Community Wireless Networks

Cutting Edge Technology for Internet Access

A report on the Center for Neighborhood Technology's project to bring community wireless access to three Illinois communities.

Center for Neighborhood Technology

November 2006

STATE OF ILLINOIS
OFFICE OF THE LIEUTENANT GOVERNOR
SPRINGFIELD, ILLINOIS 62706

PAT QUINN
LIEUTENANT GOVERNOR

As Chairman of the Illinois Broadband Deployment Council, I believe in a policy of everybody in and nobody left out. The Internet opens up important opportunities for Illinois residents. The Web is an increasingly vital tool that can help people find work, build job skills, or complete school assignments. But not everyone in Illinois has access to this important resource. A recent study by the Federal Communications Commission (FCC) concluded that Illinois ranks twenty-seventh in the country when it comes to purchasing broadband services.

The Center for Neighborhood Technology's Wireless Community Network Project offers a new approach to connecting low and moderate-income communities to the Internet. The project has connected people who have never had Internet access, and opened new doors for Illinois families.

The inspiring stories go beyond Illinois. After Hurricane Katrina struck the Gulf Coast, the Center for Neighborhood Technology staff realized that the wireless technology they were deploying locally could provide vital communications in the region devastated by the storm. Members of the Center for Neighborhood Technology wireless team mobilized and set up computers with wireless Internet access at shelters in Louisiana and Mississippi. The network helped people connect with relatives and access emergency services.

With this project, the Center for Neighborhood Technology has demonstrated that wireless community networks offer an innovative, effective strategy for connecting people not just to the Web, but also to their neighbors and to their community.

I am please to support this effort to strengthen community connections, create economic and educational opportunities, and provide vital information about issues that are important to Illinois residents.

Sincerely,

Pat Quinn
Lieutenant Governor

Room 214 State House
Springfield, Illinois 62706-4700
Phone 217-782-7884

100 W. Randolph, Suite 15-200
Chicago, Illinois 60601-3220
Phone 312-814-5220

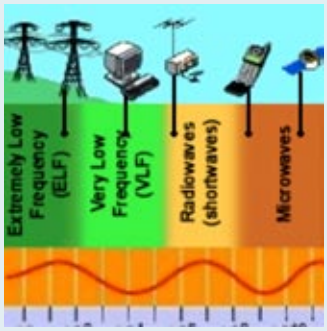
Community Wireless and the Digital Divide

Wireless community networks can be an effective strategy for addressing the digital divide. They can offer affordable access to the Internet while building community and strengthening the local economy. In an age when access to the Internet is increasingly a condition for full participation in society and the economy, the development of a community wireless network is a technology that can work on a small, manageable scale and which permits local community control.

In 2003, CNT launched the Wireless Community Network Project to develop pilot networks in three different community settings:

- **North Lawndale**, a Chicago West Side low- and moderate-income African American neighborhood.
- **Pilsen**, a Chicago Near Southwest Side mixed-income Hispanic neighborhood.
- **West Frankfort**, a Southern Illinois former coal mining town.

This project, the first of its kind in United States, has generated a wealth of hands-on experience that CNT wants to share with other groups considering launching a community wireless network. In addition, two of CNT's community wireless technicians traveled to southern Mississippi and Northern Louisiana to assist with disaster relief following Hurricane Katrina.



The telecom spectrum.

The First Sears Tower in Chicago's Lawndale community was the location of the Lawndale wireless antenna.

How Wireless Community Networks Work

Wireless community networks are a telecommunications technology that provides access to the Internet over the airwaves, rather than by land lines. Wireless uses two-way radios that take advantage of an unregulated portion of the telecommunications spectrum. Wireless community networks are organized on a geographic basis to serve a specific neighborhood or community and to improve the quality of life within that community. These networks are characterized by the linkage of many individuals in a complex web, offering flexibility to changing demands for bandwidth and adaptability when something goes wrong.

Wi-Fi Spectrum: The electromagnetic spectrum is an aspect of the physical world, like land, water, and air. Specifically, spectrum is the electromagnetic frequencies (wavelengths) used for communications including frequencies used for radio, radar, Wi-Fi and television. Wi-Fi is a term developed by the Wi-Fi Alliance to describe wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards.Use of radio frequency bands of the electromagnetic spectrum is regulated by governments in most countries, a process known as frequency allocation or spectrum allocation. The Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) regulate spectrum in the United States.

Resources on the Telecom Spectrum

www.spectrumpolicy.org/
www.fcc.gov/spectrum/
www.muniwireless.com
www.newamerica.net/

Internet Gateway: The Internet Gateway is the central antenna where the wireless network is anchored on the earth and connects with the Internet. This gateway needs to be a high enough speed to service the network. Fiber optic is optimum, but T1 lines can also work. On general rule to use is that one T1 line (1.544 megabits

The Center for Neighborhood Technology

The Center for Neighborhood Technology (CNT) was founded in 1978 to research, adapt and test new community revitalization strategies relevant to urban communities, especially strategies that harnessed the environmental and economic value of the more efficient use of natural resources. Over the years we have worked to:

- Disclose the hidden assets of the Chicagoland economy and urban areas more broadly
- Demonstrate the multi-bottom line benefits of more resource-efficient policies and practices
- Show how the value of what we demonstrated could be captured to benefit communities and their residents inclusively.

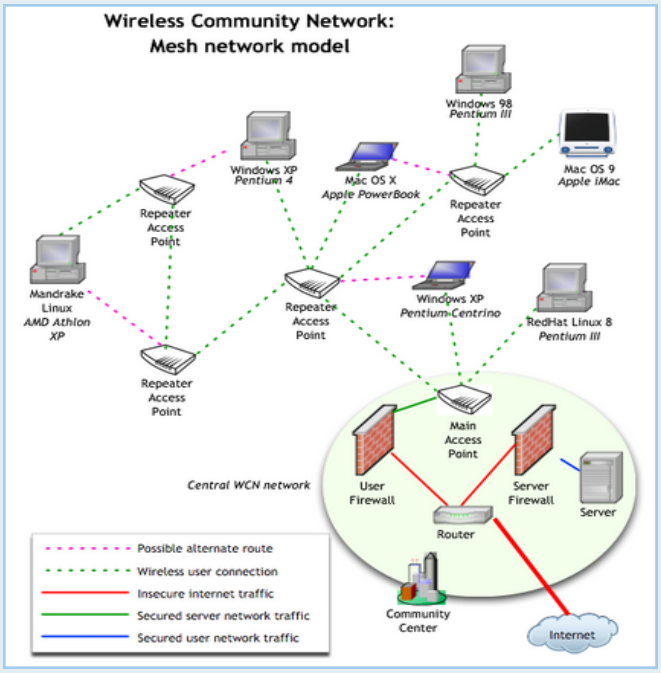
Our work, especially in the areas of energy, transportation, materials conservation and housing preservation, helped fuel a generation of community development institutions and learning, garnering us a reputation as an economic innovator and leader in the field of creative sustainable development.

per second) is capable of supporting around 300 wireless users, while 3,000 wireless users can be handled by one for each fiber optic connection (155 megabits per second).

Repeaters: Repeaters are two-way radios that send and receive messages from the Internet. The Wireless Community Network Project uses rooftop repeaters. Other systems place repeaters on lamp poles or other tall structures. The repeaters need to have reliable access to power and be located near to users.

User Connections: Members/users can connect with the repeaters either through an Ethernet cable or with a wireless card attached to their computer.

Mesh Network: Community wireless networks need a way to adapt to changes in the demand for bandwidth from minute to minute. A member may want to download a video and require lots of bandwidth for 20 minutes, then not use the network again for two days. And a repeater malfunction needs to affect the smallest number of users. A mesh network is the strategy which the Wireless Community Network used to address these challenges. It links all of the repeaters together in a complex web which offers each packet of information a range of routes to and from the Internet Gateway. WCN has piloted and tested open source mesh network software developed by the Champaign-Urbana Community Wireless Network (CUWiN). Because of the resilience and flexibility of the software developed, the network could be effectively deployed in conditions too adverse for more traditional networking systems, but since there is no fixed infrastructure for nodes in the mesh network to connect to, it's possible for individual nodes or sections of the network to become isolated from other sections.



Champaign-Urbana Community Wireless Network
E-mail: cu-wireless-support@cuwireless.net
Phone: (217) 278-3933 x30
Fax: (217) 278-7171

Hurricane Katrina

Once the impact of Hurricane Katrina began sinking in, Wireless Community Network technicians Paul Smith and Rogers Wilson III realized that wireless technology could provide essential phone and Internet communications. They headed for Rayville, Louisiana with a van full of donated computer and wireless equipment where they met up with a dozen other volunteers from Wireless Internet Service Providers (WISPs) from across the country. Paul and Rogers, with 10 other volunteers, first set up computers, Internet access, and VoIP phones at 12 nearby shelters. Over 1,000 calls were placed from the shelters within the network's first three days connecting hurricane victims with relatives and with FEMA, looking for resources and services.

Then Paul went on to Bay St. Louis, Mississippi. Working out of the Powerhouse of Deliverance Church—which had a flood line at the ceiling—a team set up wireless links for the local hospital and other locations. Volunteers received official clearance from the Emergency Operation Center to access city infrastructure for the network hardware. Paul subsequently launched the first website for what is now known as Radio Response, a network of wireless practitioners committed to providing wireless communications in emergency situations.

Our technology, designed for urban neighborhoods, proved itself to be useful and flexible far beyond our expectations. You can read more about CNT's efforts after Hurricane Katrina in the New York Times article "Talking in the Dark".

Wireless and Your Community

Community wireless networks have the potential to provide Internet accessibility that is affordable, ubiquitous, and democratically controlled. In addition, they offer an exciting new tool for community economic development that can reduce poverty, promote a sense of community, and encourage civic participation. This community aspect is especially important. Your community, however, does need to meet certain basic specifications.

User Density: The Wi-Fi signal can travel between 250 and 300 feet, depending upon the type of antenna. This defines the furthest distance that members can be from each other. The system works best when members are much closer.

Topology: Wi-Fi works on a line-of-sight basis, which means that one has to be aware of the height of each node and the presence of any obstructions, like dense foliage. Each node needs to be able to "see" other nodes in the network.

Robust Mesh Network: The mesh network software identifies the optimum route from each node to the Internet gateway. The more routes that a packet of information can take to reach the Internet gateway, the more robust and flexible the network. At a minimum, each node needs to see two other nodes, while the ability to see three or four is much preferred.

Developing a Network

Commitment to Reliability: A community wireless network is a major responsibility. Members need to be able to count on it, not just for occasional use, but to run their businesses and handle emergencies. The organizing group needs to be prepared to accept this responsibility to provide continuous, high quality accessibility to the members. Think about the phone company. When you pick up your phone, you expect a dial tone. Every time. A wireless network should aim for a comparable level of reliability.

