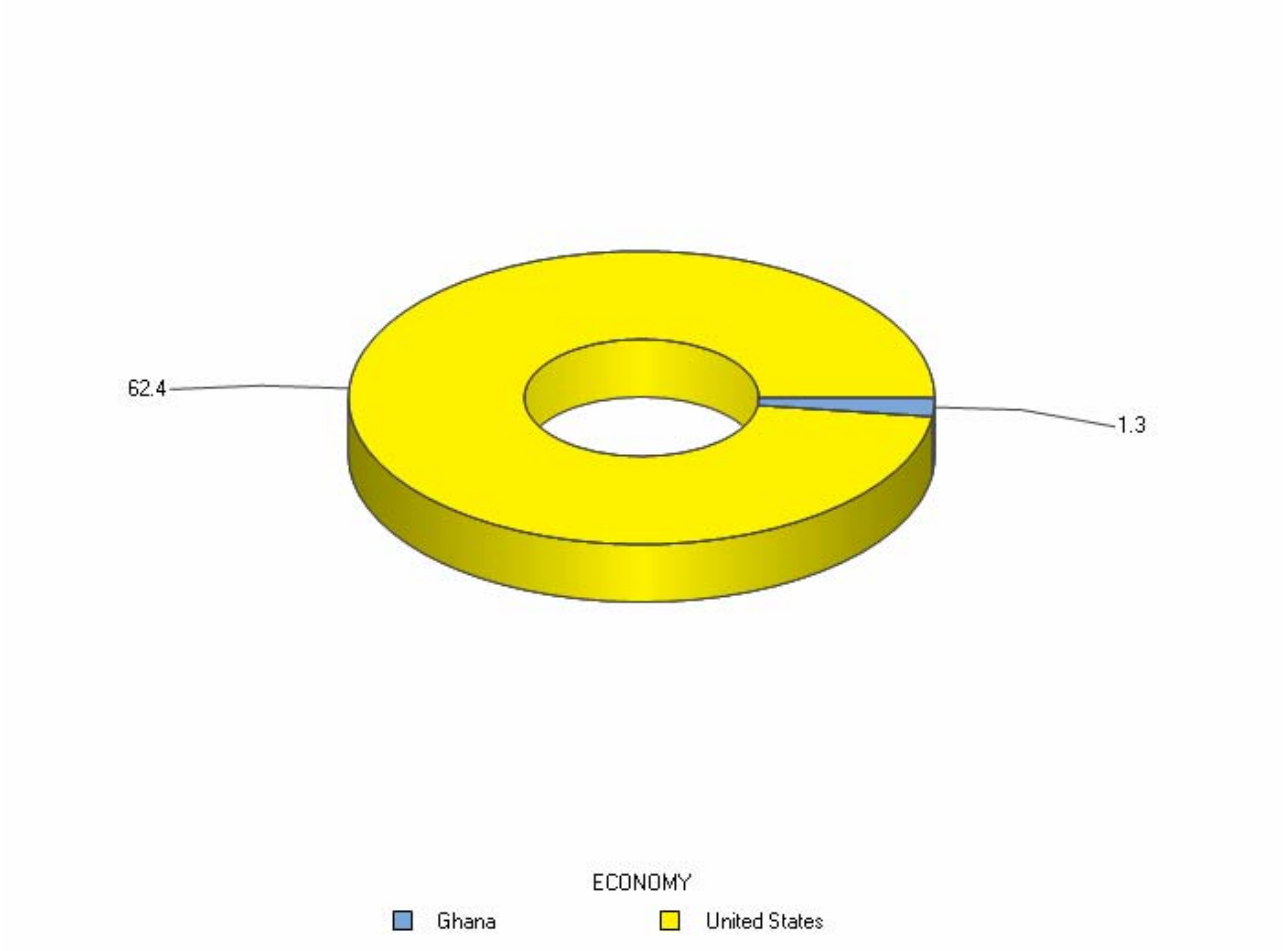
