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ICT Update

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Wireless internet improves education in rural **Dominican Republic**

Villages in **Rwanda** connect to the internet via drive-by Wi-Fi

A resourceful project brings wireless internet to rural **Ghana**

Wi-Fi

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ICT Update

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Mixed Sources

Innovation in communication

They are known around the world by many different names. In Kenya it is a 'matatu', in Ghana a 'tro tro'. It is a 'concho' in the Dominican Republic, a 'kombi' in much of Southern Africa, and a 'maxi taxi' in Trinidad and Tobago. In West Africa, it is a 'bush taxi'.

Regardless of the name, minibuses and shared taxis are a very important, although sometimes frustrating, mode of transport in many ACP countries. They usually travel fixed routes through cities, between towns and out into surrounding villages, providing an essential link to family, businesses, government offices, markets and shops for millions of people living in remote areas. Because they are used to deliver pretty much everything, it almost seems obvious to use them to deliver the internet too. But how?

The problem was solved by United Villages, a start-up company based in the US, which uses buses in Rwanda to take emails, voice mails and web pages to rural districts around Kigali. The bus doesn't even have to stop. It just drives by an antenna in each village that is linked to a computer and transfers data to a small box on the bus that is capable of storing all the necessary information. When the bus goes back to town on its usual route, the data is once again transferred wirelessly to a computer terminal with a real-time internet connection. Emails are sent, voice mails delivered and web pages are sought and found. Replies are communicated back to the bus as it makes its way out to the villages again. And all of this is achieved using Wi-Fi.

Communities

The term Wi-Fi was coined as a shorthand way of describing products that conform to the IEEE 802.11 Local Area Network (LAN) standards. This shorthand term has now become so well known it has entered into popular culture; mentioned on TV and radio, all over the internet and is even defined in dictionaries. It might be a surprise to learn that Wi-Fi is, in fact, a registered trademark owned by the Wi-Fi Alliance (who kindly gave *ICT Update* permission to use the term).

As the 200+ companies that are members of the Wi-Fi Alliance continue to develop and integrate their products with other applications, Wi-Fi is being put to good use in some innovative projects in ACP countries. The flexibility, relative low cost and the fact that several computers can operate on the same wireless network make Wi-Fi an ideal technology for improving communication in rural areas. Even the disadvantage of the relatively short range of Wi-Fi has been overcome using imaginative solutions in both Ghana and the Dominican Republic, where it has been shown that it is possible to extend the reach of the internet beyond a single telephone landline or satellite link.

These stories will surely inspire others who are struggling to bring the internet to remote areas.

The Rural Alternatives Center (CAREL), based in the small village of El Limon in the Dominican Republic, has spent the last ten years developing a wireless system that is now being extended to other areas. Each village has its own set of problems to be overcome, but a dedicated team has continually managed to come up with some very inventive solutions.

Likewise, in the small town of Apirede in Ghana, a community centre hosts a wireless network that now spans 20 km into the surrounding rural communities – an impressive feat for a project run by volunteers who used their own money to get the system started. With a combination of resourcefulness and ingenuity, the team managed to squeeze the limited bandwidth and provide a steady, reliable service.

These stories will surely inspire others who are struggling to bring the internet and other communications systems to remote areas. But they also tell us that there is much more to the success of these initiatives than just computers, routers, antennas and modems. There also have to be committed inputs from the local community, from residents, local authorities and schools to NGOs, businesses and, of course, those taxi and bus drivers. It is only when all these efforts are combined that you have a truly effective wireless network. ■

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A growing alliance

Over the last decade, Wi-Fi has become a major cultural phenomenon. It is so popular that, when asked in surveys whether they'd rather live without coffee or Wi-Fi, more than 80% of people said they would give up coffee. A similar percentage said they would rather live without chocolate than Wi-Fi, while others said they would happily see their favourite sports team lose before giving up their cherished wireless connection.

Over 450 million people use Wi-Fi worldwide. In 2007 alone, 300 million units were sold – a 40% increase on the previous year – and it is predicted that one billion devices will be shipped to businesses, consumers and government organizations around the globe by 2010. Making sure that all these products are up to standard, and that means meeting IEEE 802.11 specifications, is the Wi-Fi Alliance, a non-profit industry association that promotes the growth of wireless local area networks (WLAN). Devices that pass the testing process are awarded the official Wi-Fi Certified logo, which tells consumers that the products not only meet the required standards, but also that various devices will work together, even if they come from different manufacturers.

The popularity of Wi-Fi is due largely to its flexibility, reliability and high performance, and these benefits apply in any location, from a small village to an urban tower block. For organizations working with a tight budget, Wi-Fi also provides a relatively inexpensive way of setting up a local network, because there is no need for wires and dedicated access points. Wi-Fi can really help bring the outside world to a rural area through the internet, whether in India, Nigeria or Philadelphia. This is also the case for the computer used in the One Laptop Per Child project, as all the individual laptops can be connected in a network (although not necessarily connected to the internet).

MARVIN WOODYATT/UPPA/PHOTOSHOT/ANP

The technology also offers all the advantages of a wired system, including security, which is something the Alliance feels very strongly about. There have been no confirmed successful attacks on the latest encryption standard, Wi-Fi Protection Access 2 (WPA2). There are, of course, open networks, such as the Wi-Fi 'hotspots' in cafes and airports, which allow anyone in range to connect to the network. Some individuals also choose not to secure their home network, which is fine if it is a conscious choice, but not if it was because it is too difficult to make the system secure. A good analogy is that of seatbelts in a car: You are provided security and safety only if you choose to use your seatbelt, and once you choose to do so, using a seatbelt should be easy to do. If you choose not to secure your network, others may be able to access your data, so be very careful. If you are doing something such as looking up a map or getting travel directions, the risk is fairly low. But if you are checking the inventory or accounts of your organization, then you should take care. The chances of anyone actually accessing your information are slim, but know that it can happen and be aware of the risks.