Community Buy-In: By its very nature, a community wireless network needs to have users/members throughout the community if the mesh technology is to work well. Hence it will have the active support of a large number and broad range of community residents. It can't be created by a small group, however dedicated, on the margin of the community.

Technical Capacity: A wireless project is technically challenging. It can only be successful if there are a group of "geeks" committed to it—people who already know and love computers and the Internet. They can't be people who are getting their introduction through the wireless project. The success of the wireless network will require the care, feeding and recognition of its technology experts.

Organizational Anchor: The organizing group will have its hands full designing and implementing the network and recruiting members. It is highly desirable to locate the project in an existing

An E-Entrepreneur in North Lawndale

Using his connection from the North Lawndale Wireless Community Network, Clifton Augustine launched an e-business a couple of months after being connected. Mr. Augustine was on the cleaning staff of the Homan Square Community Center Campus, one of the neighborhood sponsors of the network.

He was an early adopter and a wireless enthusiast from the start and would give regular reports on the status of the network.

North Lawndale residents assembling Wi-Fi repeater nodes for installation on local rooftops

The project provided him his first computer in late 2005. He immediately tried to hook up Voice over Internet Protocol (VoIP) even before the network was configured for that application. Within weeks he was handing out business cards with his own URL for an out-of-the-box e-commerce site (http://www.oneightgiftshop.com/).

He also started selling a relative's performance DVD on the site. For Clifton, computer and wireless access quickly opened the doors for entrepreneurship and creativity.

institution which has by-laws, 501(c) 3 IRS non-profit status, and financial systems already in place. The organizing group should focus on the challenge of the network rather than the challenges of the network and institution building.

Computer Access: The wireless network requires that the members all have computers, either in their homes or businesses. If you want an inclusive community network, the organizers will need to take responsibility for finding and setting up used computers for those who don't already have them.

Money: Your community wireless network will require funding. The amount depends on size, technology, and whether it is developed on a volunteer or staff basis. At the beginning, there will be high capital costs; and, ongoing, the network will need to pay for Internet services, among other things. Someone with business experience needs to develop a business plan so that the economic aspects of the network are clear and members can make the critical decisions about membership and monthly fees, etc.

The Public Policy Context

Access to the wireless spectrum can't be taken for granted. It depends upon decisions by the Federal Communications Commission (FCC). There are several issues pending before the FCC which will affect you:

Stronger Wi-Fi Spectrum: The current portion of the telecom spectrum allocated to Wi-Fi provides signals that are not strong enough to go through walls. Even dense foliage can obstruct the signal. Efforts are underway to expand unregulated spectrum available for Wi-Fi using spectrum formerly allocated for analog television. Your voice is needed on this issue.

Network Neutrality: The principle that residential consumers of broadband network services must be the sole payers for these services. In other words, Network Neutrality prohibits broadband carriers from billing third parties for content or services. This is said to be good for consumer welfare because it puts consumers in control of web content moving through the broadband network to the home. In U.S. politics, network neutrality refers to a range of proposed legislation related to restricting the billing for broadband services and the kinds of services broadband carriers may offer. This legislation prohibits the sale of voice- or video-grade Quality of Service (QoS) enhancements for a fee. Finally, the legislation prohibits content- or service-sensitive blocking or censorship on the part of broadband carriers.

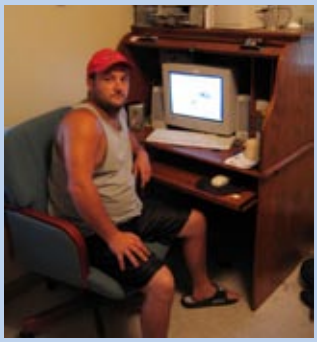
Engage the Policy Debate: The Wireless Community Network strongly encourages that you be in touch with the following national groups that address Wi-Fi policy:

Free Press: Free Press is a national, nonpartisan organization working to reform the media and involve the public in media policymaking. Through education, organizing and advocacy, Free Press promotes diverse and independent media ownership,

West Frankfort Success Story

West Frankfort is a former mining town in southern Illinois. Two and a half years ago, Willie Browder moved into one of West Frankfort's public housing complexes with his partner and four small children after he lost his license as an over-the -road truck driver and became unemployed.

His Internet through the West Frankfort Wireless Community Network Project permitted Willie to research the steps necessary to regain his license. He applied for reinstatement, registering for the necessary classes over the Internet. He then found a good paying job online with TRL Trucking. Willie now uses the internet to pay bills – even to find a house in a nearby town.



Willie Browder with his wireless broadband access at home.

Willie's four year old son was born deaf. Willie and his partner used the Internet to research a cochlear implant for the boy. The implant has restored his hearing and he has begun to talk. They find that contacting his doctors by email gets a faster response than phone calls that often go unanswered.

strong public media, and universal, affordable access to communications.

Free Press
100 Main St P.O. Box 28
Northampton, MA 01061
Phone (877) 888.1533
Fax (413)585.8904
http://www.freepress.net

New America Foundation: The purpose of the New America Foundation is to bring exceptionally promising new voices and new ideas to the fore of our nation's public discourse. Relying on a venture capital approach, the Foundation invests in outstanding individuals and policy ideas that transcend the conventional political spectrum. Through its Fellowships and Policy Programs, New America sponsors a wide range of research, writing, conferences, and events on the most important issues of our time.

New America Foundation
1630 Connecticut Avenue, N.W. 7th Floor
Washington, DC 20009
Phone: (202) 986.2700
Fax: (202) 986.3696
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Media Access Project: The Media Access Project is a thirty year old non-profit tax exempt public interest telecommunications law firm which promotes the public's First Amendment right to hear and be heard on the electronic media of today and tomorrow.

Media Access Project
1625 K Street, NW
Suite 1000
Washington, DC 20006
Phone: (202) 232.4300
Fax: (202) 466.7656
http://www.mediaaccess.org

Students built their own mesh wireless repeaters and then personalized them.

WCN Funders, Community Partners and Contributors

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CNT WCN Project Staff
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Node on a rooftop in Lawndale. with the old Sears Tower in the background.

The Future: Municipal Wireless Networks and Community Development

Much has happened since the Wireless Community Network Project was first conceived four years ago. Wireless has grown from isolated, largely indoor "hotspots" to municipal-wide wireless networks. Many large cities, including Chicago, are planning for border-to-border wireless networks. The promise, yet to be realized, is affordable Internet access without redlining, perhaps even subsidized fees and free computers for low-income users.

What municipal wireless networks lack, however, is community. They are not "place based." So far, municipal networks are not being designed to strengthen intra-community ties and grow neighborhood businesses. Indeed, it is possible that municipal networks could decrease business activity in low- and moderate-income communities as residents make purchases over the web, where local merchants have no presence.

The challenge is to design municipal wireless networks so that they mimic the neighborhood-centered characteristics of community wireless networks.

For More Information

This is a summary report which provides an overview of this three-year demonstration program. CNT has also published two other reports which address the challenges and opportunities of wireless community networks in greater detail:

What We Learned: A Guide to Thinking About Community Wireless Networks
To help communities considering developing a wireless community network decide whether it is an appropriate project for them

Building Community Wireless Networks: A How To Do It Manual
To help communities that have decided to develop a wireless community network fulfill their goals and avoid the problems which the WCN encountered

Both these reports are available on the enclosed CD and at www.cnt.org.

Node Building Party at Carole Robinson Center in Lawndale.

Center for Neighborhood Technology
2125 West North Avenue
Chicago, IL 60647
(773) 270-4800 www.cnt.org

What We Learned

A Guide to Thinking About Community Wireless Networks

Preface

Like doing rehab in an older home, you sometimes don't know what a project will look like or cost until you get into it. CNT has developed three different resources to help you define your network project.

- *The Wireless Community Network Project: App;ying Cutting Edge Technology to Improve Internet Access* provides an overview of CNT's Wireless Community Network Project.
- *What We Learned* (this document) offers information and asks strategic questions relevant to community wireless networks.
- *Building Community Wireless Networks: A How To Do It Guide* provides greater detail about the actual execution of a community wireless project.

This report is intended to help you make an informed decision about whether a community wireless network is a good fit for your organization and community.

Introduction

The Internet has become a tool used across the globe to communicate, learn and teach, and access to the Internet is becoming necessary to stay connected with today's society. Grocery shopping, applying for jobs, and continuing education are a just a few activities that traditionally were done exclusively in the physical realm, but now have migrated partially or entirely to the web. Ultimately, the Internet provides a wealth of information to individuals with access. Internet access can also be access to higher-skilled employment opportunities, health and educational resources. Most importantly, it is a tool to keep in touch with and informed about issues, events and people that matter most to the individual Internet user.

Those without access to an Internet connection, mostly working-class and poor families, are beginning to find it increasingly difficult to apply for jobs, obtain information about their children's schools, or obtain government services. This separation between those with regular, effective access to digital technologies like Internet connectivity and those without that access is known as the digital divide. The divide is both self-reinforcing, as those without access are increasingly unable to obtain the means to gain access, and growing even as the number of people gaining access to the Internet grows.

The pace at which technology advances makes it difficult, even for those who do have access, to use the Internet effectively. Now, without a high-speed connection, the amount of information that can be accessed is limited, because Internet content providers design

websites that cater to those with a high-speed connection (DSL, Cable or T1) and more advanced technology. Many families and individuals cannot afford the faster connection and they are not able to purchase a new computer every 5 years. This leaves them with outdated equipment and a painfully slow connection—dial-up—limiting their use of the Internet. Or they have no connection at all because the costs out weigh the benefits.

Households without effective computer technology obviously lack effective Internet connectivity; however, many families own personal computers but do not have the means for effective access to the Internet. Community wireless networks are one way to address this lack of Internet access.

Previously, wireless networks were developed by technically-savvy professionals primarily in corporate settings. This guide describes the Center for Neighborhood Technology's (CNT) experience in deploying wireless networks in low-income communities during our Wireless Community Networks project (WCN).

Intended Audience

This guide is intended for organizations, groups and non-profits that are looking into starting community wireless networks or that are developing the vision or mission for any kind of community broadband initiative. A more in-depth companion manual, *Building Community Wireless Networks*, is intended for groups that have moved past the consideration stage and are in the planning stages of a community wireless Internet project.

Community Wireless or Another Option?

Deploying wireless networks in low-income communities is by no means the unambiguous favorite solution. If an organization's goal is simply to increase high-speed Internet availability in a community that is currently on the wrong side of the digital divide, strategies ranging from forming partnerships with broadband providers to encouraging the development and accessibility of community technology centers within the community can and should be considered.

One factor in the consideration of the community wireless option is that while the technical challenges of deploying wireless networks and mesh wireless networks have largely been solved, they still require significant expertise. To be successful, any group hoping to implement a community wireless network will need, as part of its paid or volunteer team, people with backgrounds in networking, wireless communication and computer administration.