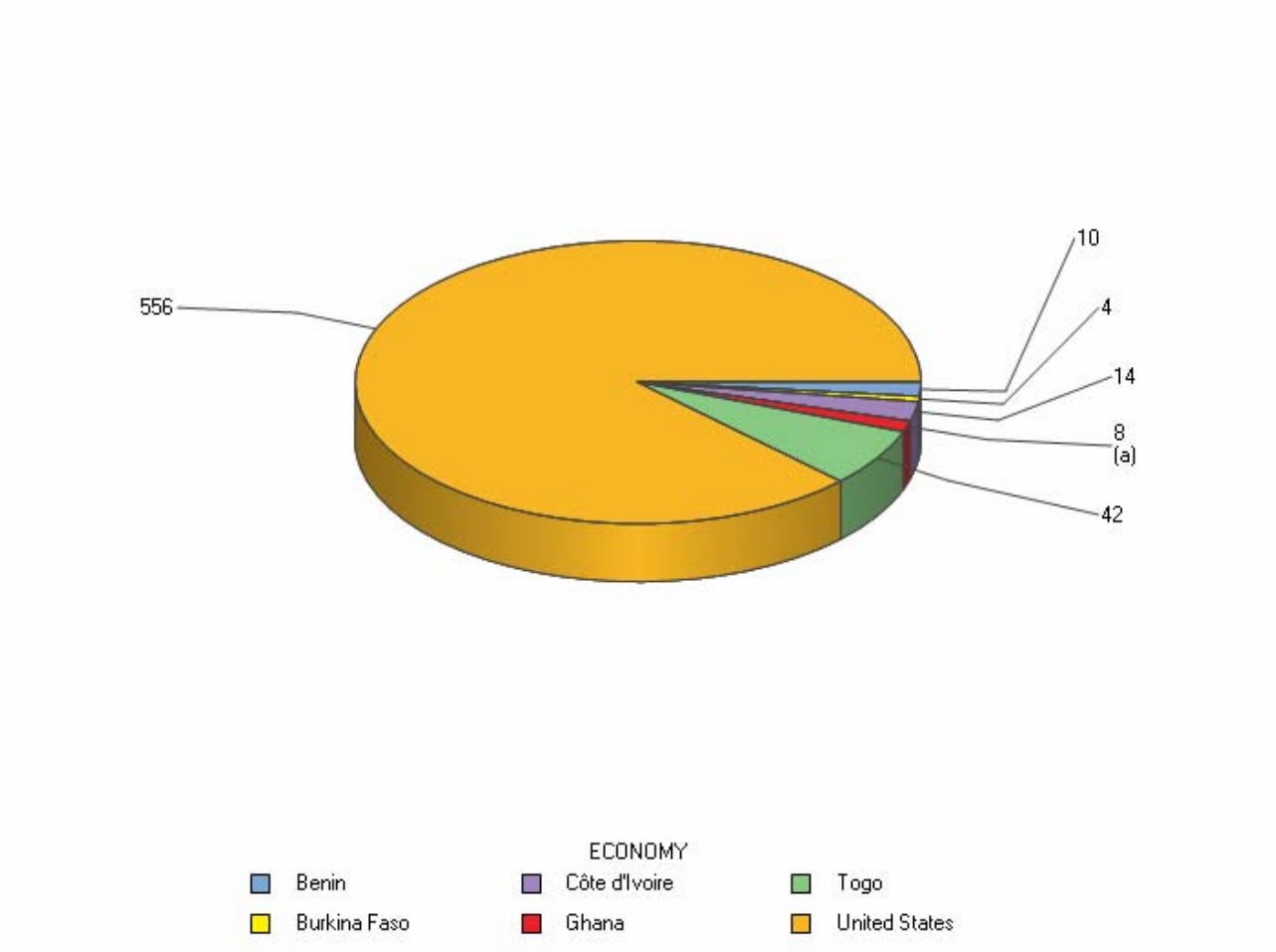


