Laura Forlano, Alison Powell, Gwen Shaffer, Benjamin Lennett

From the digital divide to digital excellence: global best practices for municipal and community wireless networks

Discussion paper

YALE LAW SCHOOL Information Society Project

New America Foundation

Policy Paper

From the Digital Divide to Digital Excellence

Global best practices to aid development of municipal and community wireless networks in the United States

By Laura Forlano, Ph.D. and Alison Powell, Ph.D.

Gwen Shaffer Ph.D., European Case Studies

Benjamin Lennett, U.S. Case Studies

Edited by Benjamin Lennett

Executive Summary

Communications technologies have continued to evolve and now increasingly provide opportunities for deploying low-cost broadband. However, conventional commercial business models for providing broadband often create bottlenecks to spreading connectivity. As a consequence, new efforts to bridge the digital divide will need to examine alternative models of ownership, technology, economic development and social inclusion. Over the past five years, successful community and municipal wireless networks have been overlooked and often dismissed, yet they hold tremendous promise for improving our nation's approach to building communications infrastructure, empowering local communities and addressing the digital divide.

A number of cities and community and municipal wireless networks around the world have developed innovative approaches in pursuit of providing universal access to citizens. In the United States, Lawrence Freenet provides free and low-cost broadband access to residents and businesses in Lawrence, Kansas, with a focus on serving poor and underserved residents. The majority of residents under the poverty line receive free access and equipment while the remaining 10 percent pay to rent the equipment. In Lompoc, California, a municipal network managed by the city's utility department provides affordable wireless access to residents that can be easily added to their existing utility bill. Minneapolis has served as a leader in digital inclusion issues through its municipal wireless partnership with US Internet.

Wireless Minneapolis created a Digital Inclusion Fund (to distribute a percentage of the wireless revenue to the community) and also provides tech-support, content management tools, a community portal and free website hosting for neighborhood associations. These resources, which are managed and run by the communities themselves, go a long way towards providing crucial communications services and information for underserved communities.

In parallel, community wireless networks in Europe have long been delivering low-cost access to broadband in rural and underserved communities. For example, in Berlin, a city that has struggled with depopulation, high unemployment and budget deficits since the fall of the Berlin Wall, the community wireless network Freifunk has provided free Internet access to residents who cannot afford commercial services since 2002. The group also holds weekly trainings to educate the community about how to design, build and administer the wireless network. Freifunk provides an important source of local knowledge-sharing along with a vibrant social infrastructure that supports the network. More recently, the community group has been in discussions with the city government to collaborate on creating a citywide wireless network to leverage the interests, needs and goals of both private and non-profit providers.

By leveraging local capacity, it is clear there are many alternative models cities can utilize to advance their communications infrastructure.

Community wireless networks in rural Denmark and Spain have played a similar role in regional economic development. For example, in Jutland, Denmark—a farming, fishing and manufacturing economy of over 80,000 people—the community wireless network has allowed residents to remain in the region rather than move away to a larger city in search of employment opportunities. According to the network's founder, 100 new jobs have been created in each village in the region. The story is similar in rural Catalonia, Spain, where residents are now able to work from home rather than making the 90-minute trip into Barcelona. Low-cost Internet access has also been important in agriculture and farming applications. In addition, businesses have opened remote branches to serve the local community.

This report details the alternative models that underpin the examples above. While no two cases are exactly alike, with each reflecting an intensely local focus and a specific response to local needs and challenges, there are lessons that can be taken and applied elsewhere. They include ownership models that emphasize shared responsibility among stakeholders; the wealth of innovation in flexible, interoperable and open technologies; and strategies that leverage these models and technologies for economic development and social inclusion through truly holistic and locally oriented processes.

We hope this report will map out a vision for community wireless networks in the future and help other cities and communities learn from the successes described so that they might develop their own unique approaches to local broadband needs. By leveraging local capacity, which can range from the technological smarts of community residents to antennae mounts on buildings, it is clear there are many alternative models cities can utilize to advance their communications infrastructure. As the United States faces the most challenging economic climate in generations and a job market that is increasingly dependent on the ability to connect to the Internet, cities around the country cannot rely solely on existing conventional commercial business models to provide affordable broadband to their citizens or wait for existing providers to consider alternative models to promote universal access. The current conditions call for creativity, and thankfully, alternative models have already demonstrated successful approaches to inspire future innovations.

Introduction: The Broadband Divide in the United States

Access to the Internet and the broader digital community is no longer a luxury. As society moves increasingly into the digital realm, those without access will be shut out of the economic, educational, social, and cultural opportunities that broadband access affords. In 2001, the U.S. ranked 4th in terms of residential broadband penetration according to the Organisation for Economic Co-operation and Development (OECD); in 2008, it ranked 15th.[1] Now federal stimulus programs, including the Broadband Technology Opportunity Program (BTOP) and Broadband Infrastructure Program (BIP), are seeking to address this decline and to extend the benefits of broadband to underserved and unserved communities.[2] This is a pressing goal, given that a 2009 survey from the National Telecommunications and Information Administration (NTIA) found that 35 percent of all households and approximately 40 percent of all persons did not have broadband at home.[3]

This is an especially important issue for minority, low-income, and rural populations, which continue to have limited or no access to broadband, further marginalizing communities that already have limited access to economic and educational opportunities. According to the NTIA survey, 54.1 percent of African-Americans, 57.4 percent of Native Americans and 60.3 percent of Hispanics did not have broadband at home, compared with 34.3 percent of White Non-Hispanics surveyed.[4] These disparities mirrored findings from a 2009 survey from the Pew Internet and American Life Project, where 54 percent of African-American respondents did not have broadband at home, compared with 35 percent of White Non-Hispanic respondents.[5]

The Pew survey also found that 47 percent of adults with incomes between $20,000 and $30,000 and 65 percent with incomes below $20,000 did not have broadband at home, compared with more than 80 percent of those with incomes greater than $50,000.[6] Similarly, in the NTIA survey from October 2009, 70.3 percent of individuals with incomes less than $15,000, 64.8 percent of individuals with incomes between $15,000 and $24,999, and 55 percent with incomes between $50,000 and $74,999 did not have broadband.[7] Moreover, a higher percentage of unemployed respondents (41.6) did not have broadband than employed (29.5).[8]

The survey also found a greater disparity in home

1 Rankings based on number of broadband subscribers per 100 inhabitants. *See* "OECD Broadband Portal," Organization for Economic Cooperation and Development Broadband, http://www.oecd.org/document/54/0,3343,en_2649_34225_38690102_1_1_1_1,00.html.

2 The National Telecommunications and Information Administration has established the Broadband Technology Opportunities Program (BTOP) under the American Recovery and Reinvestment Act of 2009. BTOP provides funding for broadband infrastructure, public computer centers, and sustainable adoption programs. *See* http://broadbandusa.sc.egov.usda.gov/files/BIP-BTOP_FAQ.pdf.

3 The report's findings are based on data collected in October 2009 through a special Internet Use Supplement, sponsored by NTIA, to the U.S. Census Bureau's Current Population Survey. The sample size was approximately 54,000 households and 129,000 citizens. *See* "Digital Nation: 21st Century America's Progress Toward Universal Broadband Access," Department of Commerce (February 2010): 1, http://www.ntia.doc.gov/reports/2010/NTIA_Internet_use_report_Feb2010.pdf.

4 *Ibid.*

5 The 2009 Pew survey found that 68 percent of Hispanic respondents had broadband at home. The discrepancy between the Pew survey and NTIA's survey may be explained by Pew inclusion of only Hispanic English speakers. It is unclear if NTIA's survey included Hispanic non-English speakers. *See* John Horrigan, "Home Broadband Adoption 2009," Pew Internet and American Life Project (June 2009): 13, http://www.pewInternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf

6 *Ibid.*, 14.

7 "Digital Nation" (2010): 5, http://www.ntia.doc.gov/reports/2010/NTIA_Internet_use_report_Feb2010.pdf

8 *Ibid.*, 7.

broadband rates for rural residents. In rural areas, 71.2 percent of African-Americans and 66.2 percent of Hispanics did not have broadband, compared with 52.2 percent and 59.9 percent of their urban counterparts.[9] Moreover, 50.4 percent of unemployed persons in rural areas did not have broadband compared with 39.8 percent in urban areas.[10] Pew found that over 50 percent of rural residents surveyed did not have broadband compared with 33 percent of urban residents.[11]

A home broadband connection deepens a user's relationship with the online world.

Why is this important? Additional surveys from the Pew Internet & American Life Project find that a home broadband connection deepens a user's relationship with the online world. "For example, on an average day, 16 percent of Internet users with a home broadband connection have created content to share online (such as a web page), compared with 3 percent of home dial-up users."[12] The Internet is also rapidly changing. Web 2.0 applications are replacing text-driven web pages and streaming videos are replacing still pictures.[13] Dial-up access speeds are no longer adequate for these multimedia uses. Advanced telecommunication services such as telehealth and distance learning have the potential to dramatically improve access to healthcare and education, but they also require a reliable high-speed home broadband connection.

According to an NTIA survey, the leading reasons among respondents for lack of broadband access at home were "Don't Need/Not Interested" (37.8 percent), "Too Expensive" (26.3 percent), and "No Computer or Computer Inadequate" (18.3 percent).[14] However, respondents that used the Internet outside the home cited cost (38.9 percent) and "No Computer or Computer Inadequate" (16.8 percent) as the leading reasons for not having an Internet connection at home.[15] Cost barriers increased to 41.3 percent for respondents with dial-up Internet access, and no availability increased from 2.7 percent to 19.9 percent as the reason for lacking broadband at home.[16] When asked what the barriers were that kept them from switching from dial-up to broadband, respondents in the Pew survey cited cost (32 percent) and availability (17 percent).[17] Among non-Internet users 22 percent said they were not interested in getting online, 16 percent could not get access, and 10 percent said it was too expensive.[18]

Despite the above challenges, the development of communications infrastructure in the United States is at a moment of opportunity. The Obama administration has made a commitment to expanding affordable broadband access. Moreover, as the U.S. looks to move its economy forward, investments that bring 21st-century communications technologies to all Americans are vital. Now is the time to explore solutions that transcend the old models of corporate, monopolized broadband provision and look to innovative efforts that leverage new technologies, empower local communities, and bridge the digital divide.

---

9 "Digital Nation" (2010): 9, http://www.ntia.doc.gov/reports/2010/NTIA_Internet_use_report_Feb2010.pdf.

10 *Ibid.,* 9.

11 "Home Broadband Adoption 2009" (2009): 14, http://www.pewInternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf

12 *Ibid.*, Or: John Horrigan and Lee Rainie, The Broadband Difference: How online behavior changes with high-speed Internet connections (June 2002): 12, http://www.pewinternet.org/~/media//Files/Reports/2002/PIP_Broadband_Report.pdf.pdf

13 http://www.pewInternet.org/topics/Web-20.aspx

14 "Digital Nation" (2010): 12, http://www.ntia.doc.gov/reports/2010/NTIA_Internet_use_report_Feb2010.pdf.

15 *Ibid.,* 14,.

16 *Ibid.*

17 20 percent of respondents indicated that nothing would get them to change from dial-up to broadband. *See* "Home Broadband Adoption 2009" (2009): 7, http://www.pewInternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf

18 *Ibid.,* 7-8.

This report describes the social and economic opportunities presented by municipal and community networks. It outlines the practical considerations involved in creating a local network, including the technical architectures, economic costs and ownership models, as well as the social and political benefits. With examples from twelve successful networks, this report describes how municipal and community wireless networks create local opportunities for economic and social development.

The Local Network Gap: Municipal and Community Wireless Networks

Both investment and creativity are required to take advantage of this opportunity. Municipal and community wireless networks in the United States and around the globe demonstrate how non-profit organizations, local governments, and citizens can take control of their communications needs. By leveraging the opportunities provided by wireless technology, they can build networks that are cheaper and more responsive to local needs.

Local networks fill critical gaps in providing connectivity to often unserved or underserved communities, groups and individuals. They can provide broadband in markets that private-sector telecommunication companies do not consider viable or where economic returns may not satisfy investor demands.[19] They change the policy calculus for broadband access by providing ways for governments to leverage the infrastructure they already own, such as telephone poles and water towers.[20] Research suggests that broadband access is correlated with increased economic success[21] and social participation.[22] Local networks can also inspire participation in building communications infrastructure among local groups, organizations and citizens. Furthermore, they promote unique partnerships between public, private and community sectors.

The most successful local networks meet the needs of the places where they are built and previous research suggests that local networks can do the following:

- bridge digital divides and contribute to local development;
- build upon government's role as a basic infrastructure provider;
- address the issues of affordability;
- capitalize on unlicensed spectrum;
- leverage community infrastructure (buildings upon which to install antennas, networks, control over urban space); and
- extend municipal administrative networks to connect citizens.[23]

[19] See Munir Mandivwalla, Abhijit Jain, Julie Fesenmaier, Jeff Smith, and Greg Myers. "Municipal Broadband Wireless Networks." *Communications of the ACM* 51, no. 2 (2008): 72-81.

[20] See Andrea Tapia, Carleen Maitland, and Matt Stone. "Making It Work for Municipalities: Building Municipal Wireless Networks." *Government Information Quarterly* 23, no. 3-4 (2006): 359-80.

[21] See Jed Kolko, "Broadband and Local Economic Development." Paper presented at the TPRC 2008: Telecommunications Policy Research Confrerence, Arlington, VA 2008. Available at: http://tprc.org.

[22] See James Katz and Ronale E. Rice. *Social Consequences of Internet Use: Access, Involvement, and Interaction*. Cambridge, MA: MIT Press, 2002 as well as Michael Oden, Sharon Strover, Nobuya Inagaki, Martha Arosemena, and Jeremy Gustafson and Chris Lucas, "*Information and Telecommunications Technology and Economic Development: Findings from the Appalachian Region*" University of Texas at Austin. Available at: http://unjobs.org/authors/sharon-strover

[23] See Mandviwalla, as above, and Andrea Tapia, Matt Stone, and Carleen Maitland. "Public-Private Partnerships and the Role of the State and Federal Legislation in Wireless Municipal Networks." Paper presented at the 33rd Research Conference on Communication, Information, and Internet Policy.Telecommunciations Policy Research Conference, Arlington, VA 2005. Available at http://tprc.org, and Gwen Shaffer, Gwen "Frame-Up: An analysis of arguments for and against municipal wireless initiatives" *Public Works Management and Policy* 11(2007): 204-216.

History and Development

Municipal and community wireless networks have a shared history, but each has its own unique characteristics. Beginning in the late 1990s, activists and advocates began meeting to experiment with building networks in their communities. These networks typically used the 802.11 "wireless fidelity" (Wi-Fi) standard, which is embedded in most laptop computers, and the bands on which they operate are unlicensed spectrum. The goals of these networks were diverse: Some were aimed at cultivating public spaces, others at providing broadband in unserved residential areas or sharing multimedia art work in cafes.

Several years later, municipal governments became interested in the possibility of deploying municipal wireless networks to increase economic development. In 2004, Philadelphia became the first large city to announce plans for a municipal wireless network.[24] After the announcement and growing interest, incumbent telecommunications and cable companies led widespread efforts to oppose the networks and the ability of local governments to provide connectivity for their residents. The policy campaign that followed resulted in state legislation in Pennsylvania that prevented municipal governments from providing broadband services. Similar laws were passed in 14 other states.[25]

As a consequence, the vision of the Philadelphia network moved from a true "municipal"-owned and -operated network to an exclusive corporate-owned franchise, owned and operated by EarthLink. Its subsequent failure has since been seen as emblematic of the failure of municipal networks, generally[26] Many of the more than 350 municipal networks launched in the U.S. between 2006 and 2007 utilized a corporate-owned franchise model.[27] These networks aimed to cover entire cities with Wi-Fi in an effort to increase access in general and affordable access in particular in order to bridge the digital divide. Many of these projects collapsed after franchise owners could not find a way to provide free or low-cost access at the same time as hitting their profitability targets, in part due to the slow adoption of broadband among underserved and low-income populations, but also because they underestimated the costs of deploying viable metro-wide networks.