However, there are substantial reasons why a community wireless network might be the preferred solution. The Center for Neighborhood Technology chose to develop community wireless networks utilizing new, innovative networks based on a mesh topology, using open-source software developed by the Champaign-Urbana Community Wireless Network (CUWiN). The vision for these networks, however, was broader than merely increasing broadband penetration in a low-income community. It saw the community wireless network as a means to address a broad range of social and economic goals (described below) which justified the investment and effort.

Education and Empowerment

The network ran off of the open 802.11b standard and the nodes that made up the network used readily available equipment from Soekris Engineering. This technical solution meant that the process of building wireless network nodes required only basic and readily teachable technical skills such as using a screwdriver and preparing CAT-5 cable. This simplicity allowed us to host "node building parties" where volunteers, members of community organizations, members of communities served by the network, and project members worked side by side, under the guidance of technicians, to create the equipment for expanding the pilot programs.

The realization that the creation of this sophisticated network equipment required knowledge and skills that were well within reach of all participants was, we believe, an important realization for all participants. There were, of course, more complex elements of the network's design and operation that were not possible to teach at a single event. We were able to use those elements to the benefit of the communities we served as well; we used them as concrete and hands-on examples for teaching fairly sophisticated network concepts to interested community members.

Involving a Diverse Volunteer Community

Volunteers came to the project from a wide variety of places. Members from communities that were served by the network were frequent volunteers at node building parties. Even though many of these volunteers knew that they were not in a specific location to connect to the network, they shared their resources to maintain and build the network out of both an interest in the educational benefits of involvement and in recognition of the importance and benefits of a community wireless network.

We also brought in volunteers from the "geek" community, people who use technology everyday for work or hobby. These volunteers were interested both in the service and the unique technological aspects of the project. They provided us with extra expertise at events and helped us educate non-technical participants.

Another set of volunteers, primarily students and youth involved in the communities in which the pilot projects took place, worked through our partner organizations to provide an early grassroots-level view of their communities. These volunteers helped to map community assets, identify potential participants, and find possible network infrastructure locations.

Democratizing the Internet

The project had an explicit goal to democratize the Internet. We believe that when expert volunteers, project members and community members get together to learn about community wireless networks and to help build the network infrastructure, more is happening than just teaching people how to prepare network cable. The technology that we used encouraged forming connections between technology haves and have-nots, and helped the latter to become the former. It put people in connection with each other and put all of the pieces of the network literally and visibly into the hands of the community using it.

Flexibility of Deployment

The CUWiN software is intended to be used in the deployment of a mesh network. A mesh network is one with many nodes spread throughout an area, each of which can communicate with any other mesh nodes, WiFi cards, or routers within range. It's called a mesh network because the overlapping and multiple paths are not unlike covering the area with a net. Mesh networks are decentralized in that if any node drops out of the network for any reason, other nodes will compensate and reroute traffic through the remaining nodes. Like the Internet, mesh networks have a resilient architecture designed to withstand disruptions to parts of it. An alternative to the mesh is the hub-and-spoke design, with a single point providing access to all other points, or a hybrid design that incorporates both models.

In reality, the deployment we created behaved much like a hub-and-spoke or hybrid network, because the density of nodes was never high enough to take significant advantage of all the properties of a mesh. Even so, the CUWiN mesh software:

- Made the deployment very flexible
- Allowed the network to grow organically in any one of many directions
- Allowed the network to adopt to a number of changing conditions
- Concretely demonstrated to non-technical community residents that adding users and nodes to the network serves the community better by making the network more resilient and dependable

Prerequisites for Community Wireless

A case can be made for community wireless as a flexible, empowering, and democratizing way of increasing broadband penetration in undeserved communities. But while we have learned about what community wireless can accomplish, we have also learned what it cannot accomplish. This section considers some of the capacities that we believe need to be already identified and in place in an environment in order for a community wireless network project to be successful.

Training and Computers

One of the dangers of technology initiatives, whether on a corporate, not-for-profit, or governmental level, is their tendency to resemble a “problem chasing a solution.” For example, community broadband initiatives cannot succeed without readily available IT/technology training at all levels—from absolutely basic computer literacy to training in online entrepreneurship. Without the availability of training and support, the systems are under-utilized at best; at worst, they are abandoned.

Even more basic than training, many residents in the pilot areas did not have computers in their homes. We were able to secure donated computers from a variety of sources (including the National Cristina Foundation, Share the Technology and multiple private donors). Volunteers, from community members to teens from the Korean American Community Services, refurbished the over 175 computers that were donated to the project over three years. In most cases, the free and open source Ubuntu operating system was installed on the erased hard drives of these donated computers.

Existing Community Ties

Using unfamiliar technology to bring broadband Internet to people who are unfamiliar with (and possibility suspicious of) technology in general demands a strong pre-existing relationship with the target community. We found that relationships, whether person-to-person or organization-to-person, were the only effective way of reaching residents and potential users who were generally skeptical of new technologies and groups "out to serve them." CNT had a good general reputation as an organization committed to neighborhoods and innovation, but did not have a large number of strong relationships with the three target communities. We formed a strategic partnership with one lead institution in each community that had deep roots and broad respect.

Together with them, the project built a range of relationships with organizations, stakeholders and politicians in each community who shared CNT's vision of community wireless networks and championed the network in their community. These community partners recruited their constituents to connect to the network, hosted training sessions and other events, and assisted in the outreach for the project.

CNT recommends strongly that a new community wireless network be anchored in an existing community institution that has legitimacy, roots, and business systems already in place. The project can then focus on the many and varied tasks of planning and launching the network, rather than the quite different tasks associated with building a new institution.

Building Alliances

Coordinating business, political, community and not-for-profit interests into a community wireless network is a complex task. There are existing different and sometimes conflicting interests in all communities, as well as a history of good and bad relationships. The imperatives of the technical network are certain to get entangled with the relational networks of interests within the target community.

The builders of a community wireless network need to acknowledge this reality and, to the greatest extent possible, approach it as an opportunity to build bridges, heal wounds, and connect residents together in a new way with the minimum of historical baggage. It needs to be acknowledged, however, that a community wireless initiative is not an automatic source of good will within a community, and that the alliances formed will not necessarily be the ones that were anticipated.

If residents or organizations within the community do not see the network addressing their needs, especially if residents and organizations overestimate the amount of money or power associated with the control of the network, the network project can devolve into an unwanted power struggle within the community.

Disaster Relief

Two of CNT's community wireless technicians traveled to southern Mississippi and Northern Louisiana to assist with disaster relief following Hurricane Katrina. The technicians helped to facilitate equipment donations, deployed wireless networks, computers, set up VoIP (computer phone) communications so displaced individuals could

register as survivors, reach family and friends, make plans for relocation, and complete FEMA paperwork. These efforts were noted in New York Times, Washington Post, and numerous blogs and websites including Donors Forum and Northeastern Illinois Planning Council. As you plan your community wireless network, think about how it might be mobilized in a similar disaster, either at home or elsewhere around the country.

National Context and Connections

There is a nationwide movement for community wireless networks. You need to be part of it, both to learn from other groups and to share your own best practices.

Part of the benefit of this national engagement will be to help you think about and influence both local and national issues of policy. The two main bodies that impact the legislative and policy context of wireless networks are the United States Congress and the Federal Communications Commission (FCC). To a lesser extent, state legislatures can set policy that affects telecommunications, but it is often preempted by federal rules.

Congress writes legislation that sets the parameters for telecommunications in this country, and as such can allow or forbid things like municipal broadband. The two main bodies that craft telecommunications policy are:

- The Subcommittee on Telecommunications and the Internet of the House Energy and Commerce Committee
- The Communications Subcommittee of the Senate Committee on Commerce, Science, and Transportation

Congress has delegated to the Federal Communications Commission the exclusive authority for setting the rules governing our communication in this country. From the use of the airwaves—the electromagnetic radio spectrum—to wire-based communication, the FCC determines who is authorized to use what resources and what the limits are on that use. Congress can pass legislation to overrule FCC decisions, and Congress can create new authority in the FCC through legislation, but because of absent congressional involvement, the FCC is the final arbiter for most decisions that directly impact the ability of communities to communicate.

It is important to get to know your own Representatives and Senators as well as the members of these committees who may not be from your own district and state. If you happen to live in the district or state of one of the members, consider yourself lucky, and don't miss the opportunity to meet with them and lobby them on your project.

Building Community Wireless Networks:
A How To Do It Manual

Before You Begin

Note to reader: Yes, lots of people skip *Prefaces, Before you Begin,* and *About this Manual*, but don't skip this one. It is important in determining whether you should be reading this manual or some other sources as you consider a wireless network project.

How it Began

From 2003 to 2006, the Center for Neighborhood Technology (CNT) operated a pilot project called Wireless Community Networks (WCN). The WCN project was designed to demonstrate the effectiveness of establishing high-speed, wireless, community-based data networking systems as a means of closing the "digital divide." The project developed pilot networks in three different communities: North Lawndale, an urban community with a mix of two-flat residential homes and industrial complexes; Pilsen, a very densely populated urban community with many small businesses; West Frankfort, a small coal-mining town in southern Illinois

Audience

This manual is for anyone interested in community wireless networks—interested in building them, understanding their composition, or sharpening their focus on an existing project or proposal. Specifically, if you work at a community organization or a municipality, or you are a community activist or community media producer, this manual is for you.

When to Read this Manual

A community wireless network is not something one organization or person can take on alone. It is a project that needs support from all members of the community served by the wireless network. That is why careful planning before implementing a community wireless network will help ensure the success of your project. CNT has developed three different resources to help you define your network project.

- *The Wireless Community Network Project: Applying Cutting Edge Technology to Improve Internet Access* provides an overview of CNT's Community Wireless Network Project.
- *What We Learned* offers information and asks strategic questions relevant to making a decision about whether a community wireless network is a good fit for your organization.
- *Building Community Wireless Networks* (this document) provides greater detail about the actual execution of a community wireless project. The time to focus on this manual is when you have determined that a community wireless network is probably a project that you want to pursue.

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Part 1: Getting Started

Intended Audience

While this manual is intended for anyone interested in community wireless networks, it focuses on the "community" in community wireless networks—from planning and operations to outreach and politics. It has technical content (although the technical detail is largely relegated to appendices), but it also points you to other resources for the technical mechanics of wireless networks.

However, this manual does assume you are familiar with the following basic concepts about wireless technology and equipment:

- TCP/IP
- 802.11
- Routing/WANs
- Security
- Radio physics/antennas
- Ethernet/LANs

If these concepts are unfamiliar to you, you should get more technically adept advisors and read *Wireless Networking in the Developing World.* This book is available as a free pdf download at www.wndw.net. It gives practical advice relevant to anyone looking to build high-speed telecommunications infrastructure in a cost-constrained environment. *This* manual assumes that you already have a general mastery of this technical background.

Community Involvement

It may seem trite or obvious to assert that community involvement is essential in a community wireless network, but it's too important a concept to be lost in the excitement of building a network.

