Once you have identified and mapped out your costs, you should also determine what and how to charge for your services. This is a complicated and time-consuming process to do correctly. These key tips will assist when making pricing decisions:

- Calculate the prices you charge so that you cover all costs to provide the service, including all recurring expenses
- Examine the prices of your competitors
- Evaluate what your customers are willing and able to pay for your services, and make sure your prices correspond with these

It is absolutely essential to make a financial plan before you start. You need to list all of your initial and recurring costs and make some calculations to find out if your project can be sustainable.

Secure the Financing

Once you have determined your initial and recurring costs and created your financial plan, you know how much financing you will need to run a successful wireless network. The next step is to research and secure the appropriate amount of money to start up and run your wireless network.

The most traditional method of receiving funding for wireless networks in the developing world is through grants given by donors. A donor is an organization that contributes funding and other types of donations to an organization or consortium of organizations to help them manage projects or support causes. Because this funding is provided in the form of grants or other donations, it is not expected to be repaid by the organizations implementing the wireless projects or by the project's beneficiaries. Such donors include large international organizations like the United Nations (UN) and various specialized UN agencies like the United Nations Development Program (UNDP) and United Nations Educational, Scientific and Cultural Organization (UNESCO). Government agencies that specialize in international development, such as the United States Agency for International Development (USAID), the United Kingdom's Department for International Development (DFID), and the Canadian International Development Agency (CIDA), are also considered donors. Large foundations like the Gates Foundation and the Soros Foundation Network and private companies are other types of donors.

Typically, receiving funding involves a competitive or a non-competitive process. The non-competitive process is more infrequent, so this chapter will focus on the competitive process at a very high level. Most donors have complicated procedures surrounding the distribution of funding. The authors in this book are by no means trying to oversimplify this in depth system of rules and regulations. The authors intend only to convey a general understanding of this process for communities attempting to establish wireless networks in the developing world. During the competitive bid process, the donor creates a ***request for proposal*** (***RFP***) or a ***request for application*** (***RFA***), which solicits various non-governmental organizations, private companies and their partners to submit proposals outlining their plans for projects within the constraints of the donors' objectives and guidelines. In response to this RFP or RFA, NGOs and other organizations compete through the submittal of their proposals, which are then evaluated by the donors based on specific established criteria. Finally, the donor organization selects the most appropriate and highest ranking proposal to fund the project. Sometimes donors also supply funding to support an organization's operations, but this type of funding is more unusual than the competitive bid process.

Another way of accessing the necessary funds to start and maintain a wireless network is through ***microfinance***, or the provision of loans, savings and other basic financial services to the world's poorest people. Pioneered in the 1970's by organizations like ACCION International and Grameen Bank, microcredit, a type of microfinance, enables poor individuals and entrepreneurs to receive loans in small amounts of money to start up small enterprises. Despite the fact that these individuals lack many of the traditional qualifications needed to obtain loans like verifiable credit, collateral or steady employment, microcredit programs have been highly successful in many developing countries. Typically, the process involves an individual or a group completing and submitting a loan application in the hopes of receiving a loan, and the lender, the individual or organization that provides the loan, giving money on condition that it is returned with interest.

The use of microcredit to fund wireless networks does pose one constraint. Usually, microcredit involves very small sums of money. Unfortunately, because a large amount of capital is needed to purchase the initial equipment for wireless network set up, sometimes a microcredit loan is not sufficient. However, there have been many other successful applications of microcredit that have brought technology and its value to the developing world. An example includes the story of village phone operators. These entrepreneurs use their microcredit loans to purchase mobile phones and phone credits. They then rent the use of their mobile phones to community members on a per-call basis and earn enough money to repay their debt and make a profit for themselves and their families.

Another mechanism for getting funding to start a wireless network is angel funding. Angel investors are normally wealthy individuals that provide capital for business start-up in exchange for a high rate of return on their investment. Because the ventures in which they invest are start ups and, therefore, often high risk, angel investors tend to expect different things in addition to their return. Many expect a board position and maybe a role in the organization.

Some angels want to have a stake in the company, while others prefer shares in the company that can be easily redeemable at face value, thus providing a clear exit for the investor. To protect their investments, angels frequently ask the businesses not to make certain key decisions without their approval. Because of the high risk involved in developing markets, it is often challenging to find angel investors to help setup a wireless network, but not impossible. The best way to find potential investors is through your social network and through research online.