However, as corporate-owned franchises are not true municipal networks their failure should not be seen as a failure of a municipal network model per se since the municipal approach is more accurately defined as "a network whose ownership and operation is under the control of a city and is run for the common good of the citizens of that city rather than for profit."[28]

Municipal and community wireless networks are nonetheless still being built, with many – including some of the case studies in this report – employing models considerably different from the franchise model, including direct investment by governments

---

[24] See Joshua Breitbart, Naveen Lakshmipathy, and Sascha Meinrath "The Philadelphia Story: Learning from a Municipal Wireless Pioneer" *New America Foundation.* Available at: http://www.newamerica.net/publications/policy/philadelphia_story

[25] For discussion of the consequences of these laws see Andrea Tapia and Julio Angel Oritz. "Municipal Responses to State-Level Broadband Internet Policy." Paper presented at the TPRC 2006: Research Conference on Communication, Information, and Internet Policy, Arlington, VA, September 29, 20, October 1 2006. Available at http://www.tprc.org

[26] See Sascha Meinrath, "Philadelphia Network Flop Points to Failure of Corporate Franchise Model," May 16, 2008, http://www.newamerica.net/publications/articles/2008/philadelphia_network_flop_points_failure_corporate_franchise_model_7205

[27] See Julio Ortiz, and Andrea Tapia "Keeping Promises: The Struggle to Narrow the Digital Divide with Municipal-Community Wireless Networks" The Journal of Community Informatics, Vol. 4, No. 1. (2008) http://ci-journal.net/index.php/ciej/article/view/436/400

[28] Sascha Meinrath "Municipal Wireless Success Demand Public Involvement, Experts Say" *Government Technology* (April 8, 2008). Available at: http://www.govtech.com/dc/articles/271842

in infrastructure, anchor tenancy by governments, and even "ownerless" or non-profit community networks, in addition to utilizing markedly different network architectures that leverage the strengths of open wireless technologies such as Wi-Fi and mesh networking.[29]

New Opportunities

The collapse of the corporate owned-franchise model, combined with the renewed commitment to increasing access and adoption of broadband from the White House, provides an opportunity for cities and communities to rethink investment in communications infrastructure and address the digital divide. In addition, scholars are arguing that municipal and community wireless networks are essential local communications infrastructure.[30]

While high-profile municipal wireless networks struggled, community networks thrived in hundreds of cities and communities around the world – some of them forming partnerships with local governments. These networks held broader goals and values than merely covering large areas with broadband Internet access. Some involved volunteers in civic life, promoting civic participation and social capital building[31], while others incubated new hardware, software and applications for wireless networks or increased broadband access in unserved areas.[32] These networks made use of different types of network architectures and pursued different strategies for ownership and governance.

There is growing evidence that these community-based models are more flexible and robust than those of traditional telecommunication companies, particularly in areas where standard models have failed. In addition, community-based models increase local autonomy.[33] Addressing this competitive gap and expanding access to broadband is especially important in light of current expectations about widespread broadband coverage; for example, one-third of Internet users use Wi-Fi when away from home or work, and only 4 percent utilize paid connections.[34] Drawing on in-depth studies of municipal and community wireless projects in Europe[35] and the United States, the case studies that follow illustrate the positive impact these networks have particularly when they leverage local

There is growing evidence that these community-based models are more flexible and robust than those of traditional telecommunication companies, particularly in areas where standard models have failed.

[29] See John Peha, B. Gilden, R. Savage, S. Sheng, B. Yankiver, "Finding an Effective Sustainable Model for a Wireless Metropolitan-Area Network: Analyzing the Case of Pittsburgh," Available at: http://www.jpeha.com/

[30] Middleton et al, *ibid.*

[31] For a discussion of social capital building see Hanna Cho "Explorations in Community and Civic Bandwidth: A Case Study in Community Wireless Networking." Ryerson University and York University, 2006; Foth, M., Bajracharya, B., Brown, R., & Hearn, G. "The Second Life of Urban Planning? Using Neogeography Tools for Community Engagement." Journal of Location Based Services (2009, in press)..

[32] The current market failure,is arguably one of the constraints on the development of broadband in the US. See Tina Nguyen, "White House Official Kicks Off Broadband Stimulus Town Hall Webcast, Decries U.S Networks as Inadequate" *BroadbandCensus.com.* Available at: http://broadbandcensus.com/2009/06/white-house-official-kicks-of-broadband-stimulus-town-hall-webcast-decries-us-networks-as-inadequate/

[33] Becca Vargo Daggett, "Localizing the Internet: Five Ways Public Ownership Solves the U.S. Broadband Problem" *Institute for Local Self-Reliance.* (April 2007). Available at: http://www.newrules.org/information/publications/localizing-Internet-five-ways-public-ownership-solves-us-broadband-problem

[34] John Horrigan, "Home Broadband Adoption 2008: Adoption Stalls for Low-Income Americans as Many Broadband Users Opt for Premium Services That Give Them More Speed." Washington, DC: Pew Internet & American Life Project, 2008.

[35] The European case studies are based upon work supported by the National Science Foundation under Grant No. 0847879. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

knowledge, capital and resources. Furthermore, the report investigates the challenge of how to develop municipal and community wireless networks to benefit local communities by lowering the cost of access and inspiring civic participation, local capacity and innovation. As the cases show, the answer to this question can be found in analyzing the goals of the network and the choices that network developers make about architecture, ownership and governance.

Building Local Communications Infrastructure

To understand what makes for sustainable and successful communications infrastructure models it is necessary to understand several characteristics of municipal and community wireless projects. This section closely examines the cases of 12 successful domestic and international projects in rural and urban areas in the United States and Europe considering their ownership structure, technical architecture, services and applications, network build-out and operations financing and costs, operation and maintenance, network management, and finally community initiatives or programs. In totality, these cases, each one included because it serves to highlight key technological, economic and social features of the projects, illustrate the ways in which building local communications infrastructure can increase competition in telecommunications and cable markets, bring substantial savings to communities and provide a reliable high-speed broadband network that enables innovation and entrepreneurship among residents.

Ownership Models

The municipal and community wireless networks profiled in this report adhere to a wide range of business models including the exclusive *corporate-owned franchise; municipal support models*, such as public utility and anchor tenant models; and *community ownership models*, such as the ad-hoc community wireless, non-profit and social entrepreneurship models. This section will give an overview of the key features of these models with examples from the case studies.

Exclusive Corporate-Owned Franchise

In 2004, Philadelphia became the first major U.S. city to explore the idea of building a citywide wireless broadband network. Due to the political battles that ensued in the press following the announcement of the **Wireless Philadelphia** project and the lengthy request for proposal process, the city decided to pursue the safest and least controversial option of granting an exclusive franchise to a private company as is commonly done in other areas of city business, e.g., cable franchises that cover specific geographic territories. EarthLink, an Atlanta-based private broadband provider, was contracted to build, own and operate the network in 2005.

While the city initially wanted the network to be owned by a non-profit, in 2005 it was agreed that EarthLink would own and operate the network. In 2008 EarthLink, having signed similar contracts with cities around the country, decided to dismantle the network due to rising costs, poor coverage and a lack of subscribers (the company had achieved less than 15 percent of the subscribers expected). Failing to see a sustainable business model, EarthLink soon pulled out of all of its commitments around the country and got out of the municipal wireless business entirely.

In the end, in order to be free of its 10-year contract, EarthLink gave the network, valued at $17 million, to Network Acquisition, a group of local investors. While use of the network soared to 150,000 visitors per month when Network Acquisition made it available to the public for free, it struggled to finance its operations going forward. In late 2009, the City of Philadelphia announced it was purchasing the network for $2 million with the goal of creating a public safety and municipal wireless network and in May of 2010, the Philadelphia City Council

committee approved the purchase with the stipulation that the network would be used primarily by government workers.[36] For the most part, the exclusive franchise model for municipal wireless provision has proven to be a failure in repeated projects throughout the country over the past five years. This has left municipalities searching for alternative models.

Municipal Support Models

Public Utility

Municipal networks in St. Cloud, Florida, and Lompoc, California, are examples of a public utility model, where broadband connectivity is treated like other city services such as water, electricity, or trash sanitation. In 2005 **St. Cloud, Florida**, a suburb of Orlando with 30,000 residents, became the first town in America to provide free wireless broadband connectivity as a public service. The municipal wireless network covers about 17 square miles and currently serves about two-thirds of the city's households. The network cost $2.75 million in initial capital costs from the city's economic development fund, including the network deployment and one year of operating costs. The ongoing yearly operating costs are approximately $500,000 and are paid for from the city budget. According to a recent survey about the network, one-third of residents use the network exclusively as their broadband service; one-third use it in conjunction with a paid service; and one-third did not use it at all.

In **Lompoc, California,** the public utility model has allowed the city to leverage the network for multiple uses while bringing down the cost of service. The network was entirely funded by Lompoc's Municipal Utility. When the network was built in 2005, it struggled with adoption and use. Two years later, the utility decided to take complete control of the network, bringing customer service, network administration and planning in-house in order to cut costs rather than relying on outside contractors. By 2009, the network had 1,450 subscribers; 10 percent of the 14,000 households in the city and nearly halfway to the goal of 4,000 subscribers needed to pay back the utility's investment. The network, which covers a population of 42,000 living in an area of 6.2 square miles, provides around 2 Mbps downstream bandwidth and 1 Mbps up to most users. The service costs residents $15.99 per month, a figure that can be automatically added to their existing municipal utility bill.

The city also utilizes the network for its police force, which has installed Wi-Fi routers in cruisers, and for automated (electric) meter reading (AMR) in over half the city's households, with plans to do the same for water meters. These uses allow the network to continue to be successful and justify the city's support. According to Richard Gracyk, Wireless Service Administrator for Lompoc's Municipal Utility, "a network cannot be successful based on any one service. You cannot expect to recoup your money just by focusing on subscriptions." Utilizing the network for city services was not originally envisioned, but now these uses are increasingly seen as integral to the sustainability of the network.

In 2005 St. Cloud, Florida, a suburb of Orlando with 30,000 residents, became the first town in America to provide free wireless broadband connectivity as a public service.

Despite the benefits of the Cyber Spot network to residents of **St. Cloud**, in September 2009 city leaders decided to shut down the service.[37] Faced

[36] Josh Fernandez, "Council committee gives OK for city to buy wi-fi network," Philadelphia Daily News, May, 26, 2010, http://www.philly.com/philly/business/technology/20100526_Council_committee_gives_OK_for_city_to_buy_wi-fi_network.html#axzz0pcGSG5VK

[37] Etan Horowitz, "St. Cloud shutting down the nation's first citywide free Wi-Fi network," *Orlando Sentinel,* Etan on Tech, September 28, 2009, http://blogs.orlandosentinel.com/etan_on_tech/2009/09/st-cloud-shutting-down-the-nations-first-citywide-free-wifi-

with a $1.3 million budget shortfall, the city council voted to eliminate the public portion of the wireless network to save $370,000 in maintenance and operational costs. After the vote, angry residents packed the commission chambers at a council meeting, demanding the city not shut down the service.[38] The council voted 3 – 2 to extend the free citywide Internet access for 120 days. In December, even with $1.9 million in cuts from the previous year's budget, three councilmen voted against continuing to fund the service.[39] It was discontinued as of February 16, 2010.[40] The network will still be used for city services.[41]

Municipal Anchor Tenant

Municipal wireless projects encounter a number of contractual obligations when it comes to negotiating with private providers of telecommunications infrastructure. These may include, for example, debt servicing, rights-of-way agreements and anchor tenancies. Rights-of-way agreements give companies access to city-owned rooftops and pole tops where antennas, routers and other wireless equipment can be installed. Cities are often asked to serve as "anchor tenants," meaning that they will use the municipal wireless network's bandwidth for city services.

These issues are at the forefront of the **Wireless Minneapolis** project. The city's Request for Proposals sought responses from private companies willing to finance, build, own and operate a citywide wireless network based on a public-private partnership model. They selected this model following the completion of a case study of municipal broadband, which took into account capital budget constraints, existing bond obligations, exposure to risk, potential regulatory and legal impediments, and the complexity of starting and operating the network on an ongoing basis. The city would serve as an anchor tenant on the network, paying for wireless services as well as wired information and communications services for city departments, schools and libraries. In addition to exclusive rights to the city's business, the private partner would have the non-exclusive right to place wireless equipment on and in city facilities, access to the city's institutional fiber network and the opportunity to build out the city's wired infrastructure as necessary to support the city's need for wired and wireless services.

In October 2005, EarthLink and U.S. Internet Wireless (USIW) emerged as finalists from a total of nine proposals submitted. After a brief pilot phase, the city finalized contract negotiations with USIW in August 2006. The terms of the contract required the city to pay $2.2 million in advance for city-acquired services and a minimum annual commitment of $1.25 million for the first 10 years. As part of their agreement with USIW, the city would own all new and existing fiber-optic network assets, provide access to city rooftops and utility/light poles, facilitate the procurement process and serve as the anchor tenant. In turn, the private partner was responsible for funding, building and operating the wholesale and retail wireless network.

---

network.html. See also Esme Vos, "St. Cloud shuts down free citywide WiFi service," MuniWireless.com, September 28, 2008.

38 Jeannette Rivera-Lyles, "St. Cloud will keep free Wi-Fi -- for now," *Orlando Sentinel,* October 2, 2009, http://articles.orlandosentinel.com/2009-10-02/news/091001018o_1_free-wi-fi-cloud-wi-fi-service.

39 Juliana Torres, "St. Cloud says 'no' to Cyber Spot," *Around Osceola,* December 11, 2009, http://oscnewsgazette.com/index.php?option=com_content&task=view&id=5257&Itemid=6.

40 See City of St. Cloud Press Release, "St. Cloud City Council Decides Cyber Spot's Future," December 14, 2010, http://www.stcloud.org/documents/Cyber%20Spot/CyberSpot%20Press%20Releases/02_121409_CyberSpot_ends_Feb162010.PDF

41 Etan Horowitz, "St. Cloud shutting down the nation's first citywide free Wi-Fi network," *supra note* 1.

Community Ownership Models

Ad Hoc Community Wireless Initiative

The majority of the community wireless projects profiled in this report could be classified as ownerless, ad-hoc community wireless initiatives since individual community members contribute their own equipment and, often, wired Internet connections to serve as backhaul for the network. In these networks, no single legal entity owns the entire network, which makes it more flexible than traditional network models. Both mesh networks and hotspot networks can be described as ownerless if the users or hosts own their own equipment. For example, members of Austria's **Funkfeuer** believes that the network itself should not own the infrastructure. "It protects us as an association if we don't legally own the nodes... [We don't] own the access points, so we can't sell them," the co-founder notes.

Image credit: shlomaster (stock.xchng)

Despite this, these projects have succeeded in partnering with private companies and government organizations. Funkfeuer is partnering with a small ISP that is laying fiber in Vienna. The company contributes bandwidth to the network and, in exchange, it gains access to the new protocols that Funkfeuer develops. "They are learning from us," said a Funkfeuer co-founder.

Similarly, Germany's **Freifunk** has been discussing the possibility of creating a "peering agreement" with city-owned hotspots in order to expand network coverage. The city of Berlin is planning to build an open wireless network in the city's commercial corridors and popular tourist destinations. "Freifunk is deployed in residential neighborhoods, but not in the touristy sections," said the network's co-founder. Freifunk's popularity convinced incumbent carriers to amend their terms of service of agreements to allow bandwidth sharing.

The city of Berlin plans to build an open wireless network in the city's commercial corridors and popular tourist destinations.

As a private company with a social mission, Austin's **Less Networks** partnered with more than a dozen restaurants, coffee shops and bookstores in Austin to deploy Wi-Fi hotspots throughout the city. This model relied on local business venues to pay for the Internet connection and an inexpensive Wi-Fi access point. Together, with a city agreement to deploy hotspots in all 22 of the city's libraries and four downtown squares, the **Austin Wireless City Project** (AWCP) and Less Networks created a fabric of connectivity in the city of Austin. The organization further expanded connectivity through a partnership with Time Warner, the local cable franchise, to market and sell pre-configured wireless routers to local businesses.

Non-Profit Community Network

The main difference between an ad-hoc community wireless network and a non-profit community wireless network is whether there a legal organization a legally recognized organization is responsible for the network. **DjurslandS.net** on the Djursland Peninsula in Denmark and **Lawrence Freenet** in Lawrence, Kansas, are good examples of the non-profit community network model.