Introducing unfamiliar technology to bring broadband Internet to people who are unfamiliar with (and possibly generally suspicious of) technology requires a strong pre-existing relationship with the target community. We have found that personal relationships, whether person-to-person or organization-to-person, are the only meaningful way of reaching people within your target community.

Community partners can have the meaningful, face-to-face connections that are necessary to gain acceptance for your project in the community. Partnerships with many different organizations, stakeholders and politicians in your community—those who want to champion community networks and share your vision for a community network—are critical to the success of a project.

Role of Planning

Building a community wireless network starts with asking questions. Because the technology is well understood and has a mature market, the technology does not necessarily determine your network. Rather, building a network is mainly a matter of deciding on a vision for it, and then determining how you will go about implementing that vision. This means your project requires extensive planning as to the vision, target audience, capacity of your organization as well as partner organizations, funding and more.

Vision

What We Learned, A Guide to Thinking about Community Wireless Networks addressed some of the issues you need to consider when determining the vision of your project. You should ask if your goals are to:

- Address the digital divide?
- Provide universal access as public policy (a more municipal goal)?
- Address the need for technical education?
- Aid in your community's economic development?

Your goals for the wireless project should reflect the vision of your organization. For example, if economic development is an important goal, you might offer more in-house network services or support for more applications. Each of these goals requires specific services, attention, review and oversight and should be considered within the context of the vision for your organization.

Identifying Your Target Audience and Its Needs

Identifying your target audience and its needs is another good way to begin to understand how your network will ultimately look. This includes determining the answers to questions like:

- What is the target population and its specific demographics? (Is it a particular population like the elderly, minorities, low-income families, youth, etc.?)
- How would the target population utilize your network?
- Does the target population have the technical skills necessary to fully utilize the network?

However, identifying your target audience should not be an exercise decided in isolation. You need data about your audience to prove or disprove whether addressing the needs of the selected audience is reflected in your goals. This means market research. Specific market research questions are covered in the next section.

Market Research for Your Audience

Once you have an idea of the audience you think you will serve, market research enables you to determine its true needs and capabilities. Depending on your budget, you can survey a sample of your target service area, or hire a market research firm. Census data may also be useful, as well as Internet research on the availability of broadband offerings.

Questions to ask about the target audience include:

- Who owns PCs?
- How many of these PCs can access the Internet?
- Who in the area can afford current broadband offerings?
- Besides Internet access, what are the anticipated uses of the network by this target audience?
- What applications do you see the network supporting?
- What applications do you see it NOT supporting? (Web hosting? VoIP? File Sharing?)

Logistics and Deployment Research

Once you have determined your audience needs, you discover the logistical factors of the service area. Questions to ask about the Internet and computer infrastructure that will help you determine the kind of network that fits your selected service area include:

- Where is broadband available in the service area?
- How will the population to be served by the network and connect to it?
- What type of network topology does the neighborhood call for (mesh, hub and spoke or a hybrid of both)?
- What are the potential obstructions to the wireless signal in the neighborhood? Is there a way to build/expand the network around these obstructions?
- What types of houses are dominant in the neighborhood and what kind of roof access do theses houses have?
- How will you secure computers for the target area and who will refurbish them if needed?
- What software will you install on the computers?

One important detail that should not be forgotten as you look at deployment is what the process will be for obtaining permission from property owners to install equipment on their roofs.

Evaluating Capacity

With a picture of the audience, network and logistics, it's time to think about your organization's capacity for a community wireless network. Can you support building and maintaining the network or do you need outside partners? The partners can have varying degrees of involvement, but first you need to look at your own organization to know what your organization can or cannot offer.

In your organization:

- Is there long-range buy-in from the executives in your organization? Is this project part of your strategic planning and fundraising?
- Can you pull existing network administrators into this project or will this overburden them or keep them from other funded tasks?
- Do you have the equipment needed for administrative support of the network (i.e., phones for support calls, copiers, capability to do mailings, fax machine, desk space, etc.)?

There are other questions to ask but these needs can be shared with partner organizations and are included in the following section.

Identifying Partners

Partners can help make the project possible. As has been mentioned before, the most important asset partner organizations can bring to the project is the person-to-person connections that will make your project a success.

There are two sets of questions to ask as you are planning partnerships. One set is used to determine if the organization is a good candidate for the project. The other set is used to help define the role of each partner organization and what the responsibilities of each of the organizations will be in the community wireless network project.

To identify the best partners ask:

- Does the community wireless network project fit into the organizations mission?
- Can the organization see itself in the picture of this project?
- Does the organization have the capacity to address this project without overburdening its resources?
- Does the organization have the internal staff to champion the project?
- Are there existing programs in the partner organization (or your organization) that can coordinate or integrate with the community wireless network?
- Does the organization have good ties or relationships with people in the community as well as other organizations?
- Can the organization mobilize other organizations and people for this community wireless network project?

Once you have found potential partners who are interested in the project, one way to solidify that interest is to determine what concrete responsibilities the partner organization can take on and which ones your organization can manage. Some questions to ask include:

- Who has lab space where the infrastructure of the network can be tested?
- Who will host the physical elements of the network and where on the selected premises will they be located?
- Where will you warehouse equipment and tools?
- Where will donated computers be stored?
- Who will pick-up and deliver the computers?
- Will the partner organization aid with or take over the refurbishing of computers?
- Where will you hold node building parties, celebrations, press conferences and training?
- Who will train the population on using the computers?
- Who will provide additional network services, if any?
- Who will provide technical support and from where?
- Who will do the installations?

Supporting Organizations

There are many important organizations that are active in the field of community wireless networking, media freedom and spectrum policy. These organizations can aid you as you develop your network or become involved in the broader social and political contexts in which your network exists. These organizations (community and municipal wireless and wired networks as well as organizations addressing media reform and spectrum policy) are listed in an appendix at the end of the manual.

Funding and Sustainability

All the previous questions raise the ultimate one—how do we finance this project? In addition, to ensure the life of the project, reasonable ongoing funding has to be found. You should find answers to the following questions about funding:

- How will you pay for the network?
- How will you raise capital funds?
- How will you raise operating funds?
- Where and how will you connect to the Internet (and how much will it cost)?
- Can you use existing resources (your own and your partners) like Internet connection, computer lab, or volunteers?
- How long will you operate this network?
- What happens at the end of the funding cycle?
- What is your plan to sustain the project?
- Are you hiring staff to support and maintain the network, or are you relying on volunteers and/or part-time help?

Funding can come from government sources, private foundations or donations. Models to examine include cooperatives, not-for-profit businesses, government services and utilities, or public and private partnerships. In addition, community wireless networks can have revenue sources such as:

- Monthly access fees to apply to recurring expenses
- Sale of refurbished computers
- Fees for classes and training to pay for teachers
- Sale of advertising (online, with mailings and on infrastructure)
- Leases to third-party service providers

Planning a Budget

Like doing rehab in an older home, you sometimes don't know what a project will look like or cost until you get into it. Because you will be dealing with a sometimes-unpredictable technology, it is recommended that you be generous with your budget projections. Try to plan for the unexpected. For example, certain pieces of equipment you use for your network could become obsolete and the new version of the same piece costs twice as much. Also, if you do your own installations, remember that insurance can be a considerable figure in your budget.

Our major costs for the Wireless Community Networks project included:

Hardware:	
Central Server (1 for every 250 users connected to the network)	$5000
Repeaters (one per building and/or per five nearby users)	$400/repeater
Ethernet cable (per repeater installation)	$15
Access Point	$250
Wireless cards (per remote connection)	$60
Installations/repairs:	
Contractors (per 2 hours)	$225
Internet Connection	$200*

*per month for a business DSL line from Speakeasy

A wireless network of 200 residents will cost between $125,000 to $150,000 to purchase and install and cost about $15,000 per year to operate—connection $1000+ per year; technician $10,000 per year part-time; equipment/network repair $2000+.

Evaluating the Project

All projects benefit from evaluations and they are especially useful when they are in place from the beginning of the project. Evaluations help to determine when and what kind of changes are needed. To evaluate your project, ask the following questions:

- What measures will you use evaluate the success of the project?
- How will you know when you have attained the goals set out by your vision for this project?
- How often and in what form will you publicly communicate the progress of your project?

Initial Deployment

To begin your project you need to find locations for nodes and participants for a pilot project. This requires outreach and acquisition of some equipment. Partner Organizations (POs) perform outreach to their people. Most of the organizing work for the CNT projects were done by POs. CNT set up the different events (Node Builds, computer refurbishing, “barn raising”) and passed information on to POs who disseminated information to their people. We also used newsletters, flyers and e-mail to organize participants.

Community Outreach

It is crucial to get information about your project out into the community. The method you select to advertise your project should reflect the habits of people in your target area and the nature of your project.

For example, community wireless networks are very social and depend on face-to-face contact. Sending out mailings to everyone in a two-mile radius may not be a bad idea, but the mailing could easily get lost in the junk mail everyone sends straight to recycling. At the same time, faceless mailings do not reflect the social nature of a CWN project.

Because a number of individual promotional materials are discussed in the appendix on documents, this section examines different methods of doing outreach. Whatever method you select, make sure that you have the staff needed to perform the outreach and that outreach is on the schedule. Outreach can easily be forgotten in the clamor of more urgent tasks.

Word of Mouth
Our experience shows that the primary means of expanding the network is going to be word of mouth. Identifying, assisting and empowering motivated members of the network can help enormously in building and expanding the network. Empowered, motivated members build on and encourage the feeling that the network is community-owned. The more effort your organization puts toward encouraging and empowering participants in recruiting others, the better.

We considered a rewards program for recommendations, but without any real rewards we cannot say whether a rewards program would be successful. However, the announcement of the program itself (without any incentive) encouraged several participants to involve their neighbors, friends and family in the project. Especially where access points are being installed in people's houses, outreach to the neighbors by the host participants is better than any other marketing incentive.

Fliers
Fliers are a highly useful way of getting out information, especially at partner organizations or in places where volunteers and staff of the project are working. If people knowledgeable about the project cannot be present, a well-done flier can be the most effective way of distributing information about the project.

Placement of fliers is an important consideration too. Fliers should always be stocked at partner organizations. At the same time, a plan for systematically placing and stocking fliers at nearby gyms, community centers, churches, and office buildings can be a very useful strategy.

Partner Organization Events or Mailings
Make sure, at a minimum, that every newsletter or update that your partner organization sends out and every resource fair that your partner organization attends mentions your project prominently. To make sure this happens:

- Get yourself on the e-mail list of people who provide stories for the newsletter.
- Make sure people from partner organizations who are going to resource fairs can easily obtain your fliers.
- Make sure any high-resolution logos or graphics are easily available to the marketing people at all partner organizations.

Community Festivals
CNT found community festivals a moderately successful way to attract new members to the project. The WCN project in Lawndale, for instance, had a presence at the Taste of North Lawndale, a block festival and resource fair held in the middle of the area to be serviced by the project.