Integration

Most of the equipment in the early days of Wi-Fi was focused on data delivery – text, email and web browsing. But the radio signal doesn't care what is inside the digital packets that it sends through the air – it could be an email, a video or a voice. Voice is very much a growing application for Wi-Fi. Significant advances in recent years have led to the development of what is called 'quality of service'. This means the Wi-Fi device allocates more space to video or voice delivery than that of text. Voice, for example, is given higher priority so that the user doesn't experience any kind of delay. A user will never notice if an email is delayed by a fraction of a second, but would certainly notice a similar delay with a video. The new generation 802.11N is even better suited to this and even makes multiple streams possible.

Another major trend is to integrate Wi-Fi into other consumer products, and this is something that is likely to continue in the future. For example, 90% of laptops now come Wi-Fi-ready and the Alliance has certified around 150 mobile phones that are both Wi-Fi- and cellular-capable. This is a good example of two technologies that co-exist very well together to give the best of both – the high performance of Wi-Fi combined with the roaming capability of a cellular network, which is better at transferring the signal from tower to tower.

My own mobile phone, for example, has Wi-Fi and cellular capabilities. Often cellular coverage inside a building is poor while Wi-Fi is very good, so when I'm in a Wi-Fi area I can take advantage of the higher performance, such as the faster download speeds. The technology is such that when I leave that Wi-Fi area I am automatically switched to the cellular network. This benefits the phone company, too, because if I'm downloading large files over the cellular network, I'm taking up bandwidth that somebody else might be trying to use for a call. The carrier can then manage their network more efficiently and get another customer while I'm on the Wi-Fi network, without having to add more capacity. The customer also gets added value, so it's a real win-win situation for all. ■

Feature

Making the village global

The village of El Limon in the Dominican Republic has had wireless internet for almost 10 years. The system continues to expand and have a major impact on the education of the young people living there.

If you drive a 4x4 pickup truck through the southwest mountains of the Dominican Republic and keep turning uphill whenever the road forks, eventually you'll get to El Limon, or a place that looks a lot like it. You'll arrive in an attractive little mountain village with perhaps 300 residents, with donkeys in the streets and farmers and their ox teams tilling the fields. Then there are the things you probably won't see, including electric lights in many homes, a phone service, books in the schools or a health centre.

The developing world is full of villages like El Limon, each facing a challenging and very uncertain future. Previously existing in isolation, these remote villages must integrate into a rapidly globalizing world, and the internet plays a key role in securing a better and sustainable future.

The story of the El Limon community and the internet began as a sideline to the installation of a small micro-hydroelectric system for the village. As manager of that project, I also had extensive experience with computers and electronics, and in the summer of 1997, I came to the village, bringing a couple of laptop computers and three college interns along with me. The students spent their days helping with construction for the hydro project and their nights introducing the people of the village to the computers, most of whom were excited to be using a computer for the first time. At the end of the summer we left one laptop behind so some of the village youth could continue learning – all off-line, of course.

When we returned to El Limon the following summer, the project team brought three 900MHz FreeWave digital radios that had been donated to us. This was the opportunity we needed to bring the internet to El Limon. We then assembled and installed a solar-powered repeater on a hilltop between El Limon and the nearby small city of Ocoa, location of closest phone line. This would relay the signal over a larger distance and between the hills that surround the village. With that, El Limon became the first rural community in the Dominican Republic to have internet access.

Developing interest

For the villagers, the process of connecting to the internet was the same as for any other user with Windows dial-up connection. But instead of having the modem in the same room, it was 8 km away in Ocoa. We connected a cable from the laptop's serial port to the first FreeWave radio, which was then connected to an antenna on the roof. The antenna took the signal 2 km to the second radio on a mountaintop, then down 6 km to the third radio in Ocoa, and continued on by serial cable to an ordinary modem plugged into the phone line.

The internet connection worked reliably, but slowly. Other than two children who had become avid computer users by this time, the village youth weren't interested in going online, and kept to their disk-based games. I used the internet a lot, along with visitors and volunteers, mostly using email for international communication and browsing the web for information on the various development projects operating in the community.

By 2003, however, El Limon's young people discovered online chatting while using the laptop in the village telecentre. They began reaching out to other Spanish-speaking youth in various countries. From there was much greater interest from young people in the technology and they quickly started to learn about the web. The single internet-connected laptop soon reached total overload but just as that happened, broadband (DSL) services were introduced in Ocoa and the project received a donation of Wi-Fi equipment that would enable us to connect to the faster system in town. The old FreeWave radios were replaced by the Wi-Fi gear, small local area networks (LANs) were installed in El Limon and Voice over Internet Protocol (VoIP) equipment was purchased to bring telephone communication to the village. El Limon became truly well connected and, in 2005, a second repeater was added and two more villages have since come online.

The telecentre is now the focal point for Limon's youth. Usage is divided between entertainment and education. The internet is now the principal library for the 15 teenagers who drive a half-hour down to Ocoa to attend school. It is also their prime social outlet, where they chat online and build friendships with peers all over the Spanish-speaking world. Like many other young people, they download music and YouTube videos and watch Mexican soap operas streamed onto the computers.