Figure 6.0.3 Internet Users per 1000 Inhabitants, Ghana (and neighboring West African countries) vs. U.S.
Source: UN Common Database (UNESCO estimates)



(a) – data from 2002

The solution to a problem of illiteracy is to promote a reading culture. CBLit's Wireless Ghana project is working, to promote literacy and a reading culture.

Key factors that make literacy programs thrive include[6]:

- Large amount of literature available to the learner in the language of instruction.
- Learner's perceived immediate economic gain from becoming literate.
- Small project with a dedicated staff.
- Learners perceive that the program is responsive to their expressed needs.

[6]Peace Corps, *Peace Corps Literacy Handbook* (Washington DC: Peace Corps – Information Collection and Exchange, M0021, 1984), 13.

The Wireless Ghana project meets these goals in various ways, but centrally through connectivity. By providing access to the Internet learners are exposed to vast collections of information and literature in the various languages. And by using the Internet to find information learners will realize the immediate economic gains that come from such information. A school student can go online to read the texts of ancient Greece, and a farmer can search the Internet for tips on better agricultural processes.

7. Policy and Regulatory Issues

At the community level policy toward the Wireless Ghana project is very simple. The community accepts the project because it is seen as generally beneficial. Policies in small towns and villages in the Akwapim North district of the Ghana's Eastern Region are more likely to be vocal acceptance by community leaders than to be written code.

7.1 Existing National Policies

National policy for the ICT sector is in the process of being made. We have found no active legislation regulating ICT-related activities, nor has anyone approached us with such legislation.

7.2 Planned Policies and Research

There have been various studies conducted to outline potential public policy for Ghana's ICT sector. It is useful to recognize the objectives and conclusions of the more potent of these studies.

In December of 2000 the Economic Commission for Africa published a *Plan for National Information and Communications Infrastructure of Ghana 2000-2005.* This research effort attempted to document the current states of ICT-related affairs and formulate a path of execution that would bring about optimal social and economic benefits via ideal public policy. Specifically, the objectives[7] of the plan were,

- Assessing the level of information and communication infrastructure in Ghana,
- Appraising Ghana's information and communication policy,
- Identifying projects with links to other project databases such AI-AIMS and Mike Jensen's project databases,
- Determining the level of ICT content development,
- Identifying links to information and communication material at country level,
- Identifying key ICT indicators,
- Determining Ghana's NICI strategic objectives and
- Proposing priority actions.

The plan developed from this study identified 5 key areas to address:

- Infrastructure development
- Education programs
- Flagship Projects
- Human resource projects
- Communication with stakeholders

Specific actions identified within the above categories include action campaigns that would give people awareness of what ICT resources are available to them, a concentration on capacity building and certification of individuals, the buildup of databases to manage the human talent of the

[7] Economic Commission for Africa, *Plan for National Information and Communications Infrastructure of Ghana 2000-2005* (UNECA, International Development Research Centre - Accra, Ghana. December 2000), 6.

workforce, and infrastructure improvements to facilitate communication across the nation. These projects are currently in various stages of development and implementation. The volunteers at Wireless Ghana have worked with regional government institutions to help the buildup of infrastructure. It has been seen firsthand that at least some of these projects are ongoing, though the one project directly observed by Wireless Ghana - public wireless Internet infrastructure in the regional capital of Koforidua - was in the very early stages and not yet a viable resource to the community.

One of the leading Ghanaians in the field of ICT is professor Clement K. Dzidonu of Valley View University. His work in conjunction with UNECA has resulted in the publication of *An Integrated ICT-Led Socio-Economic Development Policy and Plan Development Framework for Ghana*. This report includes an in-depth analysis of economic factors and trends from which conclusion and direction on ideal policy points are derived. Major research findings and lessons[8] of the study include:

The Leap-Frogging Notion - ICTs present a 'window of opportunity' for developing countries to progress from a situation of 'zero' or 'limited' technology to widespread adoption of 'sophisticated' technologies, without going through the stages of technological adaptation and learning experienced in developed countries.

Most ICT Pilot Initiatives in Developing Countries are not Primarily Directed at Impacting on the Overall Socio-Economic Development Process - The majority of the ICT projects and initiatives in most developing countries including those of Africa are community-based ICT initiatives. Most of these are typically of small-scale pilot nature and not directly targeted at achieving overall developmental policy goals and priorities of these countries. The scalability of these rural pilot initiatives cannot therefore be taken for granted; specific attentions will need to be given to addressing issue relating to: (i) local and community-level involvement and ownership of these initiatives for them to survive after the project initiators or backers have left the scene; (ii) the mobilization of the necessary financial and other resources required to implement the projects beyond the pilot stage and (iii) addressing administrative and other bottlenecks that could pose a problem for the implementation of these projects.

The Developmental Impact of ICTs is Limited… if their Deployments are not Accompanied by Changes at the Organizational Level - For ICTs to have a real appreciable impact on Ghana's development there is a need to address a number of critical success factors and conditions at the institutional and organizational levels. Some of these include enforcing changes to unproductive organizational systems, structures, procedures and processes, as well as addressing poor attitudes to work and unproductive and inefficient work ethics which could hinder the effective exploitation of these technologies to improve organizational efficiency service/produce delivery, productivity and reduction in operational cost.