In the late 1990s, in Djursland -- a rural area on the northeast coast of Denmark -- the founders of DjurslandS.net repeatedly asked the incumbent telephone carrier, Tele Denmark, to deploy DSL in

their sparsely populated community. "We realized rural people would fall behind if we didn't do something about it," the network founder said. When the phone company declined to expand the network in Djursland, residents pursued alternative means of access. "I negotiated with 35 ISPs [Internet Service Providers] in Denmark," he said. "ISPs were impressed by our initiative but, one after another, they said building the infrastructure for rural people was too expensive." Four months after DjurslandS.net's official launch as a community-owned ISP in May 2003, they had already attracted 700 users. Once DjurslandS.net began growing, its founder convinced an ISP to provide 60 DSL connections for $10,000 per month. "All over Djursland, we got bandwidth sharing," he said. In May 2005, the new 802.11a standard reduced bottlenecks in the wireless infrastructure, making it possible to cancel several DSL connections and save thousands of Euros each month. Speeds vary slightly depending on the geographic location of the user, but 10 megabytes per second (MGPS) for both uploading and downloading is typical. As of March 2009, about 8,000 households subscribed to DjurslandS.net, which has grown to encompass 10 separate broadband networks, by installing commercially manufactured rooftop antennas that cover about 10 km in diameter in all directions. New members pay a $363 initiation fee, which covers the cost of rooftop equipment as well as ongoing maintenance costs, and a monthly subscription rate of $17.

In the United States, Lawrence Freenet was founded in 2007 as a not-for-profit company in order to work with city government, service providers and the community. The network, which started in a garage in Lawrence, Kansas, has grown to 550 wireless nodes that cover most of the city. According to the network's founder Josh Montgomery, "We struggled to develop a sustainable business model where a non-profit could run and build the network and offer a return on investment." This prompted Montgomery to start Community Communications Corporation, a private company that owns the infrastructure and backhaul components of the network so that the non-profit can focus on providing service and community outreach.

Kansas Freenet offers residential access for $23.98 per month. Currently, the network has approximately 1,500 customers and has created 4,500 accounts since its citywide launch in 2007. The network provides speeds up to 7 Mbps downstream bandwidth and 512 Kbps upstream. The network does not require any contracts, making it very popular among students who can subscribe on a month-to-month basis and access it all around the city. Students are the largest users of the network, as 20 – 30 year olds make up 60 percent of users.

Technical Architecture and Design

Municipal and community wireless networks vary in their use of hardware and software, provision of services and applications, network architecture and spectrum use. Following are specific examples of technological architectures and their impact on the flexibility, scale and strength of the network and the cost of building local communications infrastructure.

Network Architecture

Wireless networks can be organized as individual hotspots, centralized and hierarchical hub-and-spoke networks, decentralized and distributed dynamic mesh networks or hybrids between these models.[42] The most common of these network architectures is the hotspot model, such as those found in cafes, parks and airports, where the Internet is broadcast to devices in close proximity. Currently, there are 272,693 Wi-Fi

[42] See Christian Sandvig, David Young, and Sascha Meinrath. *Hidden Interfaces to "Ownerless Networks."* Paper presented at the 32nd Conference on Communication, Information, and Internet Policy, Washington, DC, 2004.

hotspots in 140 countries.[43] Wi-Fi hotspots were originally designed to be used to replace cables within offices, but early Wi-Fi adopters modified them to work in new ways.

Among these early innovations was the mesh network architecture – a key feature of some municipal and community wireless networks – that allows the network to function without a centralized or hierarchical structure. In a mesh network, each participant – a household hosting a node with a router or computer – owns an equal portion of the network. Mesh networks allow a group of computers to be connected wirelessly regardless of whether they are connected to the Internet. Thus, one need not be connected to the Internet in order to communicate with other members of the network. However, if one computer is connected to the Internet all of the computers will be connected. Some dynamic mesh networks also have the ability to reroute network traffic to avoid an area of the network that is damaged or not working.[44]

In a mesh network, each participant – a household hosting a node with a router or computer – owns an equal portion of the network.

Spectrum Frequencies

Unlike cellular telephone networks, the majority of municipal and community wireless networks use *unlicensed* electromagnetic spectrum, which does not require the payment of fees to a government entity or a license or permission to innovate in the hardware, software or applications that use this spectrum. Numerous devices, including Wi-Fi networks as well as garage door openers, baby monitors and wireless microphones, use this tiny slice of spectrum.

In the late 1990s, the Institute of Electrical and Electronics Engineers (IEEE) established standards to ensure that all Wi-Fi devices are interoperable. These standards for interoperability combined with the availability of unlicensed spectrum have enabled the expansion of municipal and community wireless networks.[45] Wireless networks can also use proprietary spectrum. In this case, specialized transmitters and receivers must be purchased. This can increase the cost of the network, both for the organization that is building it and for its users. In some cases, proprietary spectrum can result in higher speed transmissions, because there may be more capacity.

Equipment, Antennas, and Access Points

The choice of antennas and access points for the network depends in part on the architecture of the network, terrain, population density, and ownership model. For ad hoc networks in dense cities, mesh hardware and user-provisioned backhaul can be effectively utilized to create a web of connectivity. For example, the **Freifunk** network in Berlin depends heavily on end-user participation. The most passive form of involvement is simply putting a re-flashed access point on ones ledge, balcony or installing it on the roof to support the meshed network. To bolster network coverage, Freifunk members have installed backhaul nodes with dedicated links — antennas that cover a distance of 2 to 10 km — on church steeples and other higher buildings throughout the city. These are part of the so called BerlinBackBone (BBB). The backhaul serves the community to interconnect the various regional meshclouds and also to connect to more gateways to the internet.

Funkfeuer (German for "radio fire") is one of the

[43] See http://jiwire.com for more information. Accessed onAugust 6, 2009.

[44] For more details see http://en.wikipedia.org/wiki/Wireless_mesh_network

[45] Currently there is only a small slice of unlicensed spectrum available. The designation of more unlicensed spectrum by the federal government would greatly improve the quality and scalability of wireless networks.

most active European Wi-Fi initiatives in terms of programming and developing protocols for mesh networking. Funkfeuer owns a 5-Gigabit (Gbps) fiber-optic link to the Vienna Internet Exchange, a peering facility at the University of Vienna. "The best motivation for people to build good links is so they have good capacity themselves," said one of Funkfeuer's leaders. The group is currently testing "a more user-friendly firmware" in order to attract new members. It is also building 5-Gbps fiber ring around the city for increased signal reliability. Such a ring "will allow people to connect more directly and with fewer hops. If one guy in the middle failed to build a proper node, the signal will still get transmitted."

Similarly, **Athens Wireless Metropolitan Network** (AWMN) utilizes end-user nodes and strategically located access points—typically placed on the sides of mountains—linking the network to emerging Wi-Fi projects on the islands of Euboea, Aegina and Salamina. Several universities allow AWMN to connect similar wireless network from other regions in Greece, including the cities of Thessalonika and Parta) through their backhauls. One-third of AWMN participants have installed mesh "backbone nodes" on their rooftops. These antennas talk to one another and serve as the primary infrastructure for the network. The other 2,000 members are referred to as "clients" who simply install the network's routing software. These participants connect to backbone nodes but do not extend the signal any further. Most clients eventually upgrade their nodes to backbones in order to obtain faster connections, which require an investment of about $1,300 worth of wireless equipment.

In rural areas or large urban public spaces, where it is necessary to cover a wide area, it is necessary to locate equipment on towers and rooftops and invest in antennas that can transmit wireless signals over long-distances.

However, mesh networks are not just limited to dense, urban areas. **Guifi.net** has grown to encompass 11,300 nodes in rural Catalonia, Spain, about 75 miles outside of Barcelona. Guifi.net has scaled up the mesh architecture, utilizing end-user equipment and rooftop antennas, along with additional network equipment deployed on street lamps and rooftops by local towns to create one of the world's largest interconnected mesh networks.[46] About 23 town councils subscribe to an ISP, in turn sharing bandwidth with residents via wireless backhaul. These local governments install $130 antennas on street lamps and roofs throughout their villages, and each of these access points has the capacity to support 30 Internet connections. With an average population of 2,000 to 3,000 residents, it costs local governments slightly more than $4,000 to deploy nodes throughout an entire village. In order to connect to the signal, individual residents and businesses purchase rooftop antennas.

[46] See http://guifi.net/ for an up to date total of the scale of the network.

In rural areas or large urban public spaces, where it is necessary to cover a wide area, it is necessary to locate equipment on towers and rooftops and invest in antennas that can transmit wireless signals over long-distances. Many of these networks are utilizing a hybrid infrastructure, of point-to-point links to carry traffic to and from a cell or neighborhood back to an aggregated Internet access point, and then using mesh technology to provide connectivity to households or businesses.

DjurslandS.net is a good example of a rural area where experimentation with antennas and access points has been a key to the success of the non-profit community network. DjurslandS.net is a fixed network that uses permanent antennas to create a complex, hybrid architecture. The antennas mounted on the towers are connected to the Internet through fiber, which is leased from various village governments. In 2000 the price of antennas had fallen to about $10,000 per access point, so the founder bought radios in bulk at a discount. The village of Glesborg agreed to build a 50-meter high tower, symbolically selling it to the network's founder for 20 cents. The founder and a group of community volunteers set up omni-directional antennas (antennas with 360 degrees of coverage) on both the tower and roof of a nearby sports hall located 1.5 km away. The experiment was successful, creating the network's first wireless link.

The towers require line-of-sight (one antenna must be directly visible to another antenna) to transmit to 300 strategically located access points in villages throughout the peninsula. The antennas operate on the 802.11 unlicensed wireless standard. A four-way directional antenna—designed by network developers themselves—links to a central radio station. Additionally, the 8,000 households that subscribe to the network host nodes created with wireless mesh antennas that operate on the 802.11 standard. DjurslandS.net provides two types of rooftop antennas to project members. A four-way directional antenna—designed by network developers themselves—links to a central radio station. Members must also install a commercially manufactured antenna that covers about 10 km in diameter in all directions.

Lawrence Freenet utilizes a combination of city water towers and light poles to deploy its 550 online nodes and 9 wireless backhaul points. The **St. Cloud** network utilizes approximately 365 Wi-Fi mesh nodes from Tropos Networks operating on the 2.4 GHz unlicensed spectrum band. Almost 100 percent of the radios are attached to city-owned light poles. The mesh nodes are connected to backhaul at City Hall using either fiber connections or Motorola wireless routers operating on 5.2 GHz and 5.8 GHz. City Hall serves as the network operations center and is connected to two separate fiber metro-Ethernet connections.

The St. Cloud network allows residents and visitors to get online in outdoor spaces throughout the city. However, due to the limitations of unlicensed spectrum in penetrating foliage and walls, the city cannot guarantee that all homes and businesses will be able to access the Internet. Instead, they encourage potential business and residential users to install an inexpensive wireless bridge device to bring the signal indoors. Howard De Young, St. Cloud's Director of Information Technology, explains, "It's the household's responsibility to connect the house to the city's water system running along the street. Similarly, it's the individual responsibility to get wireless signals from the street into their home," He compares it to rabbit ears for your TV. "It's exactly the same thing with a wireless connection; the better the antenna, the better your connection speeds." He often used the analogy at the monthly public workshops the city holds to explain the network to residents.

Wireless Routers and Firmware

Wireless routers, and the wireless radios embedded in laptop and desktop computers (such as the Apple AirPort), are the core building block of municipal

and community wireless networks. Certain routers, such as Cisco's Linksys WRT series, which cost between $40 and $80, can be reprogrammed or "flashed" with a new operating system, also known as "firmware." This is because the Linksys routers have integrated free and open source software into their operating system.

Berlin Germany's **Freifunk** (German for "free radio") network allows participants that want to host an access point to buy a pre-configured router and download and install their own firmware from the group's website. Freifunk members are very active in the development of open source firmware and protocols for wireless networking and Freifunk developed OpenWRT, an open source operating system for the Linksys WRT54G router in conjunction with C-base, a technical cooperative in Berlin[47]. This firmware has been adopted by wireless community groups around the world, including Open-Mesh (www.open-mesh.com) routers, which are sold commercially in the United States.

As of March 2009, Freifunk's network blanketed one-tenth of the city of Berlin with free Wi-Fi with about 1,000 participants. The sharing of one high-speed Internet connection is sufficient to support about 100 connections. About 350,000 residents live within range of a wireless signal belonging to the network. Participants who have an Internet connection donate bandwidth to the network. The software recognizes their routers and computers as "gateways" (or entry points to the Internet) and sends the signals wirelessly to another nearby router or computer. In some Berlin neighborhoods, 100 percent of network members pay for an Internet connection; in other neighborhoods, as few as 10 percent have broadband connections. As a result, the coverage and speed of the network vary throughout Berlin. "It is possible for someone to get

Image credit: Laura Forlana

20 Mbps connection, but it totally depends," said one of Freifunk's founders. "If you live next to someone with a fiber connection rather than DSL, you are lucky."

Since 2003, the **Austin Wireless City Project** (AWCP) and **Less Networks** have led the development of more advanced user interfaces for free Wi-Fi hotspots at coffee shops and restaurants throughout Austin. AWCP was established to improve the availability and quality of public free Wi-Fi in Austin. The organization set out to develop a "free Wi-Fi business model" in the face of paid Wi-Fi hotspots, which had been popping up in the area at various chain establishments, managed by commercial wireless providers such as T-mobile. The Austin airport was among the nation's first to offer paid wireless Internet access to travelers.

The model that AWCP conceived of relied on local businesses to pay for the Internet connection and inexpensive Wi-Fi access points. Less Networks

47 See Laura Forlano, When Code Meets Place: Collaboration and Innovation at WiFi Hotspots. Columbia University, New York, 2008.

provides small businesses with an inexpensive Wi-Fi router ($149 if purchased from Less Networks) and service plan. The service plan includes access to a customizable splash page for users to log into, technical support, security features, and various monitoring and outreach tools to boost the venue's business. Among those features is a weekly report that provides the usage change compared with the previous week alongside historic usage.

Services and Applications

There is tremendous potential for the creation of services and applications that build on municipal and community wireless networks. These include commercial applications such as real-time mapping, games and content portals as well as services intended to enhance e-government initiatives. Depending on the network architecture as discussed above, a municipal or community wireless network may enable local communities to access a range of Intranet services and applications such as Voice over Internet Protocol (VoIP), streaming and web-hosting.

In Greece, the **Athens Wireless Metropolitan Network** (AWMN), which began as a community of online video game enthusiasts, has created dozens of services and applications for its members. These include an auction site Wbay; a search engine Woogle; a channel for user-created content wTube; dating services; movie and music streaming (permitting activities that often violate copyright laws); a directory of postal codes of Europe; weather reports for each Greek island; and webcams that broadcast traffic, among other applications. "In Greece, we are users of services but we are also creators of services," said one of AWMN's leaders. The AWMN network offers members the opportunity to experiment. "The quality of the network depends on the quality of the people," another participant said. "There is a hidden competition among members to make a better service."

Yet, services and applications for wireless networks are still relatively undeveloped. While there has been a lot of experimentation with content portals, there are not any widely deployed user interfaces on which to deliver innovative services and applications. The **Austin Wireless City Project** (AWCP) set out to develop something more than just another "hotspot." Richard MacKinnon, one of the project's early volunteers and the founder of **Less Networks**, and his colleagues envisioned an "enhanced software-hotspot" that would enable a community of users as well as provide the venue itself with useful tools to enhance their business. In the first three months of operation, using open source software to develop a cost-effective solution, Less Networks developed gateway software tool to register users, manage a venue's wireless offering and link the hotspots together. In order to use the free network, users must register by creating a username and password and providing a valid e-mail address. They can also set up a profile page and join the social network, which allows users to interact with other members at hotspots around the world.

Less Networks supports approximately 50 free Wi-Fi hotspots in the Austin area and a total of 217 total in 102 cities and 6 countries. In addition to the cost of the broadband connection and Wi-Fi router, participating businesses pay $25-55 per month to purchase Less Networks' service plan. The service plan includes access to a customizable splash page, technical support, security features, and monitoring and outreach tools. Among these tools is a weekly report of usage statistics and the company's Social WiFi™ product, which integrates the business' Facebook, Twitter, and permission-based email marketing into the end-user experience.

Network Build-out and Operations

The municipal and community wireless networks profiled have financed the build-out and operation of the networks in a variety ways. Their choice of financing methods is often contingents upon the choice of ownership model and goals of the network.

They also vary in their methods for handling day-to-day operations and maintenance. Municipal networks in the U.S. have utilized outside vendors to varying degrees for maintenance, network management and technical support. However, increasingly, they have brought more and more of operational duties in-house in an effort to reduce costs. Ad-hoc community networks often rely on users or a network of committed volunteers to address technical issues and maintain certain segments of the networks.