The younger children, from about five years and up, are also very present, and some of them have amazing computer skills for their age. The young people are much more knowledgeable and have more sophisticated skills than five years ago. From the two or three who continued beyond the village primary school before the project started, 15 are now attending intermediate or high school, and at least another 10 would do so if they could afford the transportation. The adults of the village, with just a few exceptions, have remained computer-shy, though the (coin-operated) phone is still extensively used.

Continued learning

After almost ten years of rural internet experience, we have learned a great deal. Success depends on a tight integration of technical and human factors. The equipment has to be as inexpensive and as easy to maintain as

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First-ever internet access in Los Martinez village, from the back of a pickup truck

possible. We use equipment just slightly above the low-end consumer grade, which can suffer from reliability problems. We need to make a trip up to the repeaters every year or so and, in the schools, the laptops are problematic to maintain because of their fragility and lack of interchangeable parts. We prefer low-power generic PCs where the motherboards consume only 12 watts. We use standard mice, keyboards, monitors and disk drives. We've tried pushing Linux, but keep coming back to Windows, which is essential for preparing young people for the job market.

The unreliable electricity supply is a constant problem. Solar panels are expensive, and the electricity always runs short, especially in cloudy periods and as the batteries run down over time. Hydroelectricity has proven to be the best solution where water with a sufficiently fast flow is available. Even the little DC turbines based on car alternators far outpace solar panels. The tiny El Limon 3 kW hydropower system that supplies 65 families with 30 watts of power – enough for fluorescent lights and a small television - has a very adequate 500 watts reserved for the school telecentre.

We are now focusing on ways to put the telecentre to practical use for a broader segment of the community. Distance learning is a priority, but has been more difficult to put into action than expected. While a number of the youth have located and used course material from various sources, the lack of a coherent curriculum is a big problem.

Telemedicine

Another critical need for the villagers is the delivery of health services. The long distances and lack of four-wheeled vehicles and over rough roads make it difficult for the sick or the elderly (or even overweight) to get to a clinic. We have been developing a telemedicine project, which will provide the community with online access to the primary care clinics in nearby urban areas. But the clinics still need to get online too with webcams and headsets for teleconferencing. But it is not only equipment that is needed. Local residents have to be trained to act as the doctor's hands, and eventually distance learning materials will have to be developed to improve the skills of these assistants on an ongoing basis.

For the El Limon project, one of the main objectives is to create a model that can be widely replicated elsewhere. Three years ago, a second repeater was added, with a line of sight to several other nearby villages. In Los Martinez, for example, the project installed a school telecentre with two computers, and another in the home of a local activist who is becoming an avid and effective user, despite having only a basic education. Contrary to expectations, the telecentre in Los Martinez remained underutilized for the first year, mostly due to lack of computer skills in the community. It was therefore decided to send one of the best students from El Limon to provide weekly training for them. Recently the project obtained funding to buy a used motorcycle that the student can use, and Los Martinez is now getting back on track.

Naranjales, the next village beyond Los Martinez, posed a different challenge. The village has very limited solar electricity, but is currently installing its own hydroelectric power system. The school building is not well maintained and is not secure enough to leave equipment there overnight, but the local teacher is already starting to develop the villagers' computer skills. To assist her we first installed a Wi-Fi client radio to take the internet to a laptop and telephone in the teacher's house, and upgraded her existing solar panel system.

Wireless networks

- **Bluetooth**
  Wireless Personal Area Network (WPAN). Works well at distances of up to a few metres, and is commonly used in hands-free mobile phone technology. Typical data delivery rate is no more than 3 megabits per second (3 Mbit/s).
- **Wi-Fi**
  Wireless Local Area Network (WLAN). Has a range that is measured more in football field terms, but has a fast data delivery rate of 250 megabits per second (250 Mbit/s).
- **Cellular**
  Global System for Mobile Communications (GSM). Most mobile phones work on GSM cellular networks. Measured in kilometres but has a slower data delivery rate than Wi-Fi, usually only around 2.5 Mbit/s.
- **WiMAX**
  Wireless Metropolitan Area Network (WMAN). Can work up to a range of around 50 km and delivers data at speeds of up to 70 Mbit/s (although more usually at 10 Mbit/s over 10 km). Can be useful to replace a system which already has a lot of cables, and is perfect for a setup that has no wires to begin with, such as in developing countries and in rural areas. Wi-Fi can then be used from an incoming access point to deliver the web to the user.

But the school still needed public internet access. The team set up a portable system for sending and receiving the Wi-Fi signals, including a robust long-life battery, a small inverter, and a tiny USB Wi-Fi client adapter needed to capture the wireless internet signal. Each evening the battery is sent to the nearby Los Martinez hydroelectric plant to recharge overnight. Two laptops, power for several hours of operation, and the Wi-Fi client radio are easily brought to the school by motorbike and the same student from El Limon comes one day a week to help with the learning process. Once the hydropower plant is producing electricity, probably within a year, a permanent telecentre will also be installed in the community centre building in Naranjales.

In the near future, the project plans to install a telecentre with two computers in another small village, Las Caobas. Security for the equipment will be a major concern there. The villagers also have less experience in managing projects, and little exposure to computers. Once Las Caobas is online, we would like to move to implement the telemedicine project, which has so far been stalled by difficulties in getting an internet connection into the clinic in town, and in finding someone with even minimal medical and computer skills to run the project. In the longer term, we are working on a plan for a province-wide rural network that would bring internet and telephone access to some 50 villages, some of which are very isolated.