At this fair, as part of the survey phase of the project to gather information on the community's knowledge of technology and to recruit participants for the pilot phase of the project, a laptop was raffled off. This generated a large number of responses, but at the cost of lower information quality. The next year at the festival, the primary community partner in Lawndale interested over a dozen useful contacts with a simple sign-up sheet. In addition, they distributed a great deal of information.

Festivals are only especially useful if they are actually within the project area. CNT did not find the resource fair for the entire congressional district useful in generating awareness of and interest in the wireless project.

Community Meetings
Community politics can be very volatile. However, many local politicians have friendly meetings that allow citizens to express concerns and hear about important events in the community. Depending on the size of the political district, you can present information to people who are very active in the community, but make sure you select meetings in areas that significantly overlap the area serviced by the wireless project.

Schools and religious organizations often have similar meetings or fairs for people from the community. Make sure to pick locations carefully so as not to advertise a product to people who aren't in the service area. A significant (though productive) effort could go into identifying these organizations and how they can provide a captive audience who may be interested in the community wireless network.

Newsletters
The most cost- and energy-effective method for using newsletters is to ensure you can place articles in existing newsletters (those of partner organizations or other interested groups). If you decide to create a newsletter of your own, consider the needs of staff capacity, a place to assemble the mailing and costs for printing and postage. Because many of your potential participants may not currently have access to the Internet, an electronic newsletter would not be effective.

Door-to-Door Canvassing
Because face-to-face contact is so important for wireless network projects, you can consider door-to-door canvassing. However, this is a very personnel-intensive method for contacting people in the target area. You should also consider if this method is an accepted form of contact in the neighborhood.

Community Newspapers
We were mildly successful in attracting residents by using the community newspapers. A few articles were run on the project and we were also able to get a couple of training schedules posted for free. We found, when using the newspaper for outreach, that the same people read the community newspapers week to week and only occasional outreach through community newspapers is more efficient.

Radio

It is possible to get free airtime on a local radio station. We did not use this option because many of the radio stations that the communities listened to covered too broad an area. It can be time consuming communicating with people who do not live in your project's community area. We wanted to target the local audience so community members knew we were focused on building out "their" network and not trying to move from neighborhood to neighborhood throwing up networks.

Television

While TV advertising is generally too expensive for start-up projects, there are public access channels. A surprising number of people heard about the CNT wireless project through the Chicago public access channel, CAN-TV. In addition, local interest, around-the-town shows may find a short piece on your project attractive.

Purchasing and Inventory

Many residents in the CNT pilot areas did not have computers in their homes. We were able to secure donated computers from a variety of sources, such as non-profits (the National Cristina Foundation and Share the Technology) and corporations. Volunteers, from community members to teens from the Korean American Community Services, refurbished the over 175 computers that were donated to the project over three years.

You will need to plan for space to store and refurbish computers in addition to finding personnel to do the work. Alternatively, you will need to develop funding sources for some computers in addition to funding for network equipment. If you develop a method for effectively tracking inventory in the pilot project, tracking inventory will not be an overwhelming task as the project grows.

Pilot Deployment

A community wireless network has a huge potential for growth. However, you start by recruiting willing participants to be part of an initial test deployment. This ensures that the network operates normally and allows you to solve problems before going to a full deployment.

These participants should fit the demographic profile of the target population you're serving with the network so that the problems you solve are more likely to be like the problems you encounter in a full deployment. Once you complete the test deployment, you'll want these participants to be at your kickoff event and available for interviews by local media. Don't forget to acknowledge these pilot personnel at events.

Part 2: Running a Community Wireless Network

Installing Nodes

There are many, many different technical options that go into the process of installing nodes along with other logistics and personnel details. Because this manual focuses on the community aspect of community wireless networks, this section concentrates on what is the most difficult aspect of the node installation process—coordinating the different people, places and interests needed to get a node on a roof. (More information about installation problems can be found in the appendix on installations.)

To understand the multitude of installation needs, it is crucially important to understand the physical process of identifying sites and actually placing nodes. You can have your own staff or volunteers do the installations or you can hire professionals. If you are considering doing your own installations you should be aware that insurance covering your staff while performing installations is costly and it is wise to develop installation safety procedures for staff performing installations. Because of the large number of commercial enterprises that do roof installations of one sort of another (satellite cable installers, other wireless providers, even some tree trimmers as we discovered) installation best practices and installation services are not overly difficult to obtain.

Identifying Locations

There are two parts to finding locations for nodes. You need to identify a location that has both good signal strength and is in a good location within the network. You also need to get permission from property owners to install a node.

We began by using our database with addresses of interested residents to identify locations where one node can connect the largest number of people and easily expand the network. We also targeted specific city blocks and buildings with a large number of interested residents and a clear line of sight to our main antenna.

We then needed to determine signal strength at the proposed location to determine if the location is a good spot for a node. Our technicians performed site surveys at locations we identified to determine whether the site was optimal for the deployment and expansion of the network. Sometimes signal strength at a location can be determined from the ground, but there are some cases when a technician will need to access the roof of the building to determine the signal strength at a location. A site survey that needs to occur on a roof requires the technician to make an appointment with the property owner to go up on the roof to determine eligibility. Pictures should always be taken during site surveys. The ability to take and track digital pictures and maintain them in the contact database is quite helpful.

You also must have the property owner's consent before an installation is performed. A phone call or letter will usually get a response from the property owner. However, it is crucial that the permission process be as simple as possible. Either the form should be simple for tenants to get to landlords or staff should be dedicated to tracking down landlords. The bottleneck generated in getting this permission became a problem for CNT.

Performing the Installation

Installations can be performed by a contractor or by staff or technical volunteers. If the location is a good spot for a node, follow these steps for an installation:

1. Staff calls potential participant at the location to set up day and time for contractors or staff to perform installation.
2. Perform installation. A representative from your project should be present at all installations. (Contractors will usually dedicate a day for doing network installations.) If you plan on using in-house technicians to perform the installations, you will need a vehicle that can carry up to four or five nodes, all necessary tools and two ladders.
3. Participant signs paperwork/contract.
4. Technicians connect computer to network.
5. If project staff or volunteers are present, then some on-site training may occur.
6. Participant receives a new participant packet that includes information about on- or off-site training availability.

Maintenance and Support

Maintaining your network is always going to be difficult in any situation where the technical staff overlaps with the work staff. CNT found, as did several experts in wireless networking, that you should plan to dedicate half of your time and resources to maintenance. This estimate becomes more difficult when computer distribution is included as part of the project. Desktop computer maintenance can be a monumental drain on almost any project.

The primary way of looking at this problem is by asking a number of questions *before you start*. First would be determining the different places where things can go wrong, both for desktop computers and the network. Network problems clearly must be addressed by your project. However, desktop hardware, software and user error problems can swamp a project. To address these issues appropriately, consider how your organization will respond to user problems and how many of those problems you can solve.

Problems with the Network

Having a wireless network up and residents using it is a beautiful thing, but beware, when dealing with new technology; everything does not materialize as expected. For a majority of its life, our network did not experience any problems. Many of the problems CNT experienced, like a CAT-5 connection going bad when water got into it, were minor and could be handled by our technicians. Having a process to address these problems in a

short period of time and the expertise accessible to handle network problems is critical for network, and project, health.

In CNT's experience, the following were some of the types of problems encountered for the network:

- Cabling - cables that we joined were especially problematic
- Software crash - because we were using new and untested software, we did run into some bugs along the way. In all cases we were able to find a fix for the bug and update it to the network software.
- Hardware failure – you should account for hardware failure by trying to establish the expected lifetime of the hardware three years across the project
- Climate damage - know the heat/cold tolerances of all the parts of the network with a preparedness plan in the event those tolerances are exceeded
- Human error – many participants damaged equipment because they were not familiar with the equipment. Some equipment was also vandalized.

Problems with Computers

A myriad of things can go wrong with software (viruses, spyware, configuration mishaps, printer problems, any one of a thousand reasons) or the hardware on a computer (the hard drive crashes or the computer is simply outdated).

Ways we ensured that computer issues did not demand too many of our technician's resources were to make sure that all computers that were donated to the project were refurbished and received a new Ubuntu Linux operating system. All of this work was done by volunteers, freeing our project technicians to concentrate on the network. We also issued an *Ubuntu Users Guide* to participants who received a refurbished computer. The guide was a resource for participants to learn the operating system as well as to learn to troubleshoot problems themselves.

If absolutely necessary, a volunteer or technician would go over to a participant's house to try and fix a problem. We did tell participants that we did not have the resources to make house calls for every computer problem and because the computers that they were receiving were donated, they might act funny sometimes. In West Frankfort, high school technology students volunteered to handle participant's technical problems.

Who to Call

You should keep in mind that your decisions on how to handle support have consequences and there are no solutions that will solve all your problems. For example, if you choose to send users to the local franchise computer store's geek squad, then low-income or low-mobility participants may stop using their connections when their equipment has problems. On the other hand, if you use your technicians to answer these support calls they will use valuable time debugging basic problems. However, they will do so inconsistently because support is outside the actual scope of their work. If you say that software problems will be fixed by sending high-school volunteers out to install a clean free operating system like Ubuntu on computers, then perhaps you will reach more, but still not all, of your target area. Desktop problems can multiply exponentially and it is

not possible to fix all these problems. If participants, volunteers and staff all know what problems are fixable and by whom, everyone's experience will be more predictable and consistent.

Identifying how far down the repair road you can go without swamping your project can be addressed by creating two online living documents. One should be available to participants and the other to project staff or volunteers. These documents should include:

- Types of problems that will be addressed
- Who should be called
- Who might be used to fix the problem (technicians, volunteers, etc.)
- Expected response time (be realistic!)
- Expected cost range to the participant (and, potentially, to the project, i.e., How much of our resources can we spend on this kind of problem?)

Giving participants access to this sort of document from the start may help you manage expectations.

Response System

Organizing technical response is an important issue, and again, it is one where the best strategy is to know how you want to deal with problems before they happen.

- Will there be a 24-hour response line?
- If so, how often will it be checked?
- Will there be an on-call system that directs callers to a cell phone in case of an emergency?

The CNT project had a 1-866 number tied to an answering machine. Because the number was used infrequently, messages were not checked more than once a day. However, if there is an outage that affects the entire network, no matter what safeguards or automated warning systems are in place, a phone call from a participant may be the first way of finding out that crucial information. Even if users only call a help number once every few weeks, it may be a call that you'd want to be informed of in hours if not minutes. If a system existed to e-mail all group members when a message was left, it might be adequate unless the technicians themselves are primarily relying on the network for their Internet access.

Personnel

Every wireless network will work better when personnel, volunteer or paid, work in clearly identified positions with recognized job descriptions.