Financing and Costs

By moving away from the exclusive franchise model and exploring alternative ownership models and open technologies, it is possible to finance and build networks that are far less expensive than those promised by private providers in the early years of municipal wireless projects. While municipal ownership models typically require that cities leverage public funds and resources, community ownership models typically share costs across network members, with each buying their own equipment, as well as private and non-profit network partners. However, networks might also combine these models in the form of a hybrid that coordinates across municipal, business and community partners with each sharing in the cost of building and maintaining the network.

In **St. Cloud** the $2.75 million cost of the network was paid for by the city's economic development fund, while the $500,000 per year in ongoing costs is paid for from the city budget, which is offset by the efficiencies that the network creates for internal city operations. For example, the police and fire departments, building inspectors, and code enforcement officers all use the network to perform their jobs more efficiently by filing reports remotely.

In the case of **Lawrence Freenet**, the network is managed and financed by Community Wireless Communications Co., a for-profit company that was created by Joshua Montgomery, the founder of Lawrence Freenet. Montgomery secured $2.2 million in private capital from 30 investors to fund the build-out and initial operational costs of the network. "We wanted to make sure there was no cost to taxpayers," according to Montgomery. The city of Lawrence made available water towers for the mounting of antennas and equipment at a significantly reduced rate in return for free service to residents below the poverty line. The real operating costs of running the network, which broke even in October 2008, are $24,000 per month with four full-time and four part-time staff. Such a lean operation was achieved only after layoffs of just over 50 percent of the original staff, a decision that resulted in the network breaking even in October 2008.

The **Lompoc** network cost about $4 million to deploy, including the cost of equipment. Richard Gracyk, Lompoc's Wireless Service Administrator, notes, "It is cheaper to deploy a similar network today because equipment costs have dropped and people have learned a lot about deploying these networks." The network was funded from the utility company through user fees and reserve funds. It has annual operating costs of $800,000. The low operating costs are due in large part to the utility eliminating most of its outside contracts.

Community ownership models typically share costs across network members, with each buying their own equipment, as well as private and non-profit network partners.

Wireless Minneapolis was funded through an agreement with the City of Minneapolis and US Internet. The agreements required the City to pay $2.2 million in advance for services and a minimum annual commitment for the first 10 years of the contract to pay no less than $1.25 million per year. Like many similar municipal Wi-Fi projects, there

were significant issues with signal coverage, especially in neighborhoods with many trees and dense foliage. This problem and cost overruns resulted in an additional charge to the city of $1 million.

Vienna's **Funkfeuer,** an ad-hoc community wireless network, allows members to share bandwidth from a 5-GHz fiber-optic link at the University of Vienna, which eliminates the need for them to pay for additional connections to the Internet. Currently, 240 host nodes, while nearly another 200 people have registered to use the network. It costs less than $300 annually to provide bandwidth at speeds up to 35 Mbps to every node in the network. Rather than being anonymous, members are required to register in order to build a node, which costs about $165 for one or two radio links and an omni-directional antenna all of which are mounted on their rooftops. Thus, members in community-owned models typically pay for their own equipment and take advantage of free or inexpensive broadband Internet access.

Achieving financial stability has been a struggle for **DjurslandS.net**. In order to complete the initial network build out, DjurslandS.net needed to raise more than $200,000. When no bank would approve a loan, the network founder organized 10 community boards. Local boards were also charged with collecting subscription fees from subscribers in their own communities. However, some of the local boards refused to turn over the money—even though the umbrella organization had paid for the equipment. By 2004, as DjurslandS.net was quickly expanding it faced a mountain of debt and the staff of 21 was working without a salary. More strife ensued when a commercial ISP approached several local boards, proposing to purchase the infrastructure. Some board members wanted to seize the opportunity for a cash windfall. Ultimately, network participants ideologically committed to the concept of community ownership won out, but the experience spurred network members to enact rules barring future sales.

Operation and Maintenance

Municipal and community wireless networks must be creative and efficient in managing the operation of their networks. Even with subscription fees or user support, most of the networks are operating with razor-thin margins. Most municipal networks have kept down their maintenance costs by keeping much of the day-to-day operation in-house. For example, the staff members of the city of St. Cloud oversee the operation of the network and handle all repairs and radio replacements. As part of the support for the equipment, the city utilizes a remote monitoring service that monitors the operation of the mesh network. It has outsourced customer service. The service will pass questions and issues they cannot deal with to the network operation center. If they cannot handle a question, then it is passed on to the city's IT department.

Unlike municipal wireless networks, the majority of community projects rely on knowledge-sharing among volunteers to maintain the networks. While the majority of volunteers are passively involved, some play a more active role in the ongoing operations of their networks. This builds local knowledge and strong relationships within the community, which contributes to its self-reliance. For example, Denmark's **DjurslandS.net** relies heavily on volunteers who help repair equipment and participate in local board meetings and forums. At the forums, subscribers elect board members, review network finances, and vote on network management principles. "This is why it is a community network, not just a physical infrastructure," the founder pointed out.

Similarly, Greece's **AWMN** uses its Wireless Nodes Database (WiND) to centrally manage and track active nodes and traffic patterns. "WiND also gives people the ability to connect with neighbors… [about] technical problems. It is a community thing," one member explained. AWMN participants also share

knowledge through workshops, seminars and a blog. Austria's **Funkfeuer** requires node owners to be responsible for repairing their own equipment "but if you ask [nicely], someone will help with maintenance," acknowledged the organization's co-founder.

Spain's **Guifi.net** uses a number of tools, including blogs, online forums and e-mail, in addition to face-to-face meetings in order to keep in touch with participants. Like Austria's Funkfeuer, node owners are responsible for maintaining their own antennas, but volunteers are typically willing to come over to assist with repairs. However, for immediate problems, Guifi.net members hire self-employed technicians in the area who earn a living servicing network participants. For example, "If you are a large business like a supermarket, you hire someone who is always available for you to fix a problem," said Guifi.net's leader.

In the Czech Republic, the level of technical support varies from project to project since **CzFree.cz** is an umbrella organization that includes a wide range of local networks such as KlFree.net and KHnet.info. "Some people are very responsible and repair problems right away. Others don't fix the signal," a KlFree.net member said. Online forums are used to help members trouble-shoot common technical problems. KHnet.info also employs two full-time and one part-time worker, who staff a hotline 11 hours per day. "Having our own employees is quite against the idea of community networks, but it was necessary for the development of the network," said KHnet.info's leader. Yet, volunteers are still actively engaged in maintaining the networks, including deploying nodes and repairing problems. "If it isn't working, you ask your neighbor," one project participant said. They rely primarily on word-of-mouth for marketing their networks. "The best method is *Jedna paní povídala*, which means 'one woman said'... new members usually get information from their friends, relatives or neighbors," he added.

Network Management

The regulation and governance of networks includes consideration of the limitations placed on end-users. These limitations include regulation of the types of devices that can be connected to the network and management of traffic and bandwidth.

Some corporate networks attempt to manage traffic by limiting the network to certain types of devices. In contrast, many municipal and community wireless networks are open access, which means that any device can operate on the system and there is no centralized traffic management. Open access networks provide the ability for new applications and services to be developed for use on a network.

However, some networks, such as Austin's **Less Networks**, require users to sign a *terms of service agreement* during the registration process. According to Less Networks, this agreement is necessary to limit the venue's liability for illegal activities and incidents that may damage an end-user's hardware or software. The agreement prohibits the transmission of illegal or obscene material. In addition, specific venues may also request content filtering tools to block specific web pages. Some corporate venues require filtering in order prevent the exposure of obscene material to minors.

Other networks, in particular the community wireless networks, explicitly do not require a terms of service agreement. Instead, they rely on self-regulation to govern behavior. For example, in Greece's **AWMN**, "We have 1,000 administrators in the network. Everybody knows each other's ID and if someone abuses the network, other people push them out. It is a lot safer than the public Internet," said one of the association's officers. While the incumbent telephone company, OTE (Hellenic Telecommunications Organization), bars subscribers from sharing DSL bandwidth, it has never pursued violations of this policy by members of this comparatively small, non-commercial group.

Similarly, Germany's **Freifunk** does not require participants to sign a terms of service agreement, nor are they required to register their nodes. "There is social understanding that accompanies a shared network but no written policy," said the organization's co-founder.

While mesh networks can distribute Internet connectivity from one or more Internet access points across an entire network, bandwidth still needs to be managed. Bandwidth intensive activities like peer-to-peer file sharing can consume disproportionate amounts of bandwidth. Community networks have found solutions to managing this traffic. These can include restricting peer-to-peer file sharing to within the network (rather than across the Internet) or creating ways for network members to limit the amount of bandwidth they contribute to a community network. For example, while it can support any application, **Freifunk** is not suitable for file-sharing because that would render the network practically useless to everyone else. Freifunk's unique routing protocol allows participants to adjust the amount of bandwidth that they want to share with its members. For instance, while online, a participant may want to share 40 percent of his bandwidth; while away from home, he may share 100 percent. "It is important that people have the freedom to decide how much and how often they want to share," the co-founder said.

Austria's **Funkfeuer** is considering implementing stronger security measures capable of preventing spam and viruses, without infringing upon user privacy. "The infrastructure must be protected, but we don't want to inspect traffic," the co-founder said. Ultimately, the solution may not rely on technology. "The trick is to involve everybody in the network. If they helped build it, they will want to protect it," he said. This is the main reason all network users are required to sign the Pico Peering Agreement, a commitment to the basic principles of data transfer across an open access network. Similarly, Spain's **Guifi.net** developed a program that uses a proxy system to avoid traffic bottlenecks. The software generates a web page for each node that illustrates the location, traffic and network links.

Lawrence Freenet is an open access network, allowing consumers to connect any Wi-Fi capable device. They have even developed an authentication process for smartphones that does not require them to log into the service's splash page. Subscribers can bring their phones into the Freenet offices, where someone will enter the MAC address into the system to allow the user to connect automatically when in range of the network. The network management practices of the network do not block or limit specific content. However, the network will discriminate against what are considered "abusive applications," such as when it prevents users from injecting routes into the network and limits the throughput available to users of BitTorrent and other peer-to-peer applications.

Similarly, **Lompoc** is open access for any devices that are compatible up to 802.11G. Although smartphones are allowed on the network, they may not connect well because of the low-power radios in the devices. There are currently no content filters, bandwidth caps, or Quality of Service (QoS) rules, although the network has the tools available for bandwidth shaping. "One of the things we have found is that capacity issues are not bandwidth related, as much as airtime related. It's not the amount of data moving, but the amount of airtime a transmission consumes," Lompoc's Wireless Service Administrator Richard Gracyk noted. Lompoc is working with Tropos on airtime control, including the use of software and hardware that are intelligent enough to facilitate airtime congestion management.

Community Initiatives or Programs

Civic Participation and Public Input

Successful municipal and community wireless

networks integrate public input from meetings, forums, review processes and community impact statements. In particular, community wireless networks offer opportunities for citizen participation in projects that have a positive impact on their communities. Some evidence suggests that community networks mobilize people who would not otherwise be involved in volunteering.[48] Many of the networks described in our case studies are the direct result of individuals solving problems that they identified in their own cities – including providing broadband Internet, getting better access to media or creating community-owned infrastructure.

Public engagement is important for facilitating public support and use of municipal networks. After the city released its business case for **Wireless Minneapolis**, a report from the Minneapolis-based Institute for Local Self Reliance argued for a publicly owned information infrastructure including fiber and wireless.[49] The paper argued the City had not addressed the question adequately. To date, there had been no public meetings, nor public hearings on the initiative or the public ownership option. The only external working group consisted of representatives of the business sector.[50] Later that month, the City Council finally sponsored an open public forum to solicit comment on the Wireless Minneapolis Initiative. Over a dozen people's testimonies supported the City sponsored plan – but only if it included an enforceable community benefits agreement.[51]

After four years of beta testing the **Lompoc** network, the City still was not sure what kind of network it had. Unfortunately, the beta testing did not include a feedback loop for users. "There was no way to assess the end-user experience," noted the wireless service administrator. The utility also handles all customer service at its offices from 8 to 5 PM. Plenty of customers come to the utilities office with connectivity or computer issues. They even do house calls. Similarly, **St. Cloud** held monthly public workshops to explain the network to residents, which the City started holding back in November 2005.

Ad-hoc community wireless networks rely on end-user participation – from simply installing an antenna on one's roof to more active engagement in sustaining the project. For example, Germany's **Freifunk** holds monthly meetings for new members and individual members host smaller meetings for their own neighborhoods. There are also multiple online forums for posting questions and comments. "From my experience, the success of a community-project is much more about social engineering than one might think," said Freifunk's co-founder. Similarly, Austria's **Funkfeuer** also encourages members to attend weekly meetings. A "core" group of about 30 people typically attend the meetings as well as volunteer their skills and time to growing the network. In addition to meetings, members communicate through online forums and e-mail lists.

Digital Inclusion

Digital inclusion has been the impetus behind many

---

48 Alison Powell, "Last Mile or Local Innovation? Community Wi-Fi as Civic Participation." Paper presented at the Telecommunications Policy Research Conference, Arlington, VA, Sept. 29-Oct 2 2006; Catherine Middleton, Graham Longford, and Andrew Clement. "Ict Infrastructure as Public Infrastructure: Exploring the Benefits of Public Wireless Networks." Paper presented at the TPRC 2006: Research Conference on Communication, Information, and Internet Policy, Arlington, VA, September 29, 30, and October 1st 2006. Both available at http://www.tprc.org.

49 *See* "Act Now for a Democratic Information Network in Minneapolis," Institute for Local Self Reliance, December 2005, http://static.newrules.org/info/mplswireless/mplswirelesspacket.pdf.

50 *Id. See also* Aaron Neumann, "Ryback's Great Giveaway: The Selling Out of Public Wi-Fi," *Southside Pride,* February 2006, http://www.southsidepride.com/2006/2/articles/rybak.html.

51 *See* Settanni, "From Conflict to Collaboration," *supra note* 11.

municipal and community wireless projects, especially those in underserved urban and isolated rural communities. **Wireless Philadelphia,** which intends to "enhance economic development in neighborhoods, help overcome the digital divide, and improve quality of life for all Philadelphians," is a good example of some of the challenges and opportunities faced by such projects. Wireless Philadelphia launched its digital inclusion program in February 2007. The program provided computers, training and Internet access through existing agencies using preexisting neighborhood relationships. The organization also partnered with Employment Advancement Retention Network (EARN) Centers, one-stop-shops where people can access a full range of social services.

Lawrence Freenet, a 501(c)3, non-profit, uses 10 percent of its revenues to provide free service to low-income families in the community. Freenet provides 90 percent of qualified low-income residents with free service and equipment, while another 10 percent just pay to rent equipment, including wireless modems that are provided to regular customers. In total, Freenet provides broadband access to over 100 low-income families. In addition, volunteers also help refurbish donated computer equipment to provide to low-income residents. The network also provides free service to the O'Connell Youth Ranch, a boy's residential facility for troubled youth. Previously, the facility could only get access to dial-up. It was going to cost them between $10,000 and $15,000 for Sunflower Broadband to extend cable out to their facility. Freenet came out and set up all three houses and offices with Wi-Fi for free.

The Czech Republic's **CzFree.cz** includes a network that partners with its town government to provide free Internet access in schools and also allows medical providers and social service agencies to use the network free of charge. Another CzFree.cz initiative provides free connections to non-profits as well as several free hotspots for non-members.

Community Benefits Agreements

Community benefits agreements and citizen review boards have been used as ways of ensuring the accountability of network operators. The concept of a Community Benefits Agreement first emerged in a meeting between the Minneapolis Foundation, the Alliance for Metropolitan Stability and the Community Computer Access Network. These organizations worked to develop a larger, more diverse coalition that included new immigrant groups, neighborhood organizations, an independent media organization and community technology advocates.

Community benefits agreements and citizen review boards have been used as ways of ensuring the accountability of network operators.

With input from these community groups, **Wireless Minneapolis** agreed to create and enforce a community benefits agreement and develop seed funding mechanisms for digital inclusion initiatives as integral elements of the contract negotiations process. The Wireless Minneapolis "Digital Inclusion Task Force" (DITF) was established to engage city residents and businesses in developing a community technology agenda. Twenty-nine experts in the field of community technology and technology literacy volunteered their time and expertise in order to develop a report. The report became the basis for Wireless Minneapolis contract negotiations.