The wider network

Keeping the telecentres and the network going depend on good social engineering. The villages simply can't afford to call in a commercial technician, so it will be necessary to train local young people. It turns out that every village has at least one or two people with remarkable technical aptitude. It also calls for a system where more experienced volunteers can be brought in when problems get complicated, as they often do. So far, the training has been pretty informal, but if El Limon is to build a provincial network, relevant, appropriate courses will have to be developed.

Assuming that the network project will initially be dependent on donations, economic issues are likely to be important, especially the costs of maintenance and connectivity. Paying for connectivity has been an ongoing problem in the Dominican Republic. DSL costs are high (where available), and satellite connections even higher. A few years ago many high schools lost their internet connections, some permanently, when the incoming government cancelled the (admittedly expensive) contracts for satellite (VSAT) connections signed by the previous administration.

Providing a payphone service in the village appears to be a favourable way to raise money, especially since even cell phone services are rarely available outside the urban areas. El Limon's telephone and internet service (the physical phone line is 8 kms away) has been subsidized by donations for the past year, but we expect that between the three payphones, and small payments by the several development projects using the internet, we can pay the US$100 monthly charge.

Ultimately, the success of the project will depend on how effective it is in improving the quality of people's lives. An important test came in autumn 2007, when tropical storm Noel struck the Ocoa area, causing massive damage and some loss of life. Part of the main highway to Ocoa was washed into the river, along with El Limon's dirt road, and this took 10 days to repair. But throughout the emergency El Limon stayed connected by internet and telephone (the other two villages lost contact for two days, due to a wet antenna).

Coordination

The phone in the school rang constantly, as families and friends of the villagers checked in. The network was the only link to Los Martinez and Naranjales for a week, and when emergency food aid was delivered it was only through the network that the communities found out about it and were able to go down to the town to get their much-needed supplies. Later, as more assistance came in, the villages were able to use the network to link up with the relief agencies and develop a coordinated response.

Now that the emergency has passed and life returns to near-normal, much of the project's focus will be on economic recovery and development. Startup funding has been obtained for an innovative four-village economic development project, integrating hydroelectricity, solar energy, biofuels, aquaculture and food processing. The network will make it possible, for the first time, for the villages to work cooperatively for a more prosperous future. ■

The El Limon wireless network, Dominican Republic

JORGEN SCHYTTE / STILL PICTURES/ LINEAIR

The access road

By using existing roads and communication systems, rural communities in Rwanda can connect to the internet through passing buses, cars or motorbikes fitted with Wi-Fi.

Case study

Rural areas in ACP countries are often poorly served by communications networks of any kind. Phone coverage, whether mobile or landline, is often patchy, if it exists at all. Television and even radio reception fades over long distances if there are too few transmitters to carry the signal. And connections to the internet, certainly broadband, are so rare they are practically non-existent.

The main reason for this poor coverage is the lack of investment by telecommunications companies. It costs money to extend networks to rural areas – both for the necessary extra infrastructure, as well as the licence fees involved. In areas where there are too few people, and even fewer with high incomes, it is difficult for companies to recoup the costs. This in turn makes it difficult for small towns and villages to develop at the same rate as larger cities, leading to increased inequalities between urban and rural areas.

So how will the billions of people living in rural communities located beyond the reach of most telecommunications infrastructures ever get the chance to make affordable phone calls and access the internet? Satellite-based communications remain prohibitively expensive, with ongoing running costs, unreliability in extreme weather conditions and frequent maintenance problems.

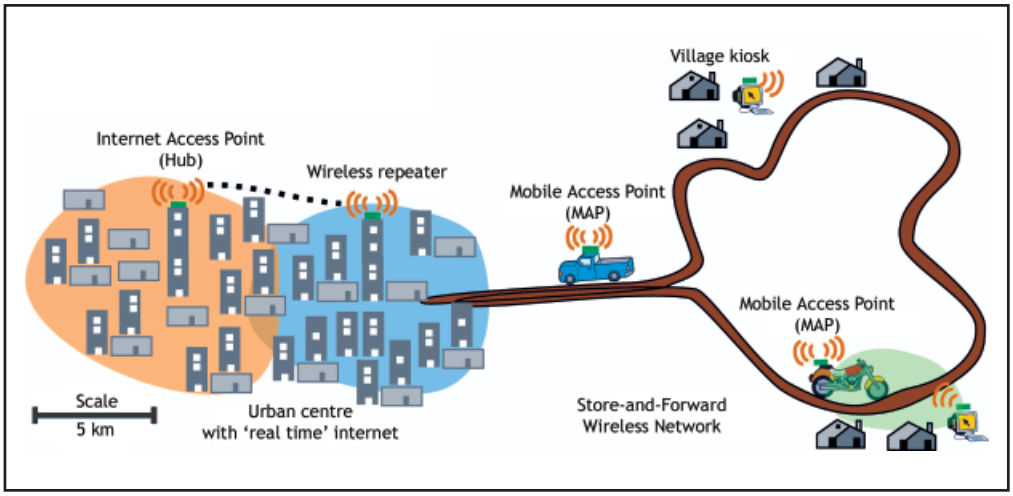
But there may be another solution. United Villages, a US-based start-up investment company, has come up with an innovative idea that has already brought the internet to rural areas around Kigali, Rwanda, as well as in Cambodia, India and Paraguay. Known as DakNet, this technology makes use of a combination of Wi-Fi and Voice over Internet Protocol (VoIP), and reaches the villages via vehicles using the existing transport infrastructure.