For ICTs to have a Significant Impact on the Overall Developmental Process, its Diffusion within the Economy and Society must Reach a Critical Mass Level - In effect the level of

[8] Dzidonu, Clement K. "An Integrated ICT-Led Socio-Economic Development Policy and Plan Development Framework for Ghana." Institute for Scientific and Technological Information. Online. Internet. Wed, August 23, 2006. <http://www.ghana.gov.gh/pbcopin/ICT4AD-Framework.pdf>.

diffusion of ICTs in [developing] countries, is far less than the critical mass threshold that is required before appreciable developmental gains are achievable from the deployment and exploitation of these technologies. In Ghana, as is the case of most African countries, areas of deficiency include the 'less-than-mature' nature of local ICT industry partly due to under-investment in the industry; the mismatch between domestic demand and supply; lack of critical mass of technical and managerial capabilities to develop, manage and support the implementation and exploitation of these technologies within the organizational set-ups, and the limited spread of the deployment and exploitation of ICTs within the economy and society to generate enough critical mass of economic activities that could impact on the overall developmental process.

The conclusions of Professor Dzidonu's research give insight to problems and solutions addressable at a national level. They are, therefore, key deductions from existing conditions and trends that may aid in the implementation of an ICT policy framework nurturing of socio-economic growth in Ghana. Research and lessons learned from both of the aforementioned studies are likely to have a significant impact on future policy, as bills are drafted and debated in the Parliament of Ghana.

8. Lessons Learned

The lessons being learned by pilot projects vary in scope. The largest scope includes:

- Local capacity Constraint: low level of capacity limits the effectiveness of communities to help with development projects and use resources productively; therefore more capacity training should be an ongoing and should be integral part of any projects.

- Ensuring a data-driven culture: on going education for data driven culture should be natured and encouraged.

- Sustainability: cannot rely completely on the communities for the sustainability of projects because of the above problems and their interdependence.

- Grants needed from outside for the first three years to cement the sustainability of the project. The three years allows the project to generate enough funds to help them stand on sound footing.

In the technical realm of problem solving Wireless Ghana is working to produce HOW-TO's that will disseminate the solutions we are continually developing. Some of the more specifically technical lessons include:

- Managing Bandwidth – There are ten nodes on the Akwapim network and they are all served Internet via a shared 128/32 kbps VSAT Internet connection. This is a constant struggle for the project and we are continually developing methods to bring the most efficiency out of the bandwidth we have. We have implemented open-source software tools that include proxy servers, caching proxy servers, browser optimizations, and layered approaches to bandwidth limiting at bottleneck network points. In Appendix D there is an example page from a HOW-TO that optimizes bandwidth at the client level. The full document is available for download on our website.

- Training – Using the Internet on a slower, shared line is very different from doing so when there is plenty of bandwidth available. We have developed methods of browsing that allow a user to obtain a very effective stream of Internet access with a very small amount of bandwidth throughput. Training efforts also include the creation of guidebooks to help people with nodes to troubleshoot their wireless networking hardware and software.

- Optimizing Wireless Network Connections – We are always looking for ways to make our software more efficient at bridging distant locations through wireless technology. Our project has achieved very long-distance connections with solid reliability. We build-out and disseminate our lessons on wireless connectivity with our partner organization, the Champaign-Urbana Community Wireless Network, via our website, their website, and their public software development mailing lists.

All of the technical knowledge in the world won't create a thriving community wireless network. Possibly the decisive factor in working in the rural parts of developing areas is the rapport a

project's members create with the leaders of the local community. When the Public Private Partnership Model is that of a Community Network the leadership of the implementing organization, as well as the core of the Policy and Regulatory Issues, are heavily influenced my the immediate leadership in the target communities. Lesson learned in this realm include:

- Clear Communication Channels – When we do an installation in a new community it is crucial to inform the local governing bodies of our presence, our timetable, and our intentions. In Ghana this means visiting with chiefs, scheduling meetings with district councilman, and, quite importantly, maintaining open communication with the local people who you are working side-by-side with. The tactics we are building for community integration may not be universal in their applicability outside of Ghana, but the awareness of the need to address them is.