Evaluate the Strengths and Weaknesses of the Internal Situation

A network is only as good as the people who work and operate it. The team you put in place can mean the difference between success and failure. That is why it is important to reflect about your team's qualifications and skills, including those of staff and volunteers, in comparison to the competencies needed for a wireless project. First, make a list of all the competencies needed to run a wireless project successfully. Capacity areas should include technology, human resources, accounting, marketing, sales, negotiation, legal, and operations, among others. Afterwards, identify local resources to fulfill these skills. Map your team's skills sets to the competencies needed, and identify key gaps.

One tool often used to assist with this self-evaluation is an analysis of strengths, weaknesses, opportunities and threats, called SWOT. To conduct this analysis, specify your internal strengths and weaknesses, and elaborate upon the external opportunities and threats in your community. It is important to be realistic and honest about what you do well and what you are lacking. Be sure to distinguish between where your organization is at the beginning of this endeavor from where it could be in the future. Your strengths and weaknesses allow you to evaluate your capacities internally and better understand what your organization can do, as well as its limits. By understanding your strengths and weaknesses and comparing them to those of your competitors, you can determine your competitive advantages in the market. You can also note the areas where you can improve. Opportunities and threats are external, which enable you to analyze real world conditions and how these conditions influence your network.

The diagram below will help you in creating your own SWOT analysis for your organization. Be sure to respond to the questions asked and list your strengths, weaknesses, opportunities and threats in the spaces designated.

Strengths	Weaknesses
• What do you do well? • What unique resources can you draw on? • What do others see as your strengths? • • • •	• What could you improve? • Where do you have fewer resources than others? • What are others likely to see as weaknesses? • • • •
Opportunities	**Threats**
• What good opportunities are open to you? • What trends could you take advantage of? • How can you turn your strengths into opportunities? • • • •	• What trends could harm you? • What is your competition doing? • What threats do your weaknesses expose you to? • • • • •

Putting it All Together

Once you have gathered all of the information, you are ready to put everything together and decide upon the best model for the wireless network in your community. Based on the results of your external and internal analyses, you must refine your mission and service offerings. All of the factors that you researched in the preceding steps come into play when determining your overall strategy. It is essential to employ a model that capitalizes on opportunities and works within the constraints of the local environment. To do this, you must often find innovative solutions to attain sustainability. By exploring several examples and discussing the components of the models implemented in those instances, you will better understand how to arrive at an appropriate model.

In the distant jungles of the Democratic Republic of Congo, there is a rural hospital in a village called Vanga in the province of Bandundu. It is so remote that patients travel for weeks to get there often through a combination of travel by foot and by river. This village, founded by Baptist missionaries in 1904, has served as a hospital for many years. Although it is extremely remote, it is renowned for being an excellent facility and has had the support of German and American missionaries who have kept this facility in operation. In 2004, a project sponsored by USAID established a telecenter in this village to help improve education in this isolated community; this Internet facility was also heavily used by the educated class in the community – the hospital's staff. The center had been a great boon to the community, offering access to the world's knowledge and even providing consultation with distant colleagues in Switzerland, France and Canada. The center required near total subsidization to operate and cover its costs, and funding was to end by 2006. Although the center added great value to the community, it did have some shortcomings, primarily technical, economic, and political issues that limited its sustainability. A study was commissioned to consider options for its future. After reviewing the center's cost structure, it was determined that it needed to cut its costs and look for new ways to increase its revenues. The largest expenses were electricity and Internet access; therefore, creative models needed to be constructed to reduce the telecenter's costs and provide access in a way that was sustainable.