Mobile solutions

The process of providing internet access for villagers in this way begins in a nearby town or city. A reliable, often high-bandwidth, internet 'hub' is set up. This accesses the internet on a standard real-time wireless local area network (WLAN). Urban subscribers living within a certain radius of the hub can use the system by logging on to the wireless network it provides. The area covered by the WLAN can also be extended using repeaters positioned on nearby hilltops or tall buildings to carry the signal. How far the network can be reasonably extended depends on the population density, the surrounding landscape and local regulations covering the amplification of such signals. These restrictions usually mean that wireless internet networks never extend far outside urban areas.

DakNet has resolved these problems

For more information on DakNet contact **Amir Alexander Hasson** (amir@unitedvillages.com) founder and CEO of United Villages, Inc. (www.unitedvillages.com and www.firstmilesolutions.com)



COURTESY OF UNITED VILLAGES

A Village Area Network

by creating village area networks (VANs). Each village in a VAN – usually no more than 10 – has a computer is installed in a kiosk or local shop. The operator, who has been trained to use the computer, can offer services such as email and web searches. The customers, however, don't expect an immediate response from their requests. Instead, their emails and other data are stored locally on the PC, ready to be transmitted at a later time. What they have to wait for, in fact, is the next bus.

A mobile access point (MAP) is a small box that can be placed inside a bus or a car, or on the back of a motorbike – in fact, any vehicle that travels regularly along routes within the village area network. Aircraft and boats could even be used. The mobile access point is capable of storing data and is fitted with Wi-Fi capability. As the bus passes through the village, for example, the MAP automatically connects to the kiosk computer and transfers the data – emails and web search requests from the customers – via the wireless connection. The Wi-Fi aerial attached to the village computer can be up to 500 metres from the road.

As the bus travels past the other villages in the network, it continues to collect data. When it returns on its route back to the city, it then automatically connects with the hub to pass on the information. The emails and web requests are then sent out via the broadband connection. As the replies come back, they are transmitted back to the MAP, ready to be taken to the villages the next time the bus leaves on its regular route.

Drive by

This 'store-and-forward' method has proven to be cost-effective in the rural areas of many countries. The PC operator in the village is obliged to offer certain services for which his customers pay. Urban users of the hub service also contribute to the overall costs. But the system was developed to provide the villagers with much more.

In addition to email and cached web searches, this system also gives villagers the opportunity to send and receive voice and text messages to and from any phone by using a combination of VoIP and traditional landline telephony, and SMS text services. This 'Voice Mail over IP' (VMoIP) solution turns each village PC into a virtual phone booth.

Customers can send and receive voice mails through a public phone at each village PC, or they can use cordless phones to access their voice mail within a limited radius from each computer kiosk. Users can create voice mail boxes, similar to an email inbox, through which they can send voice mails and receive them from cellular and landline telephones. Using the numbered keypad of a standard telephone handset, people can communicate in their mother tongue with anyone else who has a phone number. VMOIP therefore reduces the literacy requirements while connecting users into traditional telephone networks.

The system delivers the voice mails in much the same way as email. The message is first stored on the village PC until the vehicle carrying the mobile access point passes. The automatic connection is made, the voice mail data is transferred and held until the MAP reaches a real-time internet link. There, each voice mail is routed to a server and delivered to its destination phone number. For a voice mail sent to a mobile phone, an SMS message can be sent to notify the recipient to call a number to retrieve the entire message.

When sent to a landline telephone, the voice mails can be delivered either in their entirety, or as a short preview with directions on how the receiver can retrieve the complete message. Typically, voice mails for local phone numbers are delivered over standard telephone networks, while national (where legal) and international messages are delivered using VoIP. There is also the possibility for users of the VMoIP service to have a phone number wherever there is a server in order to be reachable on a local phone number, thus keeping the costs low for friends or family who want to call back.

Pick a card

One critical factor in the success of the programme has been the use of prepaid phone cards. Once the village area network has been set up, United Villages sells prepaid cards to the kiosk operators, who then sell them on to their customers. When villagers come to the kiosk for the first time to get an email address and phone number they have to buy an 'identity card'. This has a scratch-off password that must be used to activates the account. After this, users can purchase 'recharge cards' where they scratch off a 16-digit code to credit their account.

The denominations, currencies and formats of the prepaid cards are fully customizable to fit in with the tariff structure for each service, the prices of which can vary greatly from country to country. This prepaid system has been especially useful in countries where banking and credit infrastructures are poor and post-paid billing is risky. Additional services can also be integrated into the system, such as e-commerce, microcredit and telemedicine. The prepaid cards essentially provide villagers with a digital stored value account which can be used in a variety of transactions via the village PC.

By recovering costs in this way, DakNet becomes an economically viable method of distributing bandwidth by making use of existing communication and transportation infrastructures. The bus still makes it possible for rural communities to connect with friends, family, government offices and even international agencies without the need for an expensive and time-consuming trip to town. Information and services are now being brought closer to even the remotest villages ... or at least as far as the road goes. ■

Set up a wireless network

Setting up a wireless network is quite simple. Most Wi-Fi products these days come with a CD ROM explaining the process, but there are a few steps to follow to make sure your system is correctly installed right from the start.