- Follow-ups – It is common for ICT projects in developing areas to fail. When you work with people to bring them technology services it is helpful to stop by and visit them; to ask them how their technology is working for them. Maintaining friendly relations with the people let's them know that you are serious about results. They will work with you to overcome problems. This lesson re-emphasizes the significance of running a small project managed by a dedicated staff providing close attention, as mentioned earlier in the business benefits section.

- Partnerships – Making partnerships in which both parties have the opportunity to benefit is often a win-win situation. Building a community wireless network takes a lot of effort; making partnerships with organizations that hold similar interests can save time and effort. We use software from a partner organization that would have taken us years of experience to initially develop; we work with other wireless folks in other communities to assist in their implementations. As an organization, our main partnerships are educational for both parties. We learn while we are working with others, and we teach as we go along. If a partnership turns out unbeneficial for one or both parties then it is usually just abandoned. It can't hurt to ask another organization for help, or to offer your help when it is available.

Financing a community wireless project with limited capital also presents a challenge. Our model is fairly straight-forward, yet it is not completely sustainable yet.

- Network Infrastructure – If you want to be a part of the network you purchase your own wireless networking equipment. Wireless Ghana assists in installation and troubleshooting when we are available.

- Service – If you want Internet service you may purchase it from anyone on the network who is offering it. The same is true of any service on the network, as it is an open-access network. Currently Internet service is offered by the Apirede Resource Center at the cost of $35/month/computer.

- Maintenance – Wireless Ghana volunteers and team members perform maintenance on the network to keep it running. Money received from access fees is used to cover some of the costs of maintenance. This is insufficient funding though, as of right now, and much of the

infrastructure could use an upgrade. This is one of the critical aspects of ICT projects in developing areas. Because of the top-down effect of poor infrastructure (electrical supply, building quality, material quality, and attention to craftsmanship) there is an accelerated amount of equipment failures, like spoiled power supplies and ruined network cabling. Figure 8.0.1 depicts a broken UPS (Uninterruptible Power Supply) that was rebuilt with locally-available car batteries. This was innovative because it took broken computer parts and turned it into a device that is capable of powering a wireless network node for up to 24 hours of a power outage. We have developed solutions to some of the problems of maintenance, and see this as a point to which we must continually developing innovative solutions.

Figure 8.0.1 Power Outage Solution – Connecting a UPS to Car Batteries Enables Greatly Increased Power Backup in Areas Prone to Power Outages

Through the use of CBLit's innovative pilot projects, like the Akwapim Community Wireless Network, we are able to learn through mistakes, and refine our effectiveness in the various approaches through which we build local capacity for willing and motivated individuals and

communities. Throughout Phase II and Phase III of this project the team members will build upon tried and tested approaches to solving problems of connectivity, literacy, and economic progress.

Appendix A – Equipment Proposal Invoice - Internet Connectivity at NIFA Secondary School

Wireless Ghana - P.O. Box AD79 Adukrom-Akuapem Ghana - Telephone: 0244562244 / 0244955324

Equipment Proposal - Internet Access for **NIFA**:

(NIFA Aministration Building / 1 computer / intermittent, business use ~= 8/32 kbps)

Commodity	$USD Price
Connectivity Equipment	$419.00
Monthly Fee - 8/32 kbps - 1 month	$35.00
Installation Related Costs	$40.00
Transaction Fees	$50.00
Total	**$544.00**
Cedis:	5,032,000

* Installation is within 2 weeks from receipt of payment.
** Monthly fee to be paid in quarterly installments (3 months at a time) after the first month.

Wireless Ghana - A project of the Apirede Community Resource Center

Checks payable to: *Apirede Community Resource Center (ACRC)*

P.O. Box AD79 Adukrom-Akuapem
Ghana, West Africa
Telephone: 0244562244/ 0244955324
Email:gideon.amoah@gmail.com, boaeben@gmail.com

http://www.wirelessghana.com

Appendix B – Service Billing Invoice - Internet Connectivity at NIFA Secondary School

Wireless Ghana - P.O. Box AD79 Adukrom-Akuapem Ghana - Telephone: 0244562244 / 0244955324

Service Billing - Internet Access for **NIFA Administration**:

(Adukrom Premises / 2 computers / intermittent, business use ~= 32 kbps)

Commodity	$USD Price
Quarterly Fee (July - September 2006)	$210.00
Total	**$210.00**
Cedis:	1,942,500