Among the report's recommendations were: 1) an ad-supported service option that is free of charge to the public— in addition to the subscription-based service or at minimum subsidized accounts and free service that provides limited, selected community services; 2) 7 percent of gross revenue allocated for a Digital Inclusion Fund; 3) $500,000 up front to support the Digital Inclusion Fund; 4) guaranteed network neutrality, 5) infrastructure for local content

development; and 6) a location-specific portal, as well as a basic website content management system.[52] The final terms of the contract with USI Wireless included almost all of the recommendations.[53]

The above domestic and international examples provide the basis for investment in broadband access for rural and underserved communities in order to bridge the digital divide and include all citizens in the potential for connectivity. What follows is a closer look at the benefits, best practices, future directions, and policy goals that lay the groundwork for closing the local network gap in the United States.

Benefits of Municipal and Community Wireless Networks

Choices made about architecture, ownership and governance can have significant advantages for the sustainability and economic benefits of municipal and community wireless networks. These advantages include cost savings, income generation, increased competition and fostering innovation.

Cost Savings and Competition

One of the primary drivers for municipal and community wireless networks is bringing down the cost of local telecommunications infrastructure for a city and the cost of accessing broadband and communication services. Efficient use of a municipal network can cut costs for governments by making it easier to offer services to citizens or by leveraging the networks for the government's own use to make their internal operations more efficient. For example, in **St. Cloud** the police and fire departments, building inspectors, and other city officials take advantage of the network. The building inspectors use tablet PCs to schedule inspections and file reports remotely, increasing the number of inspections that they are able to perform. In addition, they are about to deploy a new service for the city's sewer and water utility that will provide an automated maintenance management and work-order system. The system will allow employees in the field to remotely report issues and progress back to supervisors.

The city of Lawrence does not use the **Lawrence Freenet** network, except for the water department. As part of Freenet's agreement to use the water towers, the department pays a small monthly fee to carry data back to its facility. At first this was just for a transmitter to tell the elevation of the water, but then Freenet offered to install TCP/IP digital cameras at the water tower sites. The cameras, along with electronically controlled gates, allow operators back at the plant to simply push a button to provide a contractor access to a water tower. The cost savings for the department have been considerable: Sending an employee to the site cost the department upwards of $50 - $60 per visit.

Municipal and community wireless networks can also foster competition in local telecommunications markets. In markets where there is only one telecommunications provider, a municipal or community wireless network can provide much-needed competition. In some communities, isolation or other political factors may mean that the market fails to deliver reasonably priced service. For example, in Canada, France and the UK community wireless networks gave providers the incentive to connect areas previously without broadband, which resulted in lowered communication costs.[54] In these

[52] *See* "Final Report," Wireless Minneapolis Digital Inclusion Task Force, July 17, 2006, http://www.digitalaccess.org/documents/MDITF%20complete.pdf

[53] *See* Wireless Minneapolis History, "Wireless Broadband IP Data Access Network-Term Sheet," Wireless Minneapolis, August 24, 2006, http://www.ci.minneapolis.mn.us/council/2006-meetings/20060901/Docs/WirelessBroadbandTermSheet.pdf.

[54] *See* Alison Powell, "Metaphors and Models for Municipal Wi-Fi" http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1330911

areas, municipal and community wireless networks can respond to market failure and deliver broadband connectivity.[55]

For example, **Lompoc** makes it as easy as possible for customers to sign-up. It offers subscriptions at $15.99 per month (includes a CPE from Pepwave) or short-term subscriptions of $9.99 for 30 days or $4.99 for 48 hours (paid via credit card). It costs utility customers nothing to sign-up, and they can have the $15.99 charge added right to their utility bill.[56] As its wireless service administrator points out, "One of the big differences in the service offerings between the city's network and private providers is no fine print." The short-term options are popular with many contractors who work for Vandenberg Air Force Base or the federal prison, where they are unable to get DSL or cable without long-term contracts.

Municipal and community wireless networks can help bring down the price of Internet access in a number of ways. For example, the use of city infrastructure lowers the cost of leasing locations for Wi-Fi transmitters. In community wireless networks, engaging volunteers in constructing and maintaining the network can cut costs and increase opportunities for civic participation. In addition, network managers often require that participants cover the cost of the necessary equipment such as antennas and routers. While this increases the upfront capital costs for participants, in most cases, their ongoing subscription costs for Internet access are significantly lower. **Guifi.net** discourages village governments from subsidizing or giving away antennas to participants. "It is important for users to understand that when joining the network, they are providers, too," stressed Guifi.net's cofounder. By contributing to the cost of building the network, participants learn to value the infrastructure much more than if they received the equipment for free.

In other community wireless networks, equipment is provided at the wholesale cost, sometimes as part of a digital divide bridging strategy. For example, a number of community wireless projects obtained discounted hardware and leveraged existing capital in order to build their networks. Austria's **Funkfeuer** got 10 Wi-Fi transmitters from a bankrupt wireless ISP. The company agreed to give them the nodes on the condition that the devices would not be used for a commercial network. Suddenly, the activists owned 10 strategically located access points around the city. When the ISP's sister companies also went bankrupt, the activists bought their equipment—including high quality switches and fiber cables—for about $2,700. "We resold the things we didn't need and made a small profit," the network leader said.

3, Fabio Josgrilberg, "Muni-Wi: An Exploratory Comparative Study of European and Brazilian Municipal Wireless Networks." 92. São Paulo, Brazil: Fundação de Amparo à Pesquisa de São Paulo, 2008. Available at: http://www.lse.ac.uk/collections/media@lse/pdf/20080829josgrilberg_muniwifi.pdf; Mark Gaved and Marcus Foth "More Than Wires, Pipes and Ducts: Some Lessons from Grassroots Networked Communities and Master-Planned Neighbourhoods in Proceedings of the OTM 2006 Workshops, 02- 03 November, Montpellier, France. Springer-Verlag.

55 Adam Fiser, TITLE; Amelia Bryne and Andrew Clement. "A Desiderata for Wireless Broadband Networks in the Public Interest." Paper presented at the 35th Research Conference on Communication, Information, and Internet Policy, Arlington, VA 2007. Available at: www.cwirp.org/files/potter_clement_tprc_2007.pdf

56 *See* Utility Department, "Broadband Division," City of Lompoc, http://www.cityoflompoc.com/lompocnet/.

The Czech Republic's **CzFree.cz** was born out of the need to bring down the cost of broadband In the mid-1990s Internet service in the Czech Republic's newly privatized telecommunications sector cost as much as $105 per month and required customers to sign up for five-year contracts. When Linksys began selling wireless routers in 1998, students in Prague got the idea to purchase dial up service and share bandwidth. When then-monopoly operator Cesky Telecom began selling residential DSL service at the beginning of 2003, Czechs upgraded their lines and signal-sharing communities grew exponentially. Today, dozens of Wi-Fi initiatives throughout the country belong to CzFree.cz. One network, the second largest in the Czech Republic with about 25,000 members, charges members a $100 initiation fee plus $17 per month. The cost of broadband Internet connections has fallen to about $60 per month and continues to drop.

Economic Development

In rural and underserved areas, the availability of a municipal or community wireless network can be an essential lifeline for income generation in the region. In these contexts, the cost of Internet access is typically offset by the potential for economic development. By making low-cost bandwidth available to both for-profit and non-profit organizations, these networks can spur innovation and entrepreneurship among application and service providers.

In Denmark's rural Djursland Peninsula, the leaders of **DjurslandS.net** take credit for rescuing the economy. Traditionally, the local economy was comprised mainly of fishing and manufacturing, but today industry has all but vanished from the region. Since the late '90s, the ferry ceased operating, the newspaper folded, the hospital closed and many stores went out of business. The only broadband network that reaches the most rural areas, including the farms and small villages, is DjurslandS.net. Without it, "People would have had to leave the area in order to compete, and only the poor would be left behind," the founder of the initiative said.

Image credit: Susan NYC (Flickr)

"Eventually all residents would be on welfare—there would not be shops, or exchange of goods, or development of roads." DjurslandS.net has created 100 new jobs in each village it serves.

The story is similar in rural Catalonia, Spain, about 75 miles outside of Barcelona, where broadband was expensive and unreliable in the late 1990s. In 2004, technology activists approached local village governments to establish a grassroots broadband initiative. They founded **Guifi.net**, a made-up word signifying that the network should be "real" and owned by the "people". About 23 town councils have Internet access that they share with residents. The initiative has allowed the communities to generate income by telecommuting while saving money on telecommunications and transportation expenses. Many residents throughout Catalonia now work from home, and businesses have opened remote branches. One furniture manufacturer that joined Guifi.net is saving $4,100 a month in telecommunications expenses. In addition, local hog and cattle farmers use Guifi.net for routine tasks, such as transmitting animal test results to veterinarians.

Innovation and Entrepreneurship

Municipal and community wireless networks have proven to be significant sources of local innovation. In particular, these networks have pioneered a wide variety of hardware, software and applications as well as new ways of doing things. These include open source network management tools and mesh routing protocols as well as social networking tools. These networks support new ways of working such as mobile work and co-working, which brings technology entrepreneurs together to share ideas and collaborate.

Mobile work and co-working have emerged, in part, due to the widespread availability of connectivity, including municipal and community wireless networks. Mobile workers describe a variety of reasons why they believe that they are more productive, efficient and inspired when working in Wi-Fi-enabled cafes, parks and public spaces than when telecommuting from home.[57] These spaces, as well as co-working communities like New Work City, reconfigure people and technologies into emergent "codespaces"[58] or "codescapes".[59] By bringing new groups of people together to work side-by-side, they offer opportunities for enhanced creativity, collaboration, innovation and entrepreneurship.

Athens Wireless Metropolitan Network functions as a laboratory for technically minded individuals to develop hardware—such as the antennas and satellite dish feeders used on many of the network's backbone nodes—and to create routing protocols and network management tools. Members use the network to test ideas for new applications. A movie and music streaming application has led to negotiations with an Internet Service Provider to create a video-on-demand service within the network, which would alleviate concerns about copyright violations.

Freifunk's success depends heavily on end-user participation. As many as 60 members with an interest in developing firmware and other technology-related projects are known to drop by the "Hackers Lab" held each Wednesday evening. In fact, Freifunk members are highly active in the global open source technology realm. Its members have optimized mesh routing firmware that wireless community initiatives around the world now use.

As lead users of wireless networking technologies,

---

57 Laura Forlano, *When Code Meets Place: Collaboration and Innovation at WiFi Hotspots*. Columbia University, New York, 2008.

58 Laura Forlano, "Codespaces: Community Wireless Networks and the Reconfiguration of Cities." In *Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City*, edited by Marcus Foth. Hershey, PA: Information Science Reference, IGI Global, 2008.

59 Laura Forlano, WiFi Geographies: When Code Meets Place. *The Information Society, 25*, 1-9, 2009.

participants in community wireless networks are constantly experimenting, testing and improving the hardware, software and applications that they need. It is well-known that lead users (whether they are individuals or firms) are important drivers of innovation in many industries including medical devices, computer hardware and software, and consumer products.[60] This is particularly true among open source projects, which are based on collaborative production among a user community.[61] Community wireless networks have been successful in attracting, amplifying and disseminating the knowledge of lead users, thereby improving the community's human capital and skills. Since the majority of community wireless networks are non-profit, they are not obligated to meet a quarterly bottom-line. Instead, they can take risks and develop entirely new means of constructing and managing networks.

Yet, there are a number of legal and economic barriers to the growth of opportunities for innovation in wireless networking. The most important of these barriers are intellectual property laws and spectrum policy. For example, developers active in creating new protocols for community wireless networks need access to the software codes that run off-the-shelf devices. However, while many technology companies have embraced and integrated the features created by their users, manufacturers of equipment for wireless networking have not developed such partnerships.

Local Communications Infrastructure Best Practices

Over the past decade, cities and communities around the country and throughout the world have experimented with a wide variety of models for building local communications infrastructure. In this report, we have profiled some of the most promising of these municipal and community wireless networks and detailed the technical, economic and social aspects of each project. From this we have gleaned a summary set of best practices that build upon Sascha Meinrath's earlier work. [62]

Design Holistic and Locally Grown Networks

The next generation of municipal and community wireless networks should be collaboratively built, owned and managed by stakeholders including the community, municipality and businesses. This will ensure that the network that is designed and built will truly reflect the needs of the community and the local political, social and economic development goals. Rather than rolling out a turn-key or cookie cutter model of communications infrastructure building, the history, context, values and ambitions of local communities can be integrated into the network. Cities should support public engagement at all stages of the process in order to ensure that networks meet the long-term communication and digital inclusion needs of the community.

This is especially true for the sustainability of municipal networks. Rather than single delivery solutions, cities and communities should plan for multiple, redundant options including fiber, Wi-Fi, WiMax, 802.11n and EVDO, as well as allowing for the incorporation of emerging technologies. Municipalities should support hybrid technologies and multiple uses of the network. For example, a network might be designed to accommodate both public-safety and public-access needs. As Richard Gracyk, Wireless Service Administrator for the

---

60 Eric Von Hippel, *Democratizing Innovation*. Cambridge: MIT Press, 2005.

61 Yochai Benkler, *The Wealth of Networks: How Social Production Transforms Markets and Freedom*: Yale University Press New Haven, CT, 2006.

62 Excerpted in part from Sascha Meinrath, "Success Depends on Public Investment and Civic Engagement: Five Guideposts for the Future of Municipal Wireless." New America Foundation, Washington, D.C., December 8, 2008. Available at: http://www.newamerica.net/publications/policy/success_depends_public_investment_and_civic_engagement

Lompoc network notes, "A network cannot be successful based on any one service. You cannot expect to recoup your money just focusing on subscriptions. You have to look at all facets at what the network can do for you," he said. "Putting on city services was not originally envisioned, nor was it part of the business plan. But, it is now increasingly seen as integral to the success of the network."

Be Realistic About the Costs and Technology

A number of wireless networks profiled in the report faced cost overruns and delays. Much of this was due to overpromising of the capabilities of Wi-Fi and other unlicensed technologies by consultants and hardware manufacturers. For example, Lompoc, like many early municipal Wi-Fi projects, was conceived and constructed by consultants as a turn key package to blanket the city with wireless. When beta testing of the network began in 2005, the network encountered several problems with the coverage. In the next three years, they did a lot of infill, immediately adding another 50 wireless nodes. They also realized that the Wi-Fi signals could not penetrate the stucco exteriors of most of Lompoc's house and thus required the use of customer premise equipment (CPE) or wireless bridges to bring the signal indoors. Similarly, the deployment by USIW in Minneapolis faced significant issues with signal coverage, especially in neighborhoods with many trees and dense foliage. This and other overruns cost the city an additional $1 million.

Realistic cost and uptake estimates are essential to developing and deploying a sustainable municipal network. In Philadelphia, EarthLink had estimated it would spend $10 million to build the network and another $10 million to maintain it for the first 10 years.[63] It expected to sign up at least 50,000 customers at approximately $20 a month, yielding gross revenues of $12 million a year.[64] But the cost to EarthLink to build the network turned out to be close to $24 million to cover 80 percent of the city's households.[65] And despite lowering its rate for its base 1 Mbps service from $21.95 to $19.95, with an introductory rate of $6.95 for six months, no more than 7,000 residents subscribed to the network.[66] Moreover, the sustainability of the networks requires a clear means to support the continued operation and maintenance of the networks. For successful ad hoc community wireless networks, users contribute directly to the build-out and maintenance of the network through the purchase of equipment or an initiation fee and potentially contributing bandwidth or technical assistance. Successful non-profit and municipal models have provided service for a modest fee to most users while offering free service to the most needy in the community.

Further, the public utility model, utilized by Lompoc, offers a sustainable means to provide affordable access to community residents. This differs from St. Cloud's network, where city support of the operational costs was made up through efficiencies gained in its internal city operations. Although the St. Cloud network will still be used for city services, faced with a $1.3 million budget shortfall, the city council voted to eliminate the public portion of the wireless network to save $370,000 in maintenance and operational costs. It is important to note that St. Cloud's initial model for the network was to provide a first tier of slower service for free, and charge for a second, faster tier. However, a Florida law enacted in 2005 placed restrictions on governmental entities providing communications services to its residents and forced the city to move in favor of a completely free service.

63 *Id.* 21.