Equipment needed

- 1 x wireless access point (also called a router)
- 1x external wireless client adapter for every laptop or PC to be connected to the network (although some laptops may already have wireless capability; see below for more details)

1. Connect the wireless access point.
You need to connect a wireless access point to your existing broadband internet connection. You probably already have a modem or router that allows you to connect one or more computers to the internet, but instead of having a cable connecting to a computer, this should now be connected to the 'wireless access point'. This will be fitted with a small antenna that sends the radio signal carrying the data that used to go along the cable to your PC or laptop. It is also possible to do this wirelessly, but connecting the access point directly to the modem or router will prevent any breaks in the signal.

2. Enable the equipment to receive the wireless signal.
Most laptops manufactured in the last two or three years come ready to receive a wireless signal. You can check this by looking for a logo with Wi-Fi or 802.11, or the 'Centrino mobile technology' symbol. These indicate that your laptop can already receive a wireless signal.
In the case of desktop computers or laptops without this capability, it will be necessary to buy a small device called an 'external wireless client', which usually fits into a USB slot. This is basically a small antenna that is capable of receiving the wireless signal and will come, if new, with a CD ROM that includes installation instructions and the necessary drivers that your computer needs to run the device.
Alternatively, you can fit a PC adaptor into your laptop that will do the same job as a wireless client adaptor. This is a small card that slides into a slot on the laptop. For desktop computers, you can also fit an internal PCI card into an available space at the back of the computer, which also has a small antenna to communicate with the wireless access point.

3. Configure the access points and adaptors.
The adaptors now have to be configured to recognize the signal being sent from your individual access point. Each access point has a name, called a service set identifier (SSID). This is usually supplied by the manufacturer and can either be a number or a name or a combination of both (e.g. SD19837G or Linksys). If your access point still has this default SSID, then it should be changed. If a person can identify the type of access point, it is easier for them to hack into it.
You can change the SSID at the time of setup, but please note that it is very difficult to change it afterwards. You should change it to something that is not immediately identifiable as being your network, so don't give it your own name or your organization's name. Choose a safe password made up of letters and numbers, but make sure you are able to recognize it later. If you are in an area with many wireless networks around, then you will need to be able to choose the correct one. You will be given the opportunity to change the SSID when you install the access point.
Next, you have to configure the client adaptor to recognize the SSID of the access point. Look for the small icon in the bottom right-hand corner of your computer screen. The icon usually looks like a small computer monitor with three arcing lines, indicating radio signals, coming from it. Double-click on this to get to the 'Wireless Network Connection' status window. Here, click on 'View Wireless Networks'. A list of networks in your area will appear; or, if there are no other networks near you, your network will be the only one listed. Make sure the network has the SSID name that you gave it. Click once on your network name and you will see a button with 'Connect' at the bottom right-hand side of that small window. Click on 'Connect' and the computer will then link to your network (this may take a few seconds).

NOTE: If your system is encrypted, making it even more difficult for others to access the data you send over the wireless network, then you will enter the encryption code at this point. This code is unique to your SSID and can be seen at the time of installing your access point. Your computer will then remember this code so you don't have to enter it every time you connect.

After this, your computer will automatically connect to your network when it is switched on ■

A – N guide to Wi-Fi

The standards continue to evolve based on the IEEE 802.11. Within that specification, there are four basic standards — A, B, G and N — that manufacturers use to ensure that a product is compatible with all others. The first basic standard was B, which is the slowest but is still adequate for a lot of applications. The A standard runs on a different frequency spectrum (5GHz) that is far less crowded but has the same performance level as G, which runs on the busier 2.4Ghz channel, the same as B. N is the next generation equipment and is available now. It offers about five times the performance of G and about twice the range. G covers about a football field. N will cover twice that distance. IEEE is still completing the N standard, but Wi-Fi Alliance has been testing this equipment and has certified close to 200 802.11N products. These are already being bought by businesses as well as consumers who want greater performance. N products are also especially useful for covering larger areas — farms, for example — because fewer access points are needed and more users can be coped with on the same network.

Wi-Fi Protected Setup

The Wi-Fi Protected Setup logo on a product indicates that consumers buying that product can automatically configure their new wireless network, add new devices and enable security without the need for any great understanding of traditional Wi-Fi configuration and security settings.
➜ www.wi-fi.org/wifi-protected-setup

How to set up a wireless network

A video from Lab Rats TV explains the steps involved in installing a wireless network.
➜ http://video.google.com/videoplay?docid=5052719230956828068

Spreading from the centre

From a small initial investment of their own money, a group of volunteers in Ghana has managed to build a wireless network spanning 20 km. Local farmers and schoolchildren have already benefited from this very inventive system.

Case study

About 65 km from the capital Accra, in the Eastern Region of Ghana, is the small town of Apirede. Its location is quite unique in that it is close to most of the other 17 towns and communities in the district– some are only 1 km away, while the farthest is no more than 8 km. Residents from all around can travel easily to Apirede, making it the ideal place to host a community resource centre. The Apirede Community Resource Center (ACRC) provides literacy lessons to children, runs programmes to enhance the skills of local women and provides educational videos on health, sanitation, childrearing and parenting for adults.

Because of its location and the popularity of the centre, Apirede was also chosen as the starting point for an ambitious rural wireless network. In 2005, the local community requested an internet connection to help it break from its rural isolation and be better able to compete with its urban counterparts. This was the beginning of Wireless Ghana, a project of Community-Based Libraries and Information Technology (CBLit), a non-government organization based in both Ghana and the United States.