Systems Administrator

While volunteers can do many of the network tasks, at a minimum you should have a systems administrator to oversee the project. The information this person knows should be tracked or passed on to more than one person so the system is not functionally without a head should the administrator leave or be unavailable for a time.

The Systems Administrator should be able to:

- Troubleshoot nodes
- Ensure network services are provided
- Ensure the system is secure
- Monitor the network
- Establish the provision bandwidth
- Integrate and ensure appropriate communication occurs between services

Program Manager/Coordinator

A person will be needed to build and maintain relationships with organizations, contractors and politicians as well as take care of any the administrative work. The Program Manager/Coordinator should be able to:

- Manage project staff and volunteers
- Communicate effectively with partner organizations and potential partners
- Write grant/proposals and reports
- Know the political landscape surrounding telecommunications and spectrum policy
- Have experience with administrative duties (budget, purchasing, etc.)

Outreach Coordinator

Outreach is one of the vital parts of your project and a person with very good knowledge of the community your project will be serving is necessary. We suggest hiring someone who is a resident of the community. This will decrease the amount of time your project and community need to "get to know each other" and will increase the amount of potential participants. The Outreach Coordinator should be able to:

- Identify community stakeholders and potential community partners
- Attract and mobilize resident volunteers
- Assist community partners and volunteers with recruitment

Recruiting Volunteers

Volunteers are an essential component of a successful CWN, but recruiting and managing volunteers, keeping them happy and engaged, and providing opportunities for their engagement can be challenging and time-consuming tasks. CWNs are wise to remember that "free" labor is never free. While it is valuable and costs nothing up front, time is required of you to convert the randomized energy of volunteers into productive work for your project.

The universe of people who can and do volunteer to help out on a community network is quite large. The largest numbers of volunteers for the CNT wireless project were "geeks" (computer and network experts) and students or youth organizations.

Computer Experts

The computer geek (or computer expert) communities are an obvious target for volunteers. User groups (of operating systems, of software packages, of programming languages, of gadgets and hardware) that are already organized can be readily tapped.

Send a representative to one of their meetings, give a presentation on your network, and ask for volunteers directly. Maintain a contact within the organization with whom you coordinate for future specific events. There may be opportunities for co-branded events where both of your organizations can pool your resources. Along those lines, consider a larger festival or fair and invite many different organizations for a day or weekend of events and workshops that tie into different aspects of the community network.

Geeks love to cross-pollinate (to interact with users and experts of different technologies) and a festival of this sort could attract a wide following. Geeks also spend a lot of time online, so be sure to tap into local mailing lists and blogs.

Geeks are good volunteers not simply because of the natural affinity with the technology, but also because they tend to be self-starters, independent and problem-solvers. Give them a little bit of direction and some parameters, and they often work with little supervision. This can cause some headaches if they go down a path that's not exactly what you had in mind, but for the most part geeks yield far more benefits than costs.

Students and Youth Programs
Many high schools and community organizations sponsor programs that connect young people with technology. These are natural sources of volunteers. You may find individual volunteers among some of the students, but they often come as a unit.

On the plus side, young people tend to absorb new technology very quickly As long as you provide good instruction and set rules and boundaries, they'll provide valuable assistance for your project as they learn from it. Also, working with youth programs is good not just for volunteer events and tasks—they can also create high-level connections with your organization and possible funders, media and other community organizations.

Managing Volunteers

Remember, frequently volunteers will go beyond your expectations. Often this is one of the positives of working with volunteers. However in some cases this can pose serious technical and interpersonal problems. Volunteers work better if you:

- Clearly define the boundaries, both of what you are asking them to do and what other people will be doing
- Provide adequate orientation and training
- Maintain regular contact with the volunteers to ensure they are on track
- Track their participation (this can be especially useful for some grants)
- Regularly acknowledge their contribution

It's important to think about what you're asking of your volunteers. Your need for them falls into two basic categories: events and ongoing operations. Your events are one-time occurrences like node build parties and computer refurbishing—time when you need manpower. You'll engage your volunteers primarily through e-mail in this case. Send a notification a few weeks before the event inviting them to it. Post the event on your blog or website as well. Send a reminder e-mail a day before the event.

Volunteers who work on ongoing operations should be treated like employees in the training and supervision they receive. However, you should always keep in mind that these "employees" are not receiving monetary compensation and show your appreciation regularly. It is always difficult to find and keep volunteers that function like employees—showing up reliably and doing the work well and efficiently. These are volunteers you should treasure.

No matter how you find your volunteers, track them in a database. Have them sign in when they come for node builds or other activities. Use the volunteer database to send e-mails when new events or other project opportunities come up. And remember to reward and acknowledge your volunteers. Making sure that they feel like they are a important part of the project will increase volunteer retention and productivity.

Outreach

Outreach is extremely important for a community wireless project. Your clientele, staff, funding, equipment—all will be affected by how you reach out to the community. The more these connections are made on a face-to-face basis, the greater the success. Build parties, classes and reaching out to other organizations were the three major ways the CNT wireless project made connections in the community.

Build Parties

In the WCN project, CNT periodically held events open to community members, participants, volunteers and any other interested person. Meeting at the CNT offices or a community center, participants in these parties collectively built the equipment that constituted the network. We called these node-building parties because the key pieces of the network were called nodes. These parties included work, fun, food and music. Node building parties were a great way to share knowledge, cross-pollinating between the different groups of people that made up the network—from operators to participants to volunteers to friends, media, and funders. These events:

- Spread good will about the network
- Provided opportunities to publicize the project
- Familiarized people with the nuts and bolts of the project both literally and figuratively
- Create a sense of ownership that is crucial to a thriving network

Node Party Activities

Node building parties are ideal knowledge sharing exercises. Typically, two or more network administrators ran the party, explaining the goals and introducing the steps. Often we were assembling kits that had an enclosure, radio, antenna, power and network cables. This meant mounting hardware and other parts, and assembling the components usually in a specific order that required time and patience. There were also very detailed procedures, such as those for creating Ethernet cabling, that are common practice in network administration but are usually opaque to most people. In the context of the node building party, people had a first-hand opportunity to engage with the hardware and learn esoteric but valuable skills in the information technology economy.

The events brought together people from the nonprofit community, from the various local communities involved in the project, and from the information technology arena, (especially the nonprofit information technology arena). As such, they provided a forum for these disparate groups to connect and interact with each other. This cross-pollination was one of the great, unintended consequences of the broad appeal (and the occasional, episodic nature) of the build parties.

Democratizing Technology

Build parties also had a "democratizing" effect on the technology aspects of the project. The build parties allowed participants to have a meaningful interaction with the project on a technical level. No one became a network expert after attending a few build parties, but it was a substantial revelation for people who were not experts (often also participants in the project) to realize that in a room were people with all the knowledge required to build and deploy these network devices. And no single part of that knowledge was unattainable for them. The idea that a wireless community network can change the perception of advanced technology from something that appears remote and unattainable to something tangible, interesting and easily manipulated was a wonderful discovery for some participants in the project and a wonderful benefit of the project.

Classes and Training

In public meetings of the Chicago Wireless Task Force, two themes dominated the discussion, despite the fact that people at the meeting came from very different organizations and supported a variety of agendas. The two essential themes were:

- If you deploy a wireless network to provide access for underserved communities, your efforts will be useless if you don’t provide computer user and network training.
- If you provide this kind of large-scale capital deployment in an underserved community and the project does not also provide jobs and job training, you will meet with organized and passionate resistance, especially in a city that is politically active, like Chicago.

The WCN project has experienced both of these themes on our smaller-scale wireless network, and has experimented during the time of the project with a wide variety of ways to address them. In all of our locations we have experimented with approaches to usability training, from basic computer literacy to more advanced ways of utilizing the networks' capabilities. In several of our locations we also addressed the job training aspect of this program with the development of a training series that sought to prepare people to participate as technicians in the wireless project. A third type of training, which was considered but never fully implemented, was a self-operating User's Group model.

Computer Usability Classes

There are two kinds of classes that can be called usability classes. The first category of usability training could also be described computer literacy. It doesn't matter if you're trying to get someone to use a 7-year-old Ubuntu desktop or a MacBook Pro; if the user doesn't know how to use a mouse, or understand what a word processor does, then they aren't going to be able to get a great deal of benefit out of any computer. And if the user

can't get any use out of the computer, then any Internet connection will serve no purpose. Thus, training naïve users in basic computer skills is essential.

Classes were run with a curriculum as basic as how to turn on the computer. However, in Pilsen, our most successful training sessions occurred when immigrant families used the Internet to research their home town or state. Challenges to training for these Spanish-speaking adults included a lack of manuals in Spanish.

In North Lawndale, our primary community partner was a computer lab that already offered these classes. Wireless community network participants in this area did not attend classes because promotion of classes was somewhat lacking and there were already many computer-experienced people in the community who could assist others without having to set aside time for attending a class. These wireless network users did express an ultimately unmet demand for more sophisticated training programs (learning how to buy and sell on EBay or how to run a business from their computer).

The Users' Group Model

The idea for a users' group came in the last eight months of the CNT project. A user's group model offers opportunities for training, support and outreach. The tests implementing a users' group were not well attended. The users' group was not sustained long enough for the user base to take over the running of the group. This approach shows promise and might be more successful if the users' group was initiated in the beginning of the project.

Would it work to have a user's group mailing list where people using the network could discuss problems? This could be an interesting outlet for technical support issues.

Technical Training Classes

More technically advanced participants were more likely to attend build parties rather than classes. Build parties are somewhat spontaneous, work like an individual project instead of a sustained commitment, and act on a more mentor-apprentice model of learning. This kind of learning doesn't require curriculum planning.

However, a training-style curriculum has at least two huge advantages over the build party model. First and most importantly, it is much more conducive to assisting in project sustainability. It gives people a reasonably predictable and consistent level of training. It can also recur on a much more regular and predictable schedule than need-oriented build parties.

Choosing Curriculum

The first major area of curriculum for a helpful volunteer or worker in a wireless project is the nuts-and-bolts knowledge of wires and wireless cards and screws—taking apart nodes, talking about them, and putting them back together.

Beyond the "build party knowledge," whether learned in a build party or in a class covering the parts of a node, a surprising amount of the hardware knowledge associated with working on a WCN can be learned by crimping CAT-5 cables and connecting them

to the nodes. The attention to detail, the importance of being neat, the use of standardization and regularity—all of this can be addressed through the simple preparation of wire.

Field Experience
Many things, like drilling through walls and scouting out sites for their suitability for connection are best done in the field and not in a classroom. This was primarily an informal process of inviting people who had been regularly participating in classes to participate in troubleshooting visits and new installations. This informal process was probably less efficient than it could have been.

Certificates
A Certificate of Completion is suggested to recognize people that finished a series of courses. This is especially useful if a part of a participant's goal in working with the project is to get some certification. However, within the WCN project the complete technical knowledge to run and maintain the project was spread between, at minimum, two or three different people; this made a determination of what, exactly, the certification would be for problematic. In addition, a certificate sets a defined end point for any course of training. Education for WCN is a more ongoing process than a single course of study.