64 *Id.*

65 Hiawatha Bray, "The trouble with hooking up," *Boston Herald*, August 2, 2009, http://www.boston.com/business/technology/articles/2009/08/02/the_trouble_with_hooking_up/.

66 *Id.*

Choose Open Platforms and Technologies

Closed systems of proprietary hardware, software and services that are tied to individual companies increase costs of municipal and community wireless networks. Cities and communities should embrace open platforms in order to ensure flexibility, interoperability and upgradeability of the networks. Open platforms – including Austin Wireless (Less Networks) and OpenWRT/OLSR (Freifunk and Funkfeuer), which are profiled in this report – will bring down costs and increase robustness while supporting public use and innovation in the creation of new applications. Moreover, open technologies allow cities and users to internalize the management of the network as well as provide a platform for users to innovate.

Embrace Change

Technology innovation is a process of constantly searching and iterating in order to learn what works best. Because of the rapid pace of change, it is not possible to choose a solution and review it periodically. Rather, the network must be constantly improved as new technologies, applications and policies emerge. Successful networks have learned from their mistakes and made the necessary adjustments to business models, deployment strategies, and network policies. Municipalities and communities must prepare for and embrace change by designing flexible models that can adapt to changing conditions.

Future Directions for Municipal and Community Wireless Networks

The case studies profiled in this report illustrate that "civic wireless" is growing as individuals, community organizations and local governments develop ways of making networks serve the public interest. This section outlines the ways in which local wireless networks can take advantage of opportunities to innovate services and applications that build on citizen's use of mobile devices and online social networks. Municipal and community wireless networks have not yet exploited opportunities to develop useful content, services and applications for their communities. With the explosion of portable, Wi-Fi enabled devices including smart phones such as Apple's iPhone and Google's Android phone, music players like the iPod Touch, and gaming systems such as the Sony Play Station Portable (PSP), it is likely that demand for these networks has grown significantly in recent years. As a result, these networks need to be developed and planned with this new generation of devices in mind. Specifically, content, applications and services must be designed to support user log-ins on smaller screens with simpler interfaces.

Further, it is important that municipal and community wireless networks going forward incorporate public input and adapt to changes in user needs and behavior. For example, in New York, 58 percent of Wi-Fi users at cafes, parks and other public spaces are looking to escape the confines of their home or office.[67] Similar trends were observed in other cities.[68] This suggests that municipal and community wireless networks should focus on covering locations where their citizens already spend time and hubs of activity in their cities. Furthermore, citizen participation in these projects can create more enduring social benefits than just Internet access.

Mobile Devices

Mobile users expect the widespread availability of connectivity that are easy to connect to. Municipal and community wireless networks must be designed

---

[67] From Laura Forlano, "Anytime? Anywhere?: Reframing Debates around Community and Municipal Wireless Networking." *Journal of Community Informatics* 14, no. 2 (2008). Available at http://ci-journal.net/index.php/ciej/issue/view/19

[68] Alison Powell and Leslie Regan Shade. "Going Wi-Fi in Canada: Municipal and Community Initiatives." *Government Information Quarterly* (2006)

with the mobile user in mind. Examples of such networks and applications include the community wireless network in Lawrence, Kansas (see appendix), and the development of location-based applications for bicycle rental such as those in Berlin and Paris, where it is possible to see the closest available bicycle on a mobile device.

Social Networks

Less Networks and Austin Wireless City's' wireless network supported the development of a network-wide social network where Wi-Fi users could develop profiles and make recommendations about the local businesses. Although these small, specific social networks are unlikely to compete with large social networks like Facebook or Twitter, it may be possible to develop locally-relevant extensions to these social networks, or to integrate information about local services or government into existing services. Google Map mashups that display user-generated photographs, reviews and local services provide a hint of what is possible in this domain.

Media Content

Several of the case studies provide a model how community wireless networks can act as a backbone for local media. The large number of users who participate in the online forum in Lawrence, Kansas (see appendix), indicates that there is interest and support for a set of alternative community media including radio and online local news. The hundreds of applications found on Athens Wireless Metropolitan Network demonstrate the viability of the networks to serve as hubs for media content. The decreasing cost and wider distribution of mobile technologies provide opportunities to expand such community media efforts to mobile devices as well.

Partnerships and Cooperation

The case studies show that the innovations that happen around community wireless projects are not limited to technical innovations. Community wireless networks demonstrate emergent organizational forms and the ability to create partnerships with existing institutions. Telecommunications service no longer needs to be provided only through privately-owned incumbent operators. Our case studies provide several examples of partnerships between community organizations and governments, including Freifunk, as well as partnerships between non-profits and the entrepreneurial corporate sector, such as Less Networks and the Austin Wireless City project.

They also connect the new possibilities of the technology with new organizational forms. The cooperative buying power of the Czech networks helped to obtain lower bandwidth costs for the networks, which they passed along to users. Such public-community partnerships or "hybrid-public" organizational arrangements[69] seem to provide means of making networks applicable to local situations. They need to be carefully structured to draw on the existing resources in the community. For example, a community with an active business sector and a well-connected institution like a university or hospital could create a three-way partnership whereby the university or hospital could act as an anchor tenant, or donate bandwidth to a free network aimed at stimulating business.

Public Policy Goals for Municipal and Community Wireless Networks

This report advocates for civic broadband as a way of leveraging partnerships and collaborations between different groups working in the public interest, and also as a way of inspiring innovation and entrepreneurship. To achieve success, policies need to change and below we outline the priorities we see for policy advocacy in this space.

[69] Andrea Tapia, Alison Powell and Julio Oritz., "Reforming Policy to Promote Local Broadband Networks." *Journal of Communication Inquiry* (forthcoming 2009).

Remove Legislative Obstacles

Legislation passed in 14 states following Philadelphia's announcement in 2004 continues to hamper the efforts of cities and communities interested in pursuing their own strategies to bridge the digital divide, decrease the cost and increase the value of broadband for their residents. Such laws often require that cities get permission from incumbent telecommunications and cable companies before they pursue plans to build municipal networks. The companies are granted the right to refuse and prevent the city's initiatives from becoming reality.

In many cases, telecommunications and cable companies successfully argued that public spending on city infrastructure was unfair competition to the private sector. This narrowing of the debate has greatly hindered our ability to come up with innovative solutions in the provision of local telecommunications infrastructure. Furthermore, it is unclear why states should seek to place unnecessary limits on local governments, particularly regarding those projects that have the support of residents. By preventing cities from using public resources, states are limiting them from creating their own local strategies that may draw upon both private and public assets, partnerships and models. Several bills were introduced in the Senate and the House of Representatives to ban state or local government from prohibiting "any public provider from providing advanced communications capability or services to any person or to any public or private entity."[70] However, those bills are unlikely to pass, and meanwhile, telecommunication companies continue to pursue municipal network bans in State governments across the country.

Affordable Access to Bandwidth

For much of the past decade, discussions about affordable broadband access have been focused on the so-called "last mile," the connection from the closest point-of-presence (POP) to the home or business. However, there are significant challenges in getting affordable access to the "middle-mile" and backhaul transport to the Internet backbone. Increasingly, access to the high-speed middle-mile links or related infrastructure that carries Internet traffic to the backbone, and the escalating costs associated with transporting traffic among networks, can create substantial barriers to the development of successful municipal and community wireless networks.

As the Federal Communications Commission observed in its report on rural broadband, in rural areas across the country "middle-mile facilities may have insufficient capacity, causing the transmission speed on otherwise adequate last-mile broadband facilities to come to a crawl or stall before the data reach the Internet backbone," and "even when the last-mile provider acquires access to adequate middle-mile facilities, that access may be prohibitively expensive."[71] The increasing cost of transporting traffic from local access networks to the Internet is not just isolated to rural areas. Given the substantial consolidation over the past decade, control of the vital interconnection points and routes in urban and suburban areas, has become consolidated into the hand of a few large telecommunications companies. In addition, deregulation of the "special access" lines in markets across the country is forcing competitive broadband providers (those that do not own their own transport facilities) to contend with excessive fees and unreasonable terms of service by special access providers.[72]

[70] See Community Broadband Act of 2007, H.R. 3281, Introduced in the U.S. House of Representatives, August 1, 2007. *See* also Community Broadband Act of 2007, S. 1853, Introduced in the U.S. Senate, July 23, 2007.

[71] See *See* Bringing Broadband to Rural America, Federal Communication Commission, May 22, 2009, ¶ 114.

[72] *Ibid.* See also Ryan Womack. "No Choke Points Coalition to Combat Special Access Providers."

There is a great need for more transparency with respect to the pricing of bandwidth in the middle-mile. Telecommunication companies do not freely share their pricing or the location of their infrastructure since they argue that it is proprietary data. This makes it very difficult to assess whether unfair prices are being charged to rural Internet Service Providers. More competition in the middle mile is also needed to reduce the price of access to the Internet for municipal and community networks. Both rural and urban/suburban high-speed broadband networks would substantially benefit from having access to alternative backhaul fiber infrastructures, an increase in the number of interconnection points and routes, and improved competition in the middle-mile.

Federal stimulus programs such as the National Telecommunication and Information Administration's Broadband Technology Opportunities Program (BTOP) and the Rural Utilities Service's Broadband Infrastructure Program (BIP) are funding middle-mile infrastructure projects. BTOP has allocated $2.35 billion for Comprehensive Community Infrastructure projects that connect community anchor institutions such as schools, libraries, and healthcare facilities. Among the requirements for the network is offering interconnection to local last-mile Internet service providers (ISPs) at reasonable rates and terms. The BTOP program, along with serious reforms to "special access" pricing and other national efforts to deploy fiber infrastructures – such as leveraging the Interstate Highway System to fund and mandate the installation of conduit and high-speed fiber bundles along all federally-subsidized and direct federal highway projects[73] – are needed to improve access to essential middle-mile facilities and allow municipal and community wireless networks to continually scale up in terms of capacity and speed.

Greater Access to Spectrum

Unlicensed or license-exempt spectrum has been essential to the success of municipal and community networks. However, the current availability of unlicensed spectrum that spurs these networks is largely inadequate. Local providers and communities will need access to additional higher quality, low-frequency spectrum in order to expand coverage areas and improve the quality of service for both fixed and mobile access. More unlicensed spectrum and more effective use of existing spectrum are required in order to provide room for subsequent innovations.

Local providers and communities will need access to additional higher quality, low-frequency spectrum in order to expand coverage areas and improve the quality of service for both fixed and mobile access.

The Federal Communication Commission's (FCC) recent decision to open unused television channels to unlicensed, cognitive or "smart radio" devices could be very beneficial to community and municipal networks.[74] This spectrum has some important advantages to existing unlicensed spectrum in 2.4 and 5 GHz. Wireless signals in TV spectrum can travel greater distances at lower power and better penetrate walls and dense foliage. These propagation characteristics would help to reduce build-out costs in rural areas or areas with dense foliage, potentially eliminate the need for customer premise equipment, and improve connectivity for

BroadbandBreakfast.com, June 23, 2009. Available at: http://broadbandbreakfast.com/2009/06/nochokepoints-coalition-to-combat-special-access-providers/

73 *See* Benjamin Lennett and Sascha Meinrath, "Building a 21st Century Broadband Superhighway," Issue Brief, *New America Foundation*, January 2009, http://www.newamerica.net/publications/policy/building_21st_century_broadband_superhighway.

74 http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-260A1.pdf

mobile devices.[75] However, the Commission is still in the process of deciding how the database that devices will be required to check for open channels will operate. Moreover, continuing debates concerning the protection of other users in the spectrum, such as unlicensed wireless microphone operators offer the potential to eliminate any spectrum availability in the TV band for wireless devices in major cities across the country.

New technologies have been developed that can dynamically adapt to use available spectrum.[76] However, new policies from government are required to better manage spectrum and facilitate these innovative uses.[77] For example, substantial amounts of spectrum allocated to federal agencies are currently underutilized. Opportunistic reuse of the spectrum through cognitive radios would substantially help to expand access to high-speed wireless broadband and increase the pace of wireless technology innovation.[78] Spectrum sharing efforts could be facilitated by adding frequency to the database being developed for the TV band, expanding the purpose of the CSEA Spectrum Relocation Trust to finance the modernization of federal systems to improve performance and facilitate spectrum sharing.[79]

Privacy and Security

Municipal and community wireless networks face important privacy and security challenges, much like other networks. Network operators need to decide whether to allow networks users to be anonymous, as well as what kind of traffic they will permit to travel on their network. Some networks choose to identify users of the network through their e-mail addresses. This approach works only with networks that offer a centralized point of control and can lead to privacy concerns about who has access to the e-mail addresses of users.

Other strategies for balancing network privacy and security on wireless networks attempt to avoid collecting personal information. One such strategy is for network operators to create lists of devices (as opposed to users) that are permitted to access the network. The advantage of such lists (the lists of permitted devices are called *whitelists* and the lists of blocked devices, *blacklists*) is that they provide a way to manage network security with less compromise of privacy.[80]

As networks become more wide-reaching, privacy policies become essential. The Center for Democracy and Technology argues that for location-based services (including those developed by community networks), users need to retain control over information that they collect, as well as how it is used.[81] Such privacy concerns can also impact economic models for community wireless networks, raising questions about the ethics of using the e-mails that network users enter in order to get access to the network as means of sending direct mail. Privacy protection and network security must be

---

75 See Dana Blankenhorn, "Golden Era of Open Spectrum Dawns." Available at http://blogs.zdnet.com/open-source/?p=3064 . (accessed December 9, 2008) See also Benjamin Lennett, Rural Broadband and the TV White Space, New America Foundation, Issue Brief #22, June 2008.

76 See IEEE. 2008. Dyspan 2008: Dynamic Spectrum Access Networks. In, http://www.ieee-dyspan.org/2008/. (accessed December 9, 2008)

77 See Michael Calabrese, "The End of Spectrum Scarcity: Building on the TV bands database to access unused public airwaves" *New America Foundation.* Available at: http://www.newamerica.net/publications/policy/end_spectrum_scarcity

78 See Victor W. Pickard and Sascha D. Meinrath, "Revitalizing the Public Airwaves: Opportunistic Unlicensed Reuse of Government Spectrum," International Journal of Communication, 3 (2009), 1052 – 1084. Available at: http://wirelessfuture.newamerica.net/sites/newamerica.net/files/policydocs/Revitalizing_the_Public_Airwaves.pdf.

79 See Reply Comments of the New America Foundation et al., Federal Communication Commission, GN Docket No. 09-157, November 5, 2009. Available at: http://wirelessfuture.newamerica.net/sites/newamerica.net/files/policydocs/PISC_09-157_COMMENTS.pdf.

80 See Matthew Gast, *802.11 Wireless Networks, 2nd Edition.* O'Reilly, 2005.

81 Center for Democracy and Technology "Location Based Security" Available at: http://www.cdt.org/security/

built into networks. Community networks built with government partners have a particular interest in protecting the privacy and security of their citizens.

Conclusion

This report describes a number of innovative models of successful municipal and community wireless projects. These networks in the United States and around the world demonstrate how non-profit organizations, local governments and citizens can provide for their communications needs through community and municipal control of communications systems. By leveraging the opportunities provided by wireless technology, they can build networks that are cheaper and offer enormous promise for providing connectivity to unserved or underserved communities, groups and individuals.

Municipal ownership models such as public utility and anchor tenancy demonstrate a sustainable means for cities and local government to offer affordable wireless broadband connectivity to residents, while also providing an infrastructure to improve the efficiency of city services. Community ownership models such as the ad-hoc community wireless, non-profit and social entrepreneurship models allow NGOs, entrepreneurs and individuals to collectively build their own networks to bridge the digital divide and create strong community ties. Leveraging freely available spectrum, open software and hardware, and innovative network architectures, these networks are scalable and flexible to cover dense cities like Berlin, mid-sized/small cities such as Lompoc, California, and the rural areas such as the Catalonia region of Spain.

The report and case studies undermine the notion that municipal or community wireless networks have failed. The report provides local government, NGOs, and individuals with clear successes to build upon and refine to develop locally grown networks that fit the specific needs and unique characteristics of each community. With additional access to unlicensed spectrum and continued innovation in open wireless technology, the networks can continue to provide a viable alternative to corporate networks and serve as a platform to bridge the digital divide, empower users and communities, and drive innovation.