The project started with next to no capital. A small amount of personal funds were used to buy the initial equipment, and hundreds of tests were carried out with antennas in different locations until finally the team was able to bridge a 5 km link. This proved the system was technologically possible and efforts were made to attract an organization to purchase the first 'node', or access point. That was successful and the network has since expanded, one node at a time, to become the Akwapim Community Wireless Network, named after the district it serves.

Sharing

There are now ten nodes spread out over a 20 km range, offering connectivity to schools, businesses and community activity centres throughout six towns in the mountainous Akwapim district. Open-source software from the Champaign-Urbana Community Wireless Network (CUWiNWare) makes shared internet access possible between the nodes in a so-called 'mesh network'.

Each node has an antenna, a router and various cables and costs roughly US$500 to build and install. In Ghana's

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rural villages, that is a lot of money to pay. The sum is out of reach for most individuals, which explains why it has mostly only been taken up by businesses and organizations so far. To try to keep the costs low, routers are built from old computers combined with new wireless cards. The computers used do not need hard drives and are therefore well suited for work in developing countries where heat and dust might cause problems.

This sum of US$500 covers all of the equipment and installation expenses necessary to mount an antenna on a rooftop, run cables indoors, set up an indoor router and connect personal computers. Nodes are guaranteed to be installed within two weeks, depending on the availability of equipment that must be imported. Wireless Ghana provides a contract which sets out all these expenses and gives the timeline for installation and the cost of internet services on the network.

One thing that is not addressed in the contracts is a maintenance service agreement. Currently minor repairs are performed free of charge, and usually maintenance is something very simple. But as Wireless Ghana is staffed solely by volunteers who do not always have time to spare, it can often take weeks to fix even a minor issue.

Maintenance costs involved in the regular upkeep of the overall system are recovered by providing an internet service to people living within range of the network. Anyone operating a node can provide this service, as it is an open-access network. Internet access at the Apirede Resource Center currently costs of US$35 per month per computer, but this still does not cover the network repair costs, as much of the infrastructure could already use an upgrade.

This is one of the critical aspects of ICT projects in developing countries. Because of the poor electricity supply, quality of building materials and lack of skills, the equipment and basic structures – antenna towers, for example – fail much sooner than expected. Erratic electricity supplies can seriously damage delicate computer parts and even ruin network cabling.

Another major drawback to telecommunications access in developing countries is the cost of services. Often the only source of broadband internet in an area with limited, or even non-existent, communications infrastructure is a satellite feed. Satellite feeds are expensive when compared to most other wired forms of access (DSL, cable, telephone line), both for the initial investment in equipment and for the continuing service. Akwapim Community Wireless Network is supplied by a single (128/32 kbit/s) satellite internet connection which has to be shared around the system. It is also a constant struggle to supply enough bandwidth to all ten nodes from the single, original source. The team has to continually develop methods to improve the efficiency of the limited bandwidth (see box, 'How to optimize bandwidth').

The solution to these problems, which are all largely financial, has been to add equipment slowly as funds become available. The centre now has very basic uninterruptible power supplies (UPS) on the two nodes that comprise the network's backbone. One of these nodes has an amplifier to strengthen its Wi-Fi signal. All antennas, most cables and connectors and the amplifier have been purchased from the United States or Poland, where equipment can be bought cheaper than in Ghana.

Inclusion

It is extremely difficult to measure how the technology has affected the local community and it will take several more years before any concrete results are seen. It is already evident, however, in the excitement and level of awareness among most of the residents that the technology and improved information exchange has had a positive effect on them and on their children's education. Parents are trying to understand ICT and are encouraging their children to use the centre and its internet facilities because they see other children benefiting from the increased access to computers.

Not only that, the communities have started to realize the economic gains that can come from such information as farmers searching for tips on rural agricultural processes to improve their harvests and discover new markets for their crops. This involvement of the community, and by having residents manage the project themselves, has caused a more positive 'can do' attitude to emerge, coupled with the tenacity to make the project a success. The women, who remained very much in the background at the start of the project, are now articulating their needs and those of their children, providing suggestions and getting the men to accept constructive criticism and involve the whole community in decision making.

The Apirede Center staff has gained in experience and confidence, too. They are now managing an HIV/AIDS programme in the surrounding towns and villages for the Ghana Commission for AIDS. The centre recognizes the strategic location and the impact the wireless project could make in enhancing community health programs, education and economic, social activities, and hopes to expand further, along with the wireless network that helped them in the first place. ■

Related resources

In its years of running the project, Wireless Ghana has put together some useful guides to help others who are working, or might be about to work, on similar systems.

How to optimize bandwidth
Wireless Ghana has developed methods of browsing that allow a user to obtain a very effective stream of internet access with a very small amount of bandwidth. This would be useful for those who work on a shared network or for anyone with a slow internet connection.
➜ **www.wirelessghana.com/node/6**

Long Distance Wi-Fi
This document gives an overview of how you can maximize the performance on a long-distance 802.11b wireless link with a minimal loss of bandwidth.
➜ **www.wirelessghana.com/node/7**

CBLIT (Community Based Libraries and Information Technology)
➜ **www.cblit.org**

Community Wireless Solutions
➜ **www.cuwireless.net/**


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Working without wires

Wi-Fi only operates over relatively short distances (less than 100 metres). How can such a system still be useful in rural areas?