Make Cheques payable to

Apriede Community Resource Centre
Wireless Ghana
P.O. Box AD79 Adukrom-Akuapem
Ghana, West Africa
Telephone: 0244562244/ 0244955324

http://www.wirelessghana.com

Appendix C – Phase II Budget

PHASE II Estimated Budget (In $USD)

	Funding Needed	Contributions	Funding Requested
Equipment For Network Strengthening			
Steel Masts (2 Locations)	$1,000	$0	$1,000
Protective Cabinetry (2 Locations)	$200	$100	$100
Lightning Protection (2 Locations)	$200	$50	$150
Antennas (2 Locations)	$400	$200	$200
Cable/Connectors (2 Locations)	$250	$0	$250
Uninterruptible Power Supplies (2 Locations)	$800	$0	$800
VSAT/Installation	$7,000	$0	$7,000
Access Fees (12 months)	$6,000	$0	$6,000
Total	$15,850	$350	$15,500
Equipment For Additional Network Nodes			
Steel Masts (5 Locations)	$2,500	$0	$2,500
Protective Cabinetry (5 Locations)	$250	$0	$250
Lightning Protection (5 Locations)	$500	$0	$500
Antennas (5 Locations)	$1,000	$0	$1,000
Cable/Connectors (5 Locations)	$625	$0	$625
Total	$4,875	$0	$4,875
General Maintenance			
4WD Vehicle	$16,000	$0	$16,000
Fuel Costs (6 Months)	$960	$0	$960
Backup Antennas	$500	$0	$500
Batteries	$200	$0	$200
Laptop Computers (2)	$2,500	$500	$2,000
Software Medium (CD-RW)	$100	$75	$25
Total	$20,260	$575	$19,685
Wireless Conference			
Keynote Speakers (Travel)	$3,000	$0	$3,000
Facility Rental	$2,500	$0	$2,500
Equipment/Supplies	$225	$0	$225
Totals	$5,725	$0	$5,725
Personnel Expenses / Management			
Project Director (50% of full-time expense)	$20,000	$0	$20,000
Projects Manager	$1,200	$0	$1,200
Technical Officer	$1,200	$0	$1,200
Fringe Benefits (15% of wages)	$3,360	$0	$3,360
Total	$25,760	$0	$25,760
Total	$72,470	$925	**$71,545**

Appendix D – HOW TO: Browsing Efficiency – Making the most use out of a slow Internet connection (Page 1 of 2).

Apirede Community Resource Centre

WG-001
A Technical Publication of Wireless Ghana

Browsing Efficiency – Making the most use out of a slow Internet connection.

This document gives an overview of how you can maximize use of a limited bandwidth connection. It has been developed during an attempt to best use a 128/32 kbps satellite connection. Used in conjunction with existing resources on the Internet it will allow you to connect more computers onto an Internet-connected network.

When we add a computer to a network we have to be very careful that that new computer won't abuse the network. The following procedure allows us to give a workable and fair browser connection to everybody. Some of these tweaks are not "ideal," but they make things work. All of the software referenced is available as a free download on the Internet.

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1. Uninstall MSN Explorer and IE. You can do this from the Add/Remove programs dialog. Disable Windows Update from the Control Panel, so that updates are always manual, and won't clog the network during peak times.

2. Install Mozilla Firefox. Mozilla is small, portable, quick, and customizable. When bandwidth is a factor these attributes are crucial in choosing a browser to work with.

IN TOOLS>>OPTIONS>>ADVANCED>>UPDATE disable all automatic updates, these will run in the background and consume bandwidth.

Updates can be done manually at off-peak bandwidth hours (nighttime) or from a CD, so that the updates are only downloaded once, and then distributed to multiple computers.

In TOOLS>>OPTIONS>>GENERAL>>CONNECTION SETTINGS setup Firefox to use a proxy. Check 'Manual proxy configuration', type in the ip address of the local computer (i.e. 192.168.0.7), use port '808', and use that for all protocols.

IN TOOLS>>OPTIONS>>CONTENT disable Java.

In TOOLS>>OPTIONS>>PRIVACY>>CACHE change the disk space of the cache to 200MB.

2.1 Install Extensions: Adblock Plus, FiltersetG, and Flashblock

Installing these extensions block certain ads and prevent downloading of flash content automatically. Users retain the options to view the content, they are just not downloaded automatically, and thus save considerable bandwidth.

3. Install Firetune for Firefox