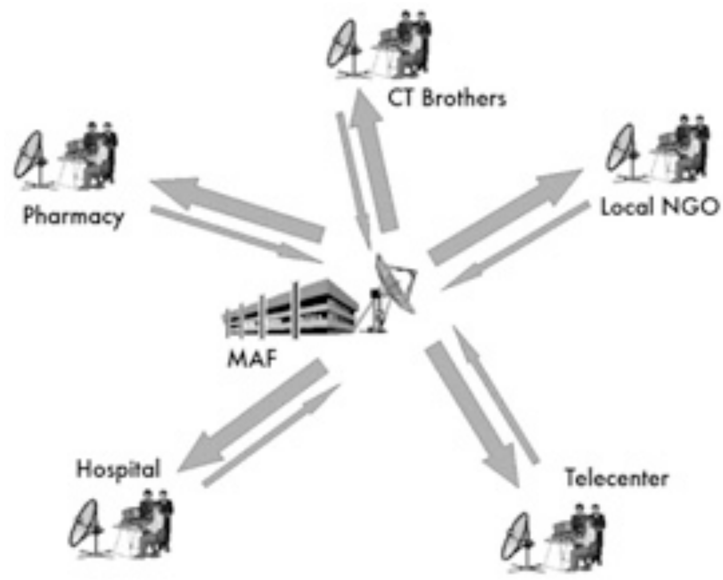

Figure 10.1: Shared Internet over wireless

In this instance, a traditional VSAT was used for connectivity. However, this model provided a unique way of accommodating local community groups' limited ability to pay for Internet services. Various organizations in the community share Internet access through a wireless network; they also share the costs associated with that connection. This model functions well due to specific conditions – namely an awareness and understanding of the value of the Internet among key community members, the necessary resources to support Internet access, and a regulatory system that permits wireless sharing. In Vanga, several organizations, including a hospital, a pharmacy, several missionary groups, a community resource center, and some non-profit organizations, have a need for Internet access and the means to pay for it. This arrangement enables the network of organizations to have a higher quality connection at a lower cost. Additionally, one organization in the village has the capacity and willingness to manage several aspects of the network's operations, including the billing and payment collection, technical maintenance and general business operations of the entire network. Therefore, this model works well in Vanga because it has been tailored to meet community demand and leverage local economic resources.

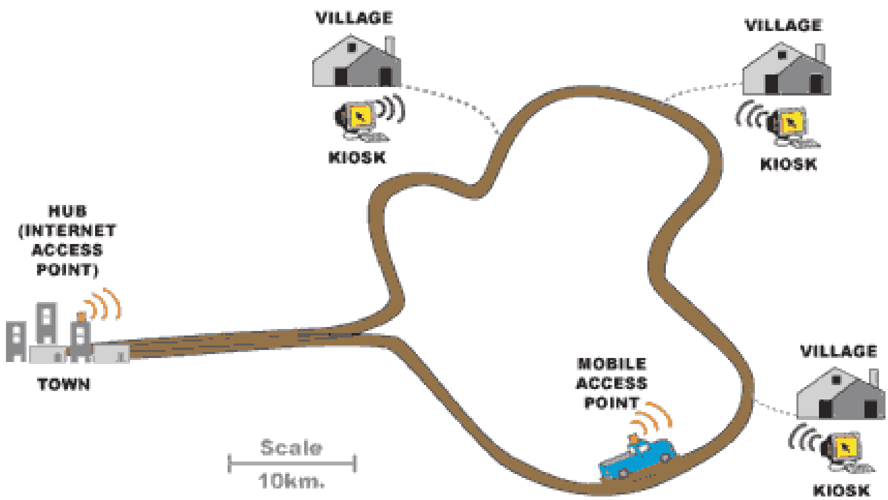

Figure 10.2: DakNet's roaming access point

Another example of a model adapted to fit the local context is that of First Mile Solutions' DakNet. This model has been deployed in villages in India, Cambodia, Rwanda, and Paraguay. By taking into account the limited buying power of villagers, this model addresses their communication needs in an innovative way. In the DakNet model, there is a franchise that exists in the country, and local entrepreneurs are recruited and trained to operate kiosks equipped with Wi-Fi antennas. Using pre-paid cards, villagers are able to asynchronously send and receive emails, texts, and voice mails, conduct web searches, and participate in e-commerce. Afterwards, these communications are stored in the local kiosk's server. When a bus or motorcycle with a mobile access point drives past a kiosk, the vehicle automatically receives the kiosk's stored data and delivers any incoming data. Once the vehicle reaches a hub with Internet connectivity, it processes all requests, relaying emails, messages, and shared files.

DakNet integrates both mobile access and franchise models to bring value to people in remote villages. For such a model to be sustainable, several key conditions need to be present. First, a franchise organization must exist to provide financial and institutional support, including an initial investment, working capital for certain recurring costs, advice on start-up practices, management training, standardized processes, reporting mechanisms, and marketing tools. Additionally, this model requires a highly motivated and dynamic individual in the village, with the appropriate skills to manage a business and willingness to accept certain requirements of the franchise organization. Because these entrepreneurs are often asked to commit their own resources to the start-up costs, they need to have sufficient access to financial resources. Finally, to ensure this model will sustain itself, there should be sufficient demand for information and communication and few competitors in the community.