➜ It is quicker and cheaper to install than most other methods, especially as there is no need for underground cables. The signal still has to be brought to the Wi-Fi hotspot, often by satellite, DSL or fibre optic cable and Wi-Fi then distributes the system throughout the local network. It's kind of like the water main coming into a street: the main source is brought along the street but individual houses and offices are served by a smaller, narrower connection, in this case, by Wi-Fi.

A lot of systems even use two different types of wireless technology, for example, WiMAX together with Wi-Fi. They each have different properties and advantages for communicating data. WiMAX, because it operates at a higher frequency, carries the signal over large distances but cannot penetrate walls. Wi-Fi uses a lower frequency, taking the signal throughout a whole building but only for a few hundred metres. WiMAX is therefore often used as the backbone of the service, bringing the internet to a building, for example, and Wi-Fi is used for local distribution to the individual computers.

How can Wi-Fi benefit a small town or village?

➜ The best way to illustrate this is to give an example. The small rural town of Piraí, in the state of Rio de Janeiro, Brazil, has a population of around 20,000 people. It had a few local industries, but suffered a serious economic setback when one of the industries shut down. The town was facing a serious financial crisis and the mayor came to the conclusion that he would have to raise taxes to ensure the financial stability of the town. The most obvious way to do this was to tax property but, as yet, there was no register of properties in the town.

With the help of funding from the state of Rio de Janeiro and a telecommunications company, a set of Wi-Fi internet kiosks were placed throughout the town where owners could register and claim their properties online. As well as raising taxes, the scheme stimulated the local economy as it created a formal housing sales market. In turn, this created a mortgage market and gave houses a real value, making it financially interesting for the owners. At the same time, the Wi-Fi network was being used for all sorts of other things, by kids to play games, for people to email and in trade cooperatives for craftsmen to sell their goods online. It has been so successful that they have now increased the number of kiosks and the mayor has been asked to replicate the project throughout the state of Rio. The idea, however, has already been expanded to Nigeria and many other countries in the developing world.

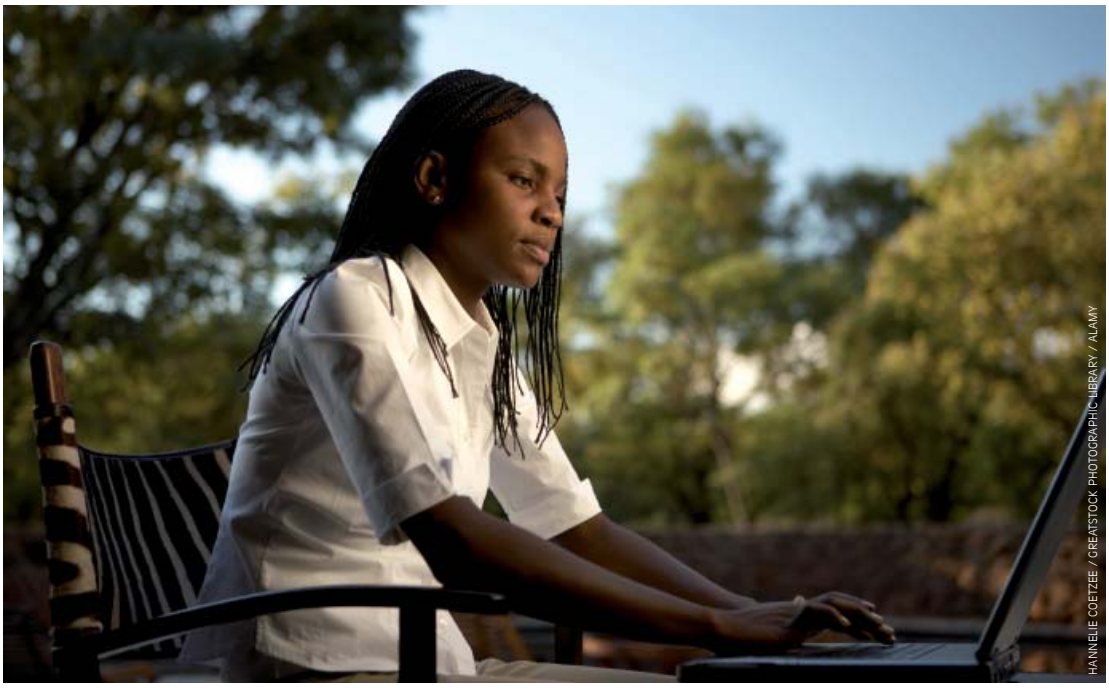
There are a few small projects bringing wireless internet to rural communities in ACP countries; is this likely to expand in the near future with more villages getting online?

➜ There have been wide-ranging efforts on a global basis to expand broadband wireless to developing countries as a low-cost method of distributing broadband. There have been some significant developments already in Nigeria, Kenya and South Africa.

But getting wireless broadband to a small rural community is a multi-step process. It actually begins by setting up a global regulatory framework to harmonize regulations and policies regarding the use of unlicensed radio spectrums throughout the world. If everyone uses the same frequency and the same specifications, manufacturers can then conduct research and produce equipment on a large enough scale to drive the cost down.

It is often said that Wi-Fi is not as secure as wired networks as, without cables, the data can be more easily intercepted. Is this really the case?

➜ Wireless networks do pose security challenges, some of which have been solved already and some of which will be solved over time. But 12 or 13 years ago, when we fist started using internet browsers, there were security problems with the wired internet and security has improved dramatically since then. A lot of security is already in place on wireless networks and more will come along. It's a continuous process. To put it into context: if you live in a developing community with no other means of communication, then any means is better than nothing. In such circumstances, security might not be your biggest concern. ■



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