Notes on Authors

Laura Forlano, Ph.D., Visiting Fellow, Information Society Project, Yale Law School. Laura Forlano is a writer, researcher and consultant based in New York City. She received her Ph.D. in communications from Columbia University in 2008.
Email: lef45@columbia.edu

Benjamin Lennett, Senior Policy Analyst, Open Technology Initiative of the New America Foundation. Benjamin Lennett holds a master's degree in public policy from American University's School of Public Affairs and bachelor's degree in political science from the University of Florida.
Email: lennett@newamerica.net

Alison Powell, Ph.D., LSE Fellow in Media and Communications, London School of Economics and Political Science. Alison Powell is a writer and scholar. She completed her postdoctoral work at the Oxford Internet Institute and her Ph.D. at Concordia University in Montreal. Email: a.powell@lse.ac.uk

Gwen Shaffer, Ph.D., Postdoctoral researcher in the Bren School of Information and Computer Sciences at the University of California, Irvine. At Irvine her research focuses on telecommunications policy. She received her Ph.D. from Temple University in 2009.
Email: g.shaffer@uci.edu

EUROPEAN NETWORK CASE STUDIES

Freifunk—Berlin, Germany

Prepared by Gwen Shaffer

Soldiers from the German Democratic Republic (GDR) began stacking the first concrete blocks of the Berlin Wall on August 15, 1961. Over the next 28 years, East Germany's neglected telecommunications infrastructure fell into disrepair. Following reunification in 1989, the German telephone company ripped out old copper lines before determining that laying fiber would be prohibitively expensive. As former East German neighborhoods gentrified, these new tech-savvy residents became frustrated at the lack of high-speed Internet access. Within this cultural context the concept for Freifunk—German for "free radio"—emerged. "I moved into this area and, as a computer specialist, I couldn't stand living in a place with no broadband," reported one of the Freifunk's co-founders.

In 2002, he placed antennas on the roof of his apartment building, connecting 35 residents to an ISP. Around the same time, he attended a workshop hosted by members of the British-based group Consume.net, which advocated the idea of putting in place low-cost infrastructure to bypass conventional telecommunications companies altogether. "They talked about making a community network by opening your signals, and I found it very interesting," the Freifunk co-founder recalled. He and a handful of friends began setting up wireless nodes in Berlin and sharing bandwidth. They formalized the effort in 2003, with the goal of creating a highly decentralized network with no ownership. "Freifunk is just a concept, it is not an entity," he said. Due to its mesh architecture, each node host owns an equal portion of the network—a structure that makes it possible for Freifunk to function without hierarchal leadership. While Freifunk members are committed to expanding broadband deployment in Germany, the group's mission is more ideological. The goal is to "spread the word about free Internet access."

Clearly, that message is being heard. As of March 2009, Freifunk had expanded to include about 1,000 mesh nodes in Berlin, blanketing one-tenth of the city in free Wi-Fi. To host an access point, participants may rent or purchase a pre-configured router—which can cost anywhere from $40 to $80—then "reflash" it by downloading the Freifunk firmware from the group's website. Participants who subscribe to an ISP donate bandwidth to the network. In some Berlin neighborhoods, 100 percent of network members pay for an ISP connection; in other neighborhoods, as few as 10 percent of network members own personal broadband connections. As a result, the coverage and speed of the network varies throughout Berlin. "It is possible for someone to get 20 Mbps connection, but it totally depends," the Freifunk leader noted. "If you live next to someone with a fiber connection rather than DSL, you are lucky."

The network is open access, allowing any wireless device to connect to the network and there is no centralized traffic management. Participants are not asked to sign a terms of service agreement, nor are they required to register their nodes. "There is social understanding that accompanies a shared network but no written policy," the co-founder said. While it can support any application—Voice-over-IP or instant messaging, for example—Freifunk is not the ideal network for file-sharing. Downloading the latest movie would consume enough bandwidth to render the network practically useless to everyone else.

Freifunk's unique routing protocol allows node hosts to adjust the amount of bandwidth they opt to share with fellow network members. For instance, while online, a node host may want to share just 40 percent of their bandwidth. While away from home, a user may make all of the bandwidth available. "It is

important that people have the freedom to decide how much and how often they want to share." To bolster network coverage, Freifunk members have installed backhaul nodes with dedicated links—antennas that cover a distance of 200 to 300 meters—on church steeples. Theoretically, 350,000 residents live within range of a wireless signal belonging to the ad hoc network.

Freifunk's success depends heavily on end-user participation. The most passive form of involvement is simply installing an antenna on the roof to support the network's backhaul. At the other end of the spectrum, 5 to 10 percent of participants are "heavily involved" in sustaining the project. As the Freifunk co-founder wrote, "From my experience, the success of a community-project is much more about social engineering than one might think." As many as 60 members with an interest in developing firmware and other technology-related projects are known to drop by the "Hackers Lab" held each Wednesday evening. In fact, Freifunk members are highly active in the global open source technology realm. Its members have optimized mesh routing firmware that wireless community initiatives around the world now use.

Freifunk has no official association with governmental or administrative organizations. At the time of data collection, however, the group was engaged in "interesting discussions" with the city of Berlin, which was planning to establish an open wireless network in the city's commercial corridors and popular tourist destinations. "Freifunk is deployed in residential neighborhoods, but not in the touristy sections," the network co-founder said. Freifunk members are interested in creating a "peering agreement" with city-owned hotspots, a move that would dramatically expand network coverage. While Freifunk does not have a peering agreement with any German ISPs, the network's popularity did convince incumbent carriers to amend their terms of service of agreements and allow DSL bandwidth sharing.

Freifunk has opened doors for participants and profoundly impacted their lives, according to the network co-founder. One volunteer developer received a foundation grant to develop a mesh VoIP telephone system for communities in South Africa. Freifunk participants have been invited to India to share details of the model, while other members have been offered full-time jobs as a result of the skills gained through the network. The co-founder interviewed for this case study met with router manufacturers in Taiwan, in an effort to convince them to sell their devices in developing countries. "I never imagined Freifunk would have this global reach when we started it," he said.

Antennae in Kreuzberg, Berlin. Image credit: am4ndas (Flickr).

The impact can be felt closer to home, of course. The Freifunk leader said he believes the grassroots Wi-Fi initiative has helped shrink the digital divide in Berlin. A broadband subscription in the city costs between $20 and $30. "Few people do not subscribe because they can't afford a high-speed connection—it just is not offered," he said. The co-founder also said he would encourage German officials to stop being "paranoid" about open access points. "It would help a lot" if the federal government dedicated additional spectrum space to unlicensed devices like mesh routers, the Freifunk co-founder said. "We are not competition to ISPs."

DjurslandS.net—Djursland Peninsula, Denmark

Prepared by Gwen Shaffer

In the late 1990s, residents of Denmark's Djursland Peninsula repeatedly asked the incumbent telephone carrier, Tele Denmark, to deploy DSL in their sparsely populated community. "We realized rural people would fall behind if we didn't do something about it," the network founder said. When the phone company declined to expand the network in Djursland, residents pursued alternative means of access. "I negotiated with 35 ISPs in Denmark," the informant added. "ISPs were impressed by our initiative but, one after another, they said building the infrastructure for rural people was too expensive."

As a result, the founder and his computer class students decided to build their own network. Prices had fallen to about $10,000 per access point, and the students were already experimenting with building their own antennas. They bought radios in bulk, at a discount. The village of Glesborg agreed to build a 50-meter high tower, symbolically selling it to the broadband activists for the equivalent of 20 cents. They set up omni antennas on both the tower and on the roof of a sports hall located 1.5 km away. The experiment was successful and created the network's original wireless link. The network founder organized community volunteers to deploy equipment, and DjurslandS.net officially launched in May 2003. The network attracted more than 700 users by fall 2003. At the time of data collection, it had grown to encompass 10 separate broadband networks across the peninsula, with about 8,000 households subscribing.

Unlike "ad hoc" wireless community initiatives, DjurslandS.net plans node deployments and functions as a community-owned ISP. It is a fixed network, with a complex hybrid architecture. Towers are connected to the Internet through fiber, which is leased from various village governments. The towers

Image credit: Gwen Shaffer

require line-of-sight to transmit to 300 strategically located access points in villages throughout the peninsula. Additionally, the 8,000 households that subscribe to the network host nodes created with wireless mesh antennas that operate on the 802.11 standard. DjurslandS.net provides two types of rooftop antennas to project members. A four-way directional antenna—designed by network developers themselves—links to a central radio station. Members must also install a commercially manufactured antenna that covers about 10 km in diameter in all directions.

New members pay a $363 initiation fee, which covers the cost of this rooftop equipment. A portion of the money also gets deposited into a fund for future maintenance of the stationary access points. In addition, members are charged a monthly subscription rate of $17 per month. Node owners are responsible for repairs to their own rooftop mesh equipment, although technical support is available over the telephone and via online forums hosted on all 10 network portals. When DjurslandS.net first began growing, its founder convinced an ISP to provide 60 DSL

Unlike "ad hoc" wireless community initiatives, DjurslandS.net plans node deployments and functions as a community-owned ISP.

connections for $10,000 per month. "All over Djursland, we got bandwidth sharing," the founder said. In May 2005, the new 802.11a standard reduced bottlenecks in the wireless infrastructure, making it possible to cancel the DSL connections and save thousands each month.

Speeds vary slightly depending on the geographic location of the user, but 10 Mbps (for both uploading and downloading) is typical. DjurslandS.net employees remotely manage the traffic, similar to the kind of administrative control exercised by commercial ISPs. "We know if a node is down and send an e-mail or SMS to those who are responsible for fixing it," the founder said. Danish law requires DjurslandS.net to maintain records of network traffic. "We have to make this information available if the government requests it, but we don't look ourselves," he added.

Achieving financial stability has been a struggle. In order to complete the initial network build out, DjurslandS.net needed to raise more than $200,000. When no bank would approve a loan, the network founder organized 10 community boards. Local boards were also charged with collecting subscription fees from subscribers in their own communities. However, some of the local boards refused to turn over the money—even though the umbrella organization had paid for the equipment. By 2004, DjurslandS.net was quickly expanding and it faced a mountain of debt. The staff of 21 was working without a salary. More strife ensued when a commercial ISP approached several local boards, proposing to purchase the infrastructures. Some board members wanted to seize the opportunity for a cash windfall. Ultimately, network participants ideologically committed to the concept of community ownership won out, but the experience spurred network members to enact rules barring future sales.

DjurslandS.net relies heavily on volunteers to sustain it. While a majority of subscribers are "passively involved" in the network, others help repair equipment and regularly attend meetings run by local boards. DjurslandS.net also hosts an annual forum for the entire peninsula. There, subscribers elect new board members, publicly review financing details, and vote on the basic principles for network management. "This is why it is a community network, not just a physical infrastructure," the founder pointed out.

Thanks to private investors and a grant from the European Union, DjurslandS.net has settled its debts, and additional nodes are constantly being deployed. Still, the network's eight full-time staff members do not receive full-time salaries. "I always build on a Robin Hood economy—I take from where there is money and give to where it is needed. I give a salary if it is needed, and others don't take it," the founder said. While expanding digital inclusion in rural Denmark is the primary mission of the project, DjurslandS.net does not offer reduced fees for low-income residents. However, subscribers can opt to pay the initiation fee in monthly installments, rather than paying $363 up front. The network is also enabling more residents to get online through free hotspots. In 2008, DjurslandS.net deployed 30 Wi-Fi access points in Grenaa, the "big" town on the Jutland peninsula (speeds are capped at 256 Kbps, up and down, for users who do not subscribe to the network). Similar hotspots are planned for the rest of Djursland, as well.

Network leaders take credit for rescuing the economy in rural Jutland. Farming, fishing and manufacturing traditionally comprised the core of the economy there. Today, industry has all but vanished from the region, while former agricultural and fishing communities rely heavily on tourism. Since the late '90s, the Grenaa ferry to Sealand ceased operating, the *Daily News Djursland* folded, the Grenaa Hospital shuttered, and many stores went out of business. While 15 broadband ISPs now operate in the region, only DjurslandS.net reaches the most rural areas, including the farms and smallest villages. Were it not for the existence of a

community-run broadband network, "people would have had to leave the area in order to compete, and only the poor would be left behind," the founder of the initiative said. "Eventually all residents would be on welfare—there would not be shops, or exchange of goods, or development of roads." He credits the network with creating 100 new jobs in each village, citing a printing press in Grenaa and tourist attractions that now subscribe to the network. His goal is to connect half of Djursland's 82,000 residents. "This is not an end—this is just a beginning," he said.

Athens Wireless Metropolitan Network—Greece

Prepared by Gwen Shaffer

In 2002, high-speed Internet access was unavailable in many parts of Athens. Where the incumbent phone company did offer DSL service, it was slow and expensive. A group of about 10 friends from a popular technical web forum became frustrated by the situation. They capitalized on their technical know-how to link their computers and share bandwidth. The nature of the network quickly shifted from one focused on digital inclusion to a tool for social networking and skills building. Since then, members of the Athens Wireless Metropolitan Network (AWMN) have created dozens of services and applications that reflect their personal interests and are available to participants exclusively.

AWMN did not emerge as an effort to expand broadband access in underserved communities. In fact, network members are exclusively "technical guys," one long-time participant said. "Installing the routing software is complicated so all the people connected to our network have technical knowledge." He estimated that about 30 percent of people who attempt to connect to AWMN actually succeed in doing so. Of the network's 3,000 members, most are in the Athens region. However, strategically located access points—typically placed on the sides of mountains—link the network to emerging Wi-Fi projects on the islands of Euboea, Aegina and Salamina. Several universities allow AWMN to connect similar wireless network from other regions in Greece, including the cities of Thessalonika and Parta) through their backhauls. "They want their students to get into the routing and they see the network as a real-world learning opportunity for them," one member explained.

AWMN functions as a laboratory for technically minded individuals to develop hardware—such as the antennas and satellite dish feeders used on many of the network's backbone nodes—and to create routing protocols and network management tools. Members use the network to test ideas for new applications. These applications mirror sites found on the public Internet: for example, the auction site Wbay; the search engine Woogle; user-created content shown on wTube; dating services; a directory of postal codes of Europe; weather reports for many different areas of Athens; and webcams that broadcast traffic, among other applications. A movie and music streaming application has led to negotiations with an Internet Service Provider to create a video-on-demand service within the network, which would alleviate concerns about copyright violations. "In Greece, we are users of services but we are also creators of services. We are activists—we don't just complain about technology, we do something about it," one network leader commented.

Image credit: g7ahn (Flickr)

One-third of AWMN participants have installed mesh "backbone nodes" on their rooftops. These antennas talk to one another and serve as the primary infrastructure for the network. The other 2,000 members are referred to as "clients" who simply install the network's routing software. These participants connect to backbone nodes but do not extend the signal any further. Most clients eventually upgrade their nodes to backbones in order to obtain faster connections—with speeds up to 130 Mbps—which requires an investment of about $1,300 worth of wireless equipment.

The network is governed by a legally recognized association, with new officers elected every two years. Fewer than 10 percent of network users pay the $70 annual fee required to join the association. Still, members of this association comprise the most active teams. They are credited with developing new software protocols, installing strategic nodes, and hosting workshops and "Antenna Fests." Beyond membership dues, the association raises money through fundraisers, such as a recent auction. Advertising on the network is frowned upon. The association's annual budget—less than $14,000—is used to build strategic nodes and to cover expenses of running four main servers that centrally manage the network using the Wireless Nodes Database (WiND). This program, developed by AWMN members, details the position of active nodes, tracks traffic patterns, graphs the line of sight between nodes, and makes it possible to search for nodes. "WiND also gives people the ability to connect with neighbors and to get instructions for technical problems. It is a community thing," one member explained.

Network members are not required to sign a terms of service agreement, and those interviewed for this case study insisted such a policy is unnecessary due to self-regulation. "We have 1,000 administrators in the network. Everybody knows each other's ID and if someone abuses the network, other people push them out. It is a lot safer than the public Internet," an association officer said. While AWMN does not promise service or a minimum connection speed, members reported that the network architecture ensures its reliability. "There are always alternative routes, creating redundancy of services," this same officer said. A single node may get bandwidth from four or five other access points, and a majority of network participants subscribe to an ISP. While the incumbent telephone company, OTE (Hellenic Telecommunications Organization), bars subscribers from sharing DSL bandwidth, it has never pursued violations of this policy by members of the comparatively small, non-commercial AWMN.