Conclusion

No single business model will enable wireless networks to be sustainable in all environments of the developing world; different models must be used and adapted as the circumstances dictate. Every community has unique characteristics, and sufficient analysis must be conducted at the onset of a project to determine the most appropriate model. This analysis should consider several key factors in the local environment, including community demand, competition, costs, economic resources, etc. Although appropriate planning and execution will maximize the chances of making your network sustainable, there are no guarantees of success. However, by using the methods detailed in this chapter, you will help to ensure that your network brings value to the community in a way that corresponds with the users' needs.

11
Case Studies

No matter how much planning goes into building a link or node location, you will inevitably have to jump in and actually install something. This is the moment of truth that demonstrates just how accurate your estimates and predictions prove to be.

It is a rare day when everything goes precisely as planned. Even after you install your 1st, 10th, or 100th node, you will still find that things do not always work out as you might have intended. This chapter describes some of our more memorable network projects. Whether you are about to embark on your first wireless project or you are an old hand at this, it is reassuring to remember that there is always more to learn.

General advice

The economies of developing countries are very different from the developed world, and thus a process or solution designed for a more developed country may not be suitable in West Africa, or Southern Asia. Specifically, the cost of locally produced materials and the cost of labour will be negligible, whereas imported goods can be much more expensive when compared to its cost in the developed world. For example, one can manufacture and install a tower for a tenth of the cost of a tower in the United States, but the price of an antenna might be double. Solutions that capitalize on local competitive advantages, namely cheap labour and locally found materials, will be the easiest to replicate.

Finding the right equipment is one of the most difficult tasks in developing markets. Because transportation, communication and economic systems are not developed, the right materials or equipment can be difficult and often impossible to find. A fuse, for example, is difficult to find, thus finding wire that has a burn-up at a certain amperage and can substitute is a great advantage. Finding local substitutes for materials also encourages local entrepreneurship, ownership, and can save money.

Equipment enclosures

Cheap plastics are everywhere in the developing world, but they are made of poor materials and are thin, thus mostly unsuitable for enclosing equipment. PVC tubing is far more resilient and is made to be waterproof. In West Africa, the most common PVC is found in plumbing, sized from 90mm to 220mm. Access points such as the Routerboard 500 and 200 can fit into such tubing, and with end-caps that are torched-on, they can make very robust waterproof enclosures. They also have the added benefit of being aerodynamic and uninteresting to passers-by. The resulting space left around the equipment assures adequate air circulation. Also, it is often best to leave an exhaust hole at the bottom of the PVC enclosure. The author did find that leaving open holes can become a problem. In one instance ants decided to nest 25 meters above ground inside the PVC holding the access point. Using a wire mesh cover made from locally available screen material is advised to secure the exhaust hole from infestations.

Antenna masts

Recovering used materials has become an important industry for the poorest countries. From old cars to televisions, any material that has value will be stripped, sold, or re-used. For example, you will see vehicles torn apart piece by piece and day by day. The resulting metal is sorted and then tossed into a truck to be sold. Local metal workers will already be familiar with how to make television masts from scrap metal. A few quick adaptations and these same masts can be re-purposed for wireless networks.

The typical mast is the 5 meter pole, comprised of a single 30mm diameter pipe which is then planted into cement. It's best to construct the mast in two parts, with a removable mast that fits into a base which is slightly larger in diameter. Alternately, the mast may be made with arms that can be securely cemented into a wall. This project is easy, but requires the use of a ladder to complete and therefore some caution is suggested.

This type of mast can be augmented by several meters with the use of guy lines. To sturdy the pole, plant three lines 120 degrees apart, forming an angle of at least 33 degrees with the tower.

Above all: involve the local community

Community involvement is imperative in assuring the success and sustainability of a project. Involving the community in a project can be the greatest challenge, but if the community is not involved the technology will not serve their needs, nor will it be accepted. Moreover, a community might be afraid and could subvert an initiative. Regardless of the complexity of the undertaking, a successful project needs support and buy-in from those it will serve.

An effective strategy in gaining support is to find a respected champion whose motives are palatable. Find the person, or persons whom are most likely to be interested in the project. Often, you will need to involve such champions as advisors, or as members of a steering committee. These people will already have the trust of the community, will know who to approach, and can speak the language of the community. Take your time and be selective in finding the right people for your project. No other decision will affect your project more than having effective, trusted local people on your team.

In addition, take note of key players in an institution, or community. Identify those people whom are likely to be opponents and proponents of your project. As early as possible, attempt to earn the support of the potential proponents and to diffuse the opponents. This is a difficult task and one that requires intimate knowledge of the institution or community. If the project does not have a local ally, the project must take time to acquire this knowledge and trust from the community.