Expanding Capacity

One of the benefits of a ubiquitous local high-speed network is that organizations can extend their reach into the community they serve. They can reach more people with the services they already provide and create opportunities for new services unique to a networked environment.

Community organizations are as varied as any other group and no two will have the same needs or resources. Nor will they each be able to fully articulate their vision for digitizing their current services and bringing them online; some will "get it" and some won't. However, new and network-unique services will require more education and demonstration and this should be considered when expanding the capacity of the network.

It's important to remember that community organizations are typically grant-funded, cash-strapped, already at capacity and struggling to meet the demands of their constituents. The introduction of a new project, no matter how revolutionary or important in the long run, will rightly be seen as an additional burden. Integration with the community network will have to fit in with existing programs or provide a clear path in terms of funding and support.

Part 3: Engaging the Larger Community

Involving Political Representatives

You should approach your elected representatives at all stages of the development of your network. Visit them in their local offices. Educate their staffers on what you are doing and what your goals are. Involve them in your media events and invite them to panel discussions and community meetings. This is important for several reasons.

Your representatives may or may not be able to secure funding for your efforts, but they can help in many ways. They can connect you with organizations that can help in your goals. They can publicize your efforts through their communications departments. They can raise awareness of your network with their colleagues.

More importantly, your representatives are powerful people who can influence your situation in ways that aren't always transparent. It is in your interest to involve them and make them a part of the building process. They should have some sense of ownership over the project, however direct or indirect.

Make friends at all levels of government:

- Local reps - your alderman, mayor, councilman (don't forget county government)
- State reps - your state senator or state representative
- Federal reps - your Congressman or Senator

Ongoing Issues for Community Networks

WCNs use the electromagnetic (E-M) spectrum for transmission. In our changing political universe, it is important for citizens to be aware of the seemingly arcane legislation that may have a radical effect on wireless community network projects.

Spectrum is the electromagnetic frequencies (wavelengths) used for communications; it includes frequencies used for radio, radar, wifi and television. In the United States the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) regulate radio transmissions.

The FCC is an independent regulatory agency that administers spectrum for non-Federal government use. The spectrum of radio frequency waves is considered so valuable it has been dubbed "beachfront property." Most licensed spectrum has been sold. Frequencies above 40GHz have not been licensed but it is assumed that the technology to transmit on these higher frequencies will be developed. However, there is also controversy concerning the licensing of frequencies. Some feel that an artificial scarcity has been created because today's technologies can differentiate mixed waves and licensing certain frequencies unnecessarily divides and limits the available spectrum.[1]

[1] *Should Airways be Licensed?*, http://computing-dictionary.thefreedictionary.com/spectrum and *Licensed Spectrum*, http://www.answers.com/licensed%20spectrum accessed 08/09/06

Policy: Senate and House Bills

Several bills are currently in Congress that will affect how much or little access wireless community network projects have to the radio spectrum. To the usual American public, these are esoteric bills. However, WCN participants can see these bills as having a direct impact on their lives and may wish to be informed, act upon or organize groups around the issues covered by these bills.

The Commercial Spectrum Enhancement Act (Senate Bill 865) seeks to help federal agencies relocate to other wavelengths to make way for private wireless carriers' advanced wireless service offerings to consumers. Some bands used by the military have already been identified for relocation to the private sector.

The Community Broadband Act is a bill that protects the rights of local government to support broadband access in the manner that is best for local needs.

Other bills to watch include the *Communications, Consumer Choice, and Broadband Deployment Act of 2006, t*he *Wireless Innovation Act of 2006* and the *American Broadband for Communities Act*. Contact information for sponsoring legislators is included in the appendix.

Network Neutrality

The Internet was developed on the principle of end-to-end neutrality. Most directly, it means that the "smarts" in the network comes from the edges, the computers that connect to the Internet—the servers, PCs, laptops, PDAs and all the other network-aware devices. It's up to the builders and users of these computers to invent and implement the applications that make the Internet so useful.

The most successful Internet applications—the World Wide Web, Voice-over-IP, and email—are all *software* programs, not *hardware*. In other words, there's nothing in the Internet *per se* that makes these applications work. The Internet ensures that the information sent gets to where it is supposed to go, and nothing more. In a sense, all the Internet does is route traffic across wires or the E-M spectrum, and it does not discriminate nor is it aware of what is contained in that traffic. It *just* moves bits in an extraordinary engineering feat. This was a decision, an architectural decision, made by the creators of the Internet. The neutrality we speak of in end-to-end neutrality refers to the Internet's unbiased and therefore *open* or non-proprietary nature. It is a system dedicated to the function of transferring information between computers.

The consequences of the decision to make the Internet neutral with respect to the applications that would run on top of it are simple but subtle and profound. It means, first of all, that no one need ask permission of the Internet's governing body (if such a thing existed) to create and deploy a new application; you, as a technology innovator or experimenter, can simply start using it immediately, following the underlying protocols of the Internet. An entire enormous worldwide economy has sprung into existence and flourished on this simple fact.

Given a robust and elegant common networking system and language—the Internet—a tremendous amount of innovation and economic activity occurs, and in far less than a generation's time, applications running on the Internet have changed societies and upended cultures.

Today the neutrality of the Internet is in jeopardy Telecommunication and cable companies are pushing for tiered access to the Internet. With tiered access to the Internet, an individual will only be able to access web pages which their Internet provider subscribes to and will have to pay extra to access “premium content”, the same set up that digital and satellite cable companies currently use.

The Internet was designed to be open and available to everyone, as are community wireless networks, which is why the Internet has been such a powerful and revolutionary tool. Organizing your network participants and community around network neutrality can be a way for them to learn what affects community wireless networks while taking action to keep community wireless as a tool against the Digital Divide.

Appendix A: Choosing the Technology

Choosing a Network Model

Depending on the terrain, type of buildings, amount of tree coverage, and other factors like existing radio frequency (RF) in WiFi bands, there are several models of wireless networks to choose from. You can build a **mesh** network, a **hub-and-spoke** network, or a **hybrid** of both.

Mesh

A mesh network is one with many devices spread throughout the area served, each of which can communicate with any other mesh device within range. These devices, or nodes, determine which connections are the strongest (connections between two nodes can be stronger or weaker depending on the distance between them, obstructions, environmental factors like heat and rain, antenna and radio types, number of competing nodes, interference, and quality of construction). Selection of the route for information to travel through the network is based on the quality of these connections. Nodes in the network forward on the traffic of their neighbors based on this routing until the information reaches its destination. It's called a mesh network because the overlapping and multiple paths are not unlike a net with nodes and vertices that cover an area.

Mesh networks are called decentralized because if any node drops out of the network for whatever reason, the other nodes compensate and reroute traffic through the remaining nodes. In this way, mesh networks are not unlike the Internet, with an architecture designed to withstand disruptions to parts of it. In addition, the gateway to the Internet can be shared. Each person on the mesh network does not need to have an individual gateway (and support the cost of that gateway) thus sharing the cost of Internet access.

Hardware

Access points/wireless routers

Embedded devices

- Soekris - www.soekris.com
- WRAP - www.pcengines.ch/wrap.htm

Recycled hardware

- Laptops
- PCs

Equipment for an outdoor environment

- Enclosures
- Mounting
- Cat5

Antennas

- Omni directional
- Sector/panel
- Parabolic

Software

Mesh routing

- OLSR - www.olsr.org
  - Pyramid Linux - www.linuxsecurity.com/content/view/123437
- HSLS - www.hsls.pitt.edu
  - CUWiNware - www.cuwireless.net/book/print/17

Appendix B: Monitoring the Network

Network Health

Basic Requirements

- Dedicated server
- Custom scripts
- SSH - www.wcug.wwu.edu/sloth/userguide/ssh.html
- SNMP - www.snmplink.org, www.net-snmp.org, www.cert.org/advisories/CA-2002-03.html

Alerts

- Nagios www.nagios.org)

Logging & graphs

- RRDtool - (www.wikipedia.org/wiki/RRDtool
- Cacti - www.cacti.net

Wireless

- Routing
- Signal strength
- Noise
- RTS/CTS - www.wi-fiplanet.com and search on RTS/CTS

Network Capacity

Capacity Issues

- Bandwidth aggregation – allows several network cards to combine into a single connection (four 100MBps network cards can provide a total of 400MBpds bandwidth). Requires that network adapters and swith support bandwidth.
- Internet gateways
- Per node bandwidth

Alerts

Process

- "Phone tree"
- Volunteers & staff
- Email/IM/SMS
- Trouble ticket

Appendix C: Databases

The Need for Databases

A community wireless network is bound to generate a large tracking burden that must be addressed. The information requirements, like many aspects of a community wireless network project, are not new problems but remain challenging ones. Resources and infrastructure will be far-flung across different organizations and perhaps hundreds of households. The requirements of the database will perhaps change throughout the course of the project as well.

Databases are something that it is important to think through from the beginning in order to have an organized and successful project. This appendix describes both a workable database, which we had for our project, and a database system, which would be ideal for community wireless networks.

Accessing The Database

It is absolutely crucial that any database be widely available to anyone who has information that needs to be put on the database or anyone that needs information from the database. If a database is not accessible from the launch of the project's active phase, information will be lost and may not be recoverable, at least not without unnecessary effort. Ease of use is also very important when designing your database. People will be hesitant to use the database if they feel that it is difficult to input and abstract data.

Contact Databases

We want to convey the crucial importance of tracking people. The database we had for people was heavily designed towards tracking people connected to the network and those who had a prospect of being connected to the network. We also suggest databases for tracking volunteers, training class members, or potential and actual partners.

Some information that we tracked, and suggest tracking, using a contact database:

- Standard contact information (Name, Address, Apt#, Phone, Fax, Email)
- Location
  Some sort of "geocoding" solution for the database, where addresses are automatically converted to points on a map, is going to be crucial to a project's efficiency unless the project area is extremely small and well defined. The potential to see all the users in a particular geographic area is important for identifying potential new participants, identifying participants likely to be affected by specific problems, and network coverage.
- Status/Eligibility
  We listed three different options, "Ineligible," "Installed," and "Potential." In this category. It was actually helpful to limit the options to a small number, though "Ineligible" did lead to some confusion—are they ineligible because they live six

miles from the project area or because the network signal does not reach to their home, but will if someone on the next block puts a node on their roof.

"Installed On" date, "Connected On" date

This database will help you keep track of who is where on the connection process and how efficient your connection process is.

Pictures

We used these to organize, annotate and store pictures from site surveys; giving installers access to pictures ahead of time can give them a better idea of what equipment might be needed, and putting these pictures in a database is a good way of increasing the chances that the right people will be able to see them.