Be careful in choosing your allies. A "town-hall" meeting is often useful to see local politics, alliances, and feuds in play. Thereafter, it is easier to decide on whom to ally, champion and whom to diffuse. Try to not build unwarranted enthusiasm. It is important to be honest, frank, and not to make promises that you cannot keep.

In largely illiterate communities, focus on digital to analog services such as Internet for radio stations, printing on-line articles and photos, and other non-textual applications. Do not try to introduce a technology to a community without understanding which applications will truly will serve the community. Often the community will have little idea how new technologies will help their problems. Simply providing new features is useless without an understanding of how the community will benefit.

When gathering information, verify the facts that you are given. If you want to know the financial status of a company/organization, ask to see an electricity bill, or phone bill. Have they been paying their bills? At times, potential beneficiaries will compromise their own values in hopes of winning funds or equipment. Most often, local partners who trust you will be very frank, honest, and helpful.

Another common pitfall is what I call "divorced parents" syndrome, where NGOs, donors, and partners are not told of each others involvement with the beneficiary. Savvy beneficiaries can earn handsome rewards by letting NGOs and donors lavish them with equipment, training and funds. It is important to know which other organizations are involved so you can understand how their activities might impact your own. For example, I once designed a project for a rural school in Mali. My team installed an open source system with used computers and spent several days training people how to use it. The project was deemed a success, but shortly after the installation, another donor arrived with brand-new Pentium 4 computers running Windows XP. The students quickly abandoned the older computers and lined-up to use the new computers. It would have been better to negotiate with the school in advance, to know their commitment to the project. If they had been frank, the computers that are now sitting unused could have been deployed to another school where they would be used.

In many rural communities in under-developed economies, law and policies are weak, and contracts can be effectively meaningless. Often, other assurances must be found. This is where pre-paid services are ideal, as they do not require a legal contract. Commitment is assured by the investment of funds before service is given.

Buy-in also requires that those involved invest in the project themselves. A project should ask for reciprocal involvement from the community.

Above all, the “no-go” option should always be evaluated. If a local ally and community buy-in cannot be had, the project should consider choosing a different community or beneficiary. There must be a negotiation; equipment, money, and training cannot be gifts. The community must be involved and they too must contribute.

—Ian Howard

Case study: Crossing the divide with a simple bridge in Timbuktu

Networks ultimately connect people together, and therefore always involve a political component. The cost of Internet in less developed economies is high and the ability to pay is low, which adds to the political challenges. Attempting to superimpose a network where human networks are not fully functioning is nearly impossible in the long term. Trying to do so can leave a project on unstable social ground, threatening its existence. This is where the low cost and mobility of a wireless network can be advantageous.

The author's team was asked by funders to determine how to connect a rural radio station with a very small (2 computer) telecentre to the Internet in Timbuktu, the desert capital of Mali. Timbuktu is widely known as an outpost in the most remote area of the world. At this site, the team decided to implement a model which has been called the ***parasitic wireless model***. This model takes a wireless "feed" that is spliced from an existing network, and extends that network to a client site using a simple bridged network. This model was chosen because it requires no significant investment by the supporting organization. While it added a source of revenue for the telecentre, it did not add a significant operational cost. This solution meant that the client site could get cheap Internet, albeit not as fast or as reliable as a dedicated solution. Because of opposed usage patterns between an office and a telecentre there was no perceptible slowing of the network for either party. Though in an ideal situation it would be best to encourage more development of the small telecentre into an ISP, neither the telecentre nor the market were deemed ready. As is often the case, there were serious concerns about whether this telecentre could become self-sustaining once its funders departed. Thus, this solution minimized the initial investment while achieving two goals: first, it extended the Internet to the target beneficiary, a radio station, at an affordable cost. Second, it added a small additional revenue source for the telecentre while not increasing its operational costs, or adding complexity to the system.

The people

Timbuktu is remote, though having a world renowned name. Being a symbol of remoteness, many projects have wanted to "stake a flag" in the sands of this desert city. Thus, there are a number of information and communications technologies (ICT) activities in the area. At last count there were 8 satellite connections into Timbuktu, most of which service special interests except for the two carriers, SOTELMA and Ikatel. They currently use VSAT to link their telephone networks to the rest of the country. This telecentre used an X.25 connection to one of these telcos, which then relayed the connection back to Bamako. Relative to other remote cities in the country, Timbuktu has a fair number of trained IT staff, three existing telecentres, plus the newly installed telecentre at the radio station. The city is to some degree over saturated with Internet, precluding any private, commercial interests from being sustainable.

Design Choices

In this installation the client site is only 1 km away directly by line of sight. Two modified Linksys access points, flashed with OpenWRT and set to bridge mode, were installed. One was installed on the wall of the telecentre, and the other was installed 5 meters up the radio station's mast. The only configuration parameters required on both devices were the ssid and the channel. Simple 14 dBi panel antennas (from *http://hyperlinktech.com/*)

were used. At the Internet side, the access point and antenna were fastened using cement plugs and screws onto the side of the building, facing the client site. At the client site, an existing antenna mast was used. The access point and antenna were mounted using pipe rings.

To disconnect the client, the telecentre simply unplugs the bridge on their side. An additional site will eventually be installed, and it too will have its own bridge at the telecentre so that staff can physically disconnect the client if they have not paid. Though crude, this solution is effective and reduces risk that the staff would make a mistake while making changes to the configuration of the system. Having a bridge dedicated to one connection also simplified installation at the central site. as the installation team was able to choose the best spot for connecting the client sites. Though it is not optimal to bridge a network (rather than route network traffic), when technology knowledge is low and one wants to install a very simple system this can be a reasonable solution for small networks. The bridge makes systems installed at the remote site (the radio station) appear as though they are simply connected to the local network.

Financial model

The financial model here is simple. The telecentre charges a monthly fee, about $30 per connected computer to the radio station. This was many times cheaper than the alternative. The telecentre is located in the court of the Mayor's office, so the principle client of the telecentre is the Mayor's staff. This was important because the radio station did not want to compete for clientele with the telecentre and the radio station's systems were primarily intended for the radio station staff. This quick bridge reduced costs, meaning that this selective client base could support the cost of the Internet without competing with the telecentre, its supplier. The telecentre also has the ability to easily disconnect the radio station should they not pay. This model also allowed sharing of network resources. For example, the radio station has a new laser printer, while the telecentre has a color printer. Because the client systems are on the same network, clients can print at either site.

Training

To support this network, very little training was required. The telecentre staff were shown how to install the equipment and basic trouble shooting, such as rebooting (power cycling) the access points, and how to replace the unit should one fail. This allows the author's team to simply ship a replacement and avoid the two day trek to Timbuktu.

Summary

The installation was considered an interim measure. It was meant to serve as a stop-gap measure while moving forward with a more complete solution. While it can be considered a success, it has not yet led to building more physical infrastructure. It has brought ICTs closer to a radio solution, and re-enforced local client/supplier relationships.

As it stands, Internet access is still an expensive undertaking in Timbuktu. Local politics and competing subsidized initiatives are underway, but this simple solution has proven to be an ideal use case. It took the team several months of analysis and critical thought to arrive here, but it seems the simplest solution provided the most benefit.

—Ian Howard

Case study: Finding solid ground in Gao

One day's drive east from Timbuktu, in Eastern Mali, is Gao. This rural city, which seems more more like a big village, sits up the the river Niger just before it dips South crossing into Niger and onto Nigeria. The city slopes into the river gently, and has few buildings taller than two stories. In 2004, a telecentre was installed in Gao. The project's goal was to provide information to the community in the hope that a better informed community would yield a healthier and more educated citizenry.

The centre provides information via CD-ROMs, films and radio, but the cornucopic source of information for the centre is the Internet. It is a standard telecentre, with 8 computers, an all-in-one printer, scanner, fax, a telephone and a digital camera. A small two room building was built to house the telecentre. It is located a bit outside of downtown, which is not an ideal location for attracting customers, but the site was chosen because of its sympathetic host. The site received funding for all construction needed, and equipment and initial training was supplied as well. The telecentre was expected to be self-sustaining after one year.

Several months after its opening, the telecentre was attracting few customers. It used a modem to dial-up to connect to an Internet provider in the capital. This connection was too slow and unreliable, and so the funder sponsored the installation of a VSAT system. There are a number of VSAT systems now available to the region; most of these services have just recently become available. Previously only C-band (which cover a larger area than Ku-band) systems were available. Recently, fiber has been laid in almost every subway tunnel and canal throughout Europe, and thus it has supplanted the more expensive satellite services. As a result, providers are now redirecting their VSAT systems to new markets, including middle and Western Africa, and South Asia. This has led to a number of projects which use satellite systems for an Internet connection.