Connection

Participants could connect to the network through a node on their roof or through a wireless card connecting to a hotspot created by a neighbor's node. Tracking connection types helps with repairs, upgrades and expansion. It is also helpful to include a feature on your database that will let you see who is connecting to the network through which nodes.

The primary problem we had with the contact database was that we had such a proliferation of ways in which we wished to categorize people ("active connection" "not connectable" "probably not connectible yet" "interested in volunteering" "does not have a computer" "political ally") that it might have been useful to take a hint from the now-popular paradigm of "tagging"—allowing short, user-defined text tags to be identified with users in the database. This would have had the benefit of allowing new categories of information to be tracked flexibly, without involving the database administrator. This would have had the drawback of possibly de-standardizing the process, though Web 2.0 experiments such as Flickr demonstrate that tagging can be effective, especially if it is easy to notice, and correct, problems such as 25 users being tagged with "Volunteering" and 12 being tagged with "Volunteer" and needing one or the other to be the standard tag for all 37.

Having this information easily exportable is crucial. Consider scenarios of how you might wish to utilize the data you are collecting in the contact database. For instance, how would you send a mailing to all volunteers? Email to every active, connected participant who was interested in training? Generate a list to call every active or interested participant who had attended a specific event?

If your database can't easily do these things, then they aren't likely to get done, drastically reducing the benefits of collecting the information in the first place.

Node Databases

CNT invested in a universal "asset tag" system—several hundred semi-permanent stickers, each having a unique identifying number. There was some tracking information, but ultimately we used this database to consistently track all of the project assets effectively.

We used the asset tags to track nodes currently deployed and nodes that were ready to be deployed. Our node database was connected to the user database. Each active user in the database had a piece of information indicating the node to which they were connected. Nodes were assigned geographic locations either by geocoding or by hand using Google Earth as a reference. Besides the location and asset tag number, for each node we also tracked:

- Internal IP address range (the IP addresses the node assigned to its clients)
- External IP address (the IP address of the node in the wireless mesh)
- Wireless MAC address (useful for malfunctioning nodes or if the algorithm to determine external IP address failed)
- Software version number
- Users connected to that node

Asset Databases

Items that should be tracked by this system include tools, network appliances such as switches or wireless routers, and donated or refurbished computers. An ideal asset tracking system would allow the full information of a node to be tracked, but could also track other objects (along with serial and product numbers) and track who (be it an individual or a nonprofit partner) had possession of it.

Tasks/ Problems Databases

The last major category of database items are assigning tasks and dealing with problems. Whenever a specific task needed to be accomplished, we could assign a "ticket" to the person who is responsible for completing the task and an e-mail would be sent to that person informing them that a ticket had been assigned to them. This database also allowed us to view what tickets have been resolved and what tickets still needed attention. While the "ticket" system that we used was criticized for sending out too many e-mails (one whenever anyone changed any piece of data), it was the best system we had for dealing with low- to medium-urgency tasks, such as splitting the responsibility for 30 site surveys between four different technicians. It was also useful for self-reminders. Each ticket essentially consisted of:

- Title
- Description
- Urgency ("low" "medium" "high")
- Status ("complete" "incomplete" "duplicate" "irrelevant")
- Responsible party - from a list of people who could log in to the database

- Connected user (optional) - from the list of people in the database. Each user information page also had an “assign ticket” option, which is how the vast majority of tickets were assigned.
- Due date

It is recommended that you use this database for *events*, not just problems and tasks (for instance, for recording the information that Technician B and C need to be at such-and-such house at 2:00 Thursday for an installation, and allowing the rest of the team to see this fact). This would not have to be a highly sophisticated system, but by the same token something along the lines of a Microsoft Exchange server likely could have handled both the calendaring and ticket-management needs of the team.

Appendix D: Installations

Scheduling

Task: Identify buildings in good locations for nodes, site survey, confirming install day and time, pass information on to contractors.

Challenges: Using an outside contractor, the CNT/ITP/Krueger schedule did not match schedules of those who wanted to be connected. Only being able to schedule for one day a week:

- Limits number of participants to be connected per month
- Can hamper progress if something happens on the one designated day
- Resulted in rescheduling some people over five times

Appendix E: Documents

Documents can be a critical factor in how well informed your participants, stakeholders and administration are during the project. The more shared and distributed your materials are, the better able everyone will be to handle different situations to the benefit of the project as a whole.

Consider the possibility of a web repository (such as a web folder or a wiki that allows attachments). Everyone should have ready access to the materials they may need to distribute as part of their (and possibly others') roles. Considering a standardized way to collect these materials early on will make this distribution and the entirety of the project more efficient.

The document lists in this appendix fall into several categories.

- Marketing materials to let people know about, and sign up for, the project
- Informational and training materials
- Forms, fliers and information you need to get to property owners and stakeholders in the community where the network will be deployed
- The too-easily overlooked collection of materials that every member of the wireless community network needs to have
- A library of educational materials for participants

Thoughts on Documents

An extremely important but easily forgotten aspect of the project is the materials that will be used to represent the project to the outside world. Many of these will certainly end up prepared during the day-to-day operation of the network, but the more that are completed in advance, the more efficient your project will be and the more consistent it will be throughout. The point of this appendix is to give you a starting list of what kinds of materials might be needed.

Giving at least some thought to how your materials will be distinguished is important. If marketing materials look like any other letter, they will be ignored. Talk to people with a background in design about:

- How to make your documents easy to modify
- How to make your documents distinct
- How to choose a consistent paper color
- How to design (or find a volunteer or employee with a design background to design) your materials

Marketing

Full Informational Brochure

CNT created a dozen-plus page brochure that showed all the parts and pieces of the wireless network and also included an exhaustive list of frequently asked questions. It was generally a little too large to stock and give to lots of participants, but it was useful on occasion, primarily as part of a folder that included other informational material (map,

contact information, some stickers and other materials). This folder could be given to people who had a deeper interest in the project, such as people visiting from other cities or potential partners and/or donors.

Area Maps

The local aspects of a community wireless network are difficult to work with—while technicians will eventually gain a good idea of the network's suitability in the service area, most people don't have a need for such an instantaneous birds-eye understanding of their neighborhoods. However, good promotional material will help people identify whether they are in the area that the network can reach, saving everyone time. Three kinds of maps were created for this project.

The first was a simple-looking street map of the neighborhood which discussed the proposed project area; this showed an area significantly larger than the area CNT was ultimately able to connect but was a good item to put in the initial folder at the project launch event. We drafted, but never put into use, a second version that highlighted the area connectable by the project. (EarlyNetworkMap.pdf) The third map actually showed nodes and their connection on top of an area map pieced together from TerraServer (www.terraserver.microsoft.com). It was difficult to keep up-to-date, but even an occasionally updated version was a very good visual indication of the scope and size of the network. (NetworkMap.pdf)

One-Page Flier

In Lawndale, a one-page flier was generated that gave a quick overview of what the project offered on the front page, and answered a number of frequently asked questions on the back page. (Flier.pdf) People in the centers found this flier extremely helpful and it could easily be dropped at other locations (information tables, resource fairs, churches, etc).

Sign-up Sheet

There were several kinds of sign up sheets for this project. One was a several-page questionnaire that was used during the research phase of the project. This was far too intimidating for someone who wanted to quickly express interest in the project, and it was difficult to track. There were also a number of older half-page signup forms on card stock that did not concisely capture the essential information needed. However, the half-page model was the most successful. There was some struggle with those who would use the backs of the forms as scratch paper. (SignupForm.pdf)

Large-format Posters

A large poster (24 by 36 inches) cross-advertised CNT, the Homan Square Community Campus, and NTRC's participation in the wireless project. We put this in front of a clinic at Homan Square, where it served to raise awareness of both the open computer lab at NTRC, Homan Square and the offerings of the wireless network. As a result of the sign we received a number of queries from the population of people that used the community campus' health center.

Stickers
We also had window stickers made up. This idea could have been extended further (think the stickers you get when you buy any Apple product).

Training Fliers
For some of our network training classes, we primarily advertised through a flier that we sent to every person in the network database (TrainingFlier.pdf).

Training
This is mostly an attachment section with little commentary, hopefully the purposes of these documents should be relatively self-explanatory. See the sections on outreach and classes for more on the outreach efforts.

Operating System Users' Guides
- Windows
- Ubuntu (Guide_Ubuntu.doc) (Guide_Ubuntu_Cover.doc)

Worksheets for Classes
- Intro to CAT-5 (Train_Cat-5.doc) - the graphics on this sheet were effective, though the worksheet itself is less clear than it should be about the difference between the crossover *wiring* (which is a wiring for an individual RJ-45) and the crossover *cable* (which is a combination of two different wirings).
- Getting Inside the Network I (Train_Network1.doc) - the first in a series of classes where the users actually connected to the network (or a test bed) itself.
- Getting Inside the Network II (Train_Network2.doc) - the second in the series.
- Getting Inside the Network III (Train_Network3.doc) - the third in the series.

Community Relations
This is really a subsection of a very important class of documents dealing with getting permission to do what you do:
- What documents would you need to signed by a landlord?
- What documents would you need to be *sent* to a landlord if they were non-responsive?
- What do you need to give to potential donors to the project?
- What is a packet that would be useful to give to influential community leaders? (see the Full Informational Brochure in Documents/Marketing)

Client Information Packet

Unfortunately, our project never had a coherent set of materials to hand to a user upon becoming connected to the project. As a result, this is more a list of what such a packet might include if it existed:

- A generic flier

- Stickers

- A introduction guide that might include answers to the following questions:
  - Who runs the project?
  - What is the mission of the project?
  - What are the current and future costs of using the network? (perhaps even include electricity!)
  - What are the long-term plans for the network? What are the best/worse case scenarios?
  - What kinds of things is the network good for (web browsing? downloading?)
  - What kinds of things would the network not be as good for (VoIP?)
  - Who should you call when things go wrong?
  - Who should you call with general questions about the project?

- A guide to help users connect other people to the network, including:
  - What is the distance range for secondary connections?
  - What area is appropriate for new connections?
  - What should the wait time be on secondary connections? New connections?
  - What are the benefits to the user if they get neighbors and friends connected?

- A simple troubleshooting guide showing visually:
  - How all the parts are supposed to be connected within the house (Ethernet cable, power cable, etc.)
  - How to check for common problems
  - Who to call for various problems and what response time you can (realistically!) expect.

- A flier about getting more involved and describing:
  - Node builds
  - Political action
  - Getting other people connected
  - Other volunteer opportunities
  - Mentoring opportunities

- A guide to using the operating system in place (Windows, Linux, etc.)

Appendix F: Supporting Organizations

Community Wireless Networks

- CUWiN (www.cuwireless.net)
- Tribal Digital Village (www.tribaldigitalvillage.org)
- Wireless Philadelphia (www.wirelessphiladelphia.org)

Municipal Wireless and Wired Networks

- Philadelphia, PA
- St. Cloud, FL
- Madison, WI
- Tulsa, OK
- Monticello, FL

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