After the VSAT was installed, the connection provided 128 kbps down and 64 kbps up, and cost about $400 per month. The site was having trouble earning enough revenue to pay for this high monthly cost, so the telecentre asked for help. A private contractor was hired, who had been trained by the author to install a wireless system. This system would split the connection between three clients: a second beneficiary, a radio station, and the telecentre, each paying $140. This collectively covered the costs of the VSAT, and the extra revenue from the telecentre and the radio station would cover support and administration of the system.

The people

Though capable and willing, the author's team did not do the actual installation. Instead, we encouraged the telecentre to hire the local contractor to do it. We were able to reassure the client by agreeing to train and support the contractor in the fulfillment of this installation. The premise of this decision was to discourage a reliance on a short-term NGO, and rather to build trust and relationships between domestic service providers and their clients. This design proved to be fruitful. This approach took much more time from the author's team, perhaps twice as much, but this investment has already begun to pay-off. Networks are still being installed and the author and his team are now home in Europe and North America.

Design choices

Initially, it was conceived that a backbone connection would be made to the radio station, which already had a 25 meter tower. That tower would be used to relay to the other clients, avoiding the need to install towers at the client sites, as this tower was well above any obstacles in the city. To do this, three approaches were discussed: installing an access point in repeater mode, using the WDS protocol, or using a mesh routing protocol. A repeater was not desirable as it would introduce latency (due to the one-armed repeater problem) to an already slow connection. VSAT connections need to send packets up to the satellite and back down, often introducing up to 3000 ms in delay for a round trip. To avoid this problem, it was decided to use one radio to connect to clients, and a second radio for to the dedicated backbone connection. For simplicity it was decided to make that link a simple bridge, so that the access point at the radio station would appear to be on the same physical LAN as the telecentre.

In testing this approach functioned, though in the real world, its performance was dismal. After many different changes, including replacing the access points, the technician decided that there must be a software or hardware bug affecting this design. The installer then decided to place the access point at the telecentre directly using a small 3 meter mast, and to not use a relay site at the radio station. The client sites also required small masts in this design. All sites were able to connect, though the connections were at times too feeble, and introduced massive packet loss.

Later, during the dust season, these connections became more erratic and even less stable. The client sites were 2 to 5 km away, using 802.11b. The team theorized that the towers on either side were too short, cutting off too much of the Fresnel zone. After discussing many theories, the team also realized the problem with the performance at the radio station: the radio frequency 90.0 MHz was about the same as the frequency of the high-speed (100BT) Ethernet connection. While transmitting, the FM signal (at 500 watts) was completely consuming the signal on the Ethernet cable. Thus, shielded cable would be required, or the frequency of the Ethernet link would need to be changed. The masts were then raised, and at the radio station the speed of the Ethernet was changed to 10 Mbps. This changed the frequency on the wire to 20 MHz, and so avoided interference from the FM transmission. These changes resolved both problems, increasing the strength and reliability of the network. The advantage of using mesh or WDS here would be that client sites could connect to either access point, either directly to the telecentre to the radio station. Eventually, removing the reliance on the radio station as a repeater likely made the installation more stable in the longer-term.

Financial model

The satellite system used at this site cost approximately $400 per month. For many IT for Development projects this expensive monthly cost is difficult to manage. Typically these projects can purchase equipment and pay for the establishment of a wireless network, but most are not able to pay for the cost of the network after a short period of time (including the recurring Internet costs and operational costs). It is necessary to find a model where the monthly costs for a network can be met by those who use. For most community telecenters or radio stations, this is simply too expensive. Often, the only feasible plan is to share the costs with other users. To make the Internet more affordable, this site used wireless to share the Internet to the community, allowing a greater number of organizations to access the Internet while reducing the cost per client.

Typically in Mali, a rural community has only a few organizations or companies that could afford an Internet connection. Where there are few clients, and the Internet connection cost is high, the model developed by his team included ***anchor clients***: clients whom are solid and are low-risk. For this region, foreign NGOs (Non Governmental Organizations), the United Nations Agencies and large commercial enterprises are among the very few whom qualify.

Among the clients selected for this project were three anchor clients, who collectively paid the entire monthly cost of the satellite connection. A second beneficiary, a community radio station, was also connected. Any revenue earned from the beneficiaries contributed to a windfall, or deposit for future costs, but was not counted upon due to the small margins that both of these community services operated on. Those clients could be disconnected and could resume their service once they can afford it again.

Training needed: who, what, for how long

The contractor taught the telecentre technician the basics of supporting the network, which was fairly rudimentary. Any non-routine work, such as adding a new client, was contracted out. Therefore it was not imperative to teach the telecentre staff how to support the system in its entirety.

Lessons learned

By sharing the connection, the telecentre is now self-sustaining, and in addition, three other sites have Internet access. Though it takes more time and perhaps more money, it is valuable to find the right local talent and to encourage them to build relationships with clients. A local implementor will be able to provide the follow-up support needed to maintain and expand a network. This activity is building local expertise, and demand, which will allow subsequent ICT projects to build on this base.

—Ian Howard

Case Study: Fantsuam Foundation's Community Wireless Network

Kafanchan is a community of 83,000 people located 200 km northeast of Abuja, in central Nigeria. Kafanchan used to be known as a busy and thriving town as it was the host of one of the main junctions of the national railway. When the railway industry was booming, almost 80% of Kafanchan's populations relied on it in one way or another. Following the complete breakdown of the Nigerian railway system, the population of Kafanchan has been forced to go back to its original source of income, which is agriculture.

Kafanchan is a poorly connected area in terms of fixed telephony and Internet connectivity. Today, no fixed telephony (PSTN) is available in the area and GSM only just arrived in 2005. However, the GSM coverage is just as poor as the quality of the service. At the moment, SMS services are the most reliable communication service because voice conversations tend to cut off in the middle and suffer heavy noise.

Poor access to electricity brings further challenges to the people of Kafanchan. The national electric power company of Nigeria, generally known as NEPA (National Electric Power Authority), is more commonly known to Nigerians as "Never Expect Power Always". In 2005, NEPA changed its name to Power Holding Company of Nigeria (PHCN).

Kafanchan is receiving power from NEPA on an average of 3 hours per day. For the remaining 21 hours, the population relies on expensive diesel generators or kerosene for illumination and cooking. When NEPA is available on the grid, it provides an unregulated voltage in the range of 100-120 V in a system designed for 240 V. This voltage must be regulated to 240 V before most loads can be connected. Only light bulbs can be fed straight to the grid power since they can handle the low voltage without damage.

Project participants

Given the challenging background of Kafanchan, how could anyone come up with the idea of establishing the first rural Wireless ISP in Nigeria there? Fantsuam Foundation did and they made it happen.

Fantsuam Foundation is a local, non-governmental organization that has been working together with the community of Kafanchan since 1996 to fight poverty and disadvantage through integrated development programs. Fantsuam's focus lies on micro finance, ICT services and social development in rural communities of Nigeria. Becoming the first rural wireless ISP in Nigeria was part of their mission to be a recognized leader in the provision of rural development initiatives, as well as the foremost rural knowledge economy driver in Nigeria.

The Wireless ISP of Fantsuam Foundation, also know as ***Zittnet***, is funded by IDRC, the International Development Research Centre of Canada. IT +46, a Swedish based consultancy company focusing on ICTs for development, has worked together with the Zittnet team to provide technical support for wireless communications, bandwidth management, solar energy, power backup systems and VoIP deployments.

Objectives

The main objective of Zittnet is to improve access to communications in the area of Kafanchan by implementing a community wireless network. The network provides intranet and Internet access to local partners in the community. The community network is formed by community-based organizations such as educational institutions, faith-based institutions, health services, small enterprises and individuals.

Power Backup System

In order to provide a reliable service to the community, Zittnet needed to be equipped with a stable power backup system that would make the network run independently of the NEPA.

A hybrid power system was designed for Fantsuam, consisting of a deep-cycle battery bank and 2 kW (peak) solar panels. The system can charge from three different sources: a diesel generator, a solar array, and from NEPA when electricity is available. The network operation center (NOC) of the organization runs completely from solar energy. The rest of the Fantsuam's premises runs from NEPA or the generator via the battery bank, which provides uninterrupted voltage stability. The NOC load has been separated from the rest of the load of Fantsuam to ensure a reliable power source to the critical infrastructure in the NOC, even when the battery bank is running low on power.

Figure 11.1: 24 solar panels with a nominal power of 80 W have been mounted to the roof of the NOC to provide power to the system 24/7.

Simulations with the best existing solar data reveal that Kaduna State, where Kafanchan is located, receives at least 4 sun peak hours during its worst months which stretch from June to August (the rainy season).

Each of the solar panels (Suntech 80 W peak) provides a maximum current of 5 A (when the solar radiation is highest during the day). In the worst months of the year, the system is expected to produce not less than 6 KWh/day.