Leaders of this wireless community initiative said they perceive the digital divide to be a marginal problem in Greece because the quality of DSL throughout the country has improved dramatically over the past few years. Despite the fact that the phone company has no competition—there is no cable Internet service in Athens and a fiber network is under construction—the price-point for DSL has dropped to $20 per month. So it is not surprising that, traditionally, digital inclusion has been a peripheral concern for community mesh participants in Athens. Recently, however, network leaders began developing plans to deploy free hotspots around Athens. Non-members will be able to use the connections after creating guest accounts, and existing members will be one step closer to ubiquitous connectivity.

Leaders of this wireless community initiative said they perceive the digital divide to be a marginal problem in Greece because the quality of DSL throughout the country has improved dramatically over the past few years.

AWMN has gained a national reputation. Greek regulators have turned to network members for advice related to federal telecommunications policy. Additionally, participants have made an effort to forge partnerships with the academic community in Athens. They hope these relationships will lead to opportunities for collaboration—in particular, joint development of more efficient routing protocols. Currently, AWMN uses BGP. It also runs OLSR, but this protocol is "too noisy" to be applied to the entire network. To avoid latency, network developers have broken it up into "independent confederations." As one software developer noted, "For our needs, we need a new protocol…right now, we are using the best of what exists."

CzFree.cz—Czech Republic

Prepared by Gwen Shaffer

After 41 years of communist rule, the peaceful "Velvet Revolution" allowed Czechoslovakia to revert to a liberal democracy in November 1989. Three years later, the country split into the independent Czech Republic and Slovakia. The Czech Republic swiftly privatized 2,700 state-owned firms, ranging from banks and hotels to manufacturing. Newly under corporate control, the telecommunications system charged prices beyond the means of the typical Czech household. In the mid-1990s, Internet subscriptions cost as much as $105 per month, and required customers to sign contracts committing them to as many as five years of service. When Linksys began selling wireless routers in 1998, students in Prague got the idea to purchase dial-up service and share bandwidth. In time, word got around about sharing, and more projects sprung up based on a similar concept. Because these residential subscribers were not selling service commercially, incumbent ISPs could not penalize them for violating terms of service agreements.

When then-monopoly operator Cesky Telecom began selling residential DSL service at the beginning of 2003, Czechs upgraded their lines and signal-sharing communities grew exponentially. Today, dozens of Wi-Fi initiatives throughout the country belong to the umbrella organization CzFree.cz. These ad hoc broadband projects support an array of applications: web hosting, e-mail, VPNs, anti-virus software, game servers, Voice-over-IP and IP-TV. Although CzFree.cz is loosely organized, most participating networks have agreed to peer—or seamlessly transmit data over their infrastructures—and consequently create a de facto nationwide grassroots network with two key benefits. First, interconnectivity greatly improves the flow of data files. Second, individual networks gain leverage when negotiating bandwidth prices with ISPs.

KlFree.net in Kladno, about 25 km northwest of Prague, is the second largest community Wi-Fi network in the Czech Republic with about 25,000 members. It has evolved from all wireless signal sharing to 75 percent of participants directly connected to fiber. KHnet.info in Kutná Hora, about 87 km southeast of Prague, began when a group of friends who worked in IT realized they could save money by sharing a single Internet connection. Since February 2003, this initiative has grown to include 120 mesh nodes and one direct gateway to the Internet. More than 2,050 households pay $18

Image credit: Ondra Soukup (Flickr)

per month to subscribe to the network. These fees, along with loans from members, have enabled KHnet.info to invest about $750,000 in infrastructure, according to a network leader. The third initiative included in this case study is Spojovaci.net, in the city of Prague. Spojovaci.net includes 200 mesh nodes and 5,000 members. "We started out using Pringles cans because a real antenna was too expensive," an active member of the Wi-Fi project reported. Today, participants spend about $188 to mount open source antennas on their roofs and purchase Wi-Fi cards and cables—then take advantage of free Internet access.

"CzFree.cz is a vision—not a legal entity," stressed a Kladno.net leader. This helps explain why CzFree.cz

projects are established as non-profit associations, as opposed to competitive ISPs. These organizations each have their own board members and unique fee structures. For example, KlFree.net members are charged the same rate whether their connections are wired or wireless because they are paying to join the association "and *just happen* to get Internet access as a benefit," an active KlFree.net participant reported. Members of his network pay a $100 initiation fee, plus $17 per month. Spojovaci.net's monthly board meetings are open to all network members who wish to attend. Similarly, KHnet.info participants elect a seven-member commission every three years, and the membership keep up with new developments through updates posted to a website and a blog.

The level of technical support provided by CzFree.cz networks varies from project to project. "Some people are very responsible and repair problems right away. Others don't fix the signal," a KlFree.net member said. Both this network and Spojovaci.net host online support forums to help members trouble-shoot common technical problems. KHnet.info has a more comprehensive approach—this grassroots Wi-Fi initiative employs two full-time and one part-time worker, who staff a hotline 11 hours per day. "Having our own employees is quite against the idea of community networks, but it was necessary for the development of the network."

Still, volunteers remain the glue that holds together KHnet.info and other community networks in the Czech Republic. A long-time member of KlFree.net said he devotes more time and mental energy to the project than to his professional job. The president of Spojovaci.net reported spending three hours each evening dealing with administrative and technical aspects of the initiative. All three Wi-Fi communities in this case study rely on volunteers to help with the physical deployment of nodes and with repairing problems. "If it isn't working, you ask your neighbor," one project participant said. Additionally, all three networks characterized word-of-mouth as their primary means of marketing. "The best method is *Jedna paní povídala (one woman said)*, which implies new members usually get information from their friends, relatives or neighbors, who are involved."

Among CzFree.cz projects, the methods established for assessing fees range from "a few guys collecting money from their neighbors" to automated billing systems that cut off bandwidth to delinquent accounts. Connection speeds vary, as well. The fastest upstream speeds are 5 Mbps, with slower speeds for Wi-Fi connections traveling in the unlicensed 2.4 GHz, 5.4 GHz, 5.7 GHz bands. The projects in this case study all host websites displaying maps that show available nodes. They also have software to manage traffic, control spam and detect viruses. KHnet.info administrators use bandwidth shaping to prevent any one member from "taking over the whole Internet connection," the network leader reported.

Several of interviewees said they are convinced CzFree.cz is impacting incumbent broadband providers.

Several of interviewees said they are convinced CzFree.cz is impacting incumbent broadband providers. For instance, ISPs peer with KlFree.net to avoid the expense of routing traffic around the grassroots network. In addition, the cost of a typical DSL subscription has fallen to about $60 per month and continues to drop. Even so, digital inclusion remains a key tenet of many ad hoc wireless projects in the Czech Republic. KlFree.net partners with its town government to provide free Internet access in schools. It also allows medical providers and social service agencies to use bandwidth free of charge. Similarly, KHnet.info offers free connections to non-profits.

Funkfeuer—Vienna, Austria

Prepared by Gwen Shaffer

In opposition to a proposed Internet data retention law, online privacy activists set up a single Wi-Fi hotspot near Vienna's Museum Quarter in 2003. They intended only to make a political statement, but their efforts evolved into a far broader initiative. In fact, the temporary stunt led the activists to consider long-term uses for wireless nodes, which were new on the market at the time. They had a vague idea "to create an experiment open to anyone who wanted to participate," reported one of the original co-founders. But the idea actually gelled when they read about a wireless ISP that had gone bankrupt after investing in 10 Wi-Fi transmitters. The company agreed to give away the nodes on the condition that the devices would not be used for a commercial network. Suddenly, the activists owned 10 strategically located access points around the city. When the ISP's sister companies also went bankrupt, the activists bought their equipment—including high quality switches and fiber cables—for about $2,700. "We resold the things we didn't need and made a small profit," the network leader said.

In late 2003, the co-founders of Funkfeuer hosted a public meeting where they recruited additional volunteers to help create a mesh network in Vienna. Funkfeuer has grown to include 400 registered users, all of whom have downloaded and installed Funkfeuer's routing software. "We don't want an anonymous network. You should register and build a node to help neighbors downstream," the co-founder said. Among these Funkfeuer participants, 240 also host nodes. These members make an up front investment of about $165 to place one or two radio links on their rooftops, as well as one omni-directional antenna. The fastest speed individual users can expect is about 35 Mbps. "The best motivation for people to build good links is so they have good capacity themselves," the Funkfeuer leader said. Node owners are responsible for repairing their own equipment, "but if you ask friendly, someone will help with maintenance," Funkfeuer's co-founder acknowledged.

Image credit: www.vix.at

Funkfeuer owns a 5-Gbps fiber-optic link to the Vienna Internet Exchange, a peering facility at the University of Vienna. Members share that bandwidth, eliminating the need to contribute personal ISP connections to the network. Funkfeuer spends less than $300 annually to provide bandwidth to every node in the network. As well, participants rent a building across the street from the Vienna Internet Exchange and have transformed the cellar into a co-location center. The facility provides "housing" and bandwidth for servers that belong to non-profits and businesses, for a fee slightly below market rate. The revenue from the co-location center helps support Funkfeuer's current needs and ensures long-term sustainability.

Funkfeuer's former status as a commercial ISP qualifies it as a voting member of the Internet Service Providers Austria. As a member of this industry association, Funkfeuer is eligible to purchase public Internet Protocol (IP) addresses. An annual grant of about $2,800 from the city of Vienna, as well as individual donations, help cover the cost. (By contrast, community broadband initiatives typically assign private IP addresses, which cannot be routed through the public Internet.) Funkfeuer does not display advertising on a splash page or on its website, but the group does run Google ads on a wiki used for archiving technical documents. The ads generate about $42 per month—just enough to pay for the electricity consumed by one network server.

Despite membership in the ISP association, the Funkfeuer co-founder insisted the initiative poses no threat to the incumbent carrier. "It takes determination to build a node. Telecom Austria realize most people are content to pay [$35] each month for Internet," he said. However, the network leader noted, Telecom Austria is buying up small ISPs—making the remaining competitors nervous and "forcing them to fight for every customer." As a result, Funkfeuer has experienced "some negativity from them," he added. Still, Funkfeuer is partnering with a small ISP that is laying fiber in Vienna.

In fact, the Vienna network is among the most active European Wi-Fi initiatives in terms of programming and developing protocols. At the time of data collection, developers were testing "a more user-friendly firmware," which they hoped would attract new members. In order to increase network signal reliability, Funkfeuer is also building a 5-Gbps ring around city and beginning to lay fiber. Currently, the longest links are about 30 km apart, but this new static network will extend the main uplink to all of Vienna. "It will allow people to connect more directly and with fewer hops. If one guy in the middle failed to build a proper node, the signal will still get transmitted," the Funkfeuer leader said. At the same time, some network members are shifting their focus away from software development and toward policy. Following the lead of media activists in the United States, they founded a group that is lobbying the European Union to make additional unlicensed spectrum available. "Once we have that property, we can build totally scalable networks with multiple fiber uplinks," the Funkfeuer informant noted.

At the time of data collection, network leaders were struggling with how to implement stronger security measures capable of preventing spam and viruses, without infringing upon user privacy. "The infrastructure must be protected, but we don't want to inspect traffic," the co-founder said. Ultimately, the solution may not rely on technology. "The trick is to involve everybody in the network. If they helped build it, they will want to protect it," he said. This is the main reason all network users are required to sign the Pico Peering Agreement, a commitment to the basic principles of data transfer across an open access network. Funkfeuer members are also encouraged to attend weekly meetings, during which information about new hardware and software is presented. A "core" group of about 30 people typically attend the meetings, as well as volunteer their skills and time to growing the network. Not all these active members are professionally involved in computer technology. In fact, they include lawyers, a heart surgeon, construction workers, journalists and a dentist. In addition to meetings, members communicate through online forums and e-mail lists.

The Vienna network is among the most active European Wi-Fi initiatives in terms of programming and developing protocols.

Some of the greatest challenges faced by community networkers are not technical but, rather, "centered around social dynamics," the Funkfeuer co-founder said. The initiative has an "official" president, but most decisions are made according to consensus. "Everybody in the core team gets a strong voice and we try to maintain a flat management structure," he said. This informant would also like to see more collaboration between Funkfeuer developers and academic researchers. To that end, the University of Vienna is undertaking a project to analyze the network's routing data. Finally, this Funkfeuer co-founder said he would like to see a team of "talented programmers" develop an open source platform that combines the best features of "all the software and tools" developed by community networks throughout Europe. "Why keep repeating mistakes?" he asked. "We need a reusable platform for all the groups."

Guifi.net—Catalonia, Spain

Prepared by Gwen Shaffer

Since the late 1990s, Spanish incumbent carrier Telefónica has offered DSL in some parts of rural Catalonia, Spain—about 75 miles outside of Barcelona. However, the service was expensive and unreliable. A few "hackers" living in the community had experimented with creating wireless communities as an alternative, but their efforts failed to attract critical mass. In 2004, a technology activist conceived the idea to establish a grassroots broadband initiative by attracting entire village governments, as opposed to individuals. He and the other co-founders made up a word, Guifi.net, to reflect their belief that the network should be a "real thing," owned by the people.

Five years later, Guifi.net has grown to encompass 11,300 nodes and handles about 2,000 terabytes of data annually. About 23 town councils subscribe to an ISP, in turn sharing bandwidth with residents via a wireless backhaul. These local governments install $130 antennas on street lamps and roofs throughout their villages, and each of these access points has the capacity to support 30 Internet connections. With an average population of 2,000 to 3,000 residents, it costs local governments slightly more than $4,000 to deploy nodes throughout an entire village. In order to connect to the signal, individual residents and businesses purchase rooftop antennas. Guifi.net recommends equipment but, because it is an open access network, participants choose mesh devices based on their budgets and needs.

A genuine demand for reliable Internet access in rural Catalonia served as the driving force behind the project. "If we don't have Guifi.net, I'm not even able to live here," the network's founder said, pointing to his need to work from home when it is not possible to make the 90-minute drive into Barcelona. The ability to run Internet applications ranging from Voice-over-IP to surveillance cameras has benefited local economies throughout Catalonia.

Like the network founder, many residents now work from home, and businesses have opened remote branches. Local hog and cattle farmers also rely on Guifi.net for routine tasks, such as transmitting animal test results to veterinarians. Rather than paying an ISP for a 20 Mbps symmetrical line, one furniture manufacturer made an up front investment in Guifi.net and is now saving $4,100 each month in connectivity costs.

In addition to technology needs, ideology plays an important role in sustaining the grassroots network. "The way the Internet has evolved, it is owned by the telecos. So we are trying to extend Internet neutrality to the edge by providing an alternative to the ISPs," the Guifi.net founder said. For this reason, Guifi.net leaders discourage village governments from subsidizing or giving away antennas for residential participants. "It is important for users to understand that when joining the network, they are providers, too. You can't be opportunistic if it is going to work," he stressed.

In 2008, Guifi.net won Spain's National Telecommunications Award, accompanied by $21,000 in cash. Guifi.net used this money to establish a foundation meant to help develop open, free networks around the world. (Participants have already provided guidance on community wireless projects in India and Africa.) In contrast to the foundation, Guifi.net itself is not an organization

but "a concept," the founder said. Members are jointly responsible for managing the network, with individuals taking on a variety of roles—including the development of open source software. A program developed "over thousands of hours" uses a proxy system to avoid traffic bottlenecks. Additionally, the software generates a unique web page for each node in the network. These pages identify the location of the node and analyze the amount of traffic passing through it during the past 24 hours, week or year. The mapping software also illustrates which nodes are linked to one another.

In addition, the Guifi.net model relies on volunteers to present information about the initiative to potential members. "We call this the wheel because it turns on and, if we do it right, creates momentum," the network founder said. In fact, public presentations describing the necessary equipment, time commitments and costs associated with joining are Guifi.net's most important recruiting tool. "At the beginning, it was difficult to introduce the idea. Local governments assumed the bandwidth must be pirated because it was free. But, now, it is like the domino effect—we just show the traffic map and they can see the network works," he said. Once a village purchases equipment, Guifi.net members attempt to deploy the nodes within six months. This is to ensure residents remain "motivated" and "optimistic" about the community broadband initiative. "Then it is up to the villages to keep the wheel turning by hosting their own meetings and recruiting more neighbors to extend the network," the leader explained.

Beyond face-to-face meetings, Guifi.net organizers keep in touch with participants through online tools such as blogs, forums and e-mail. Individual node owners are responsible for maintaining the antennas on their own rooftops. However, volunteers are typically willing to come over and assist with repairs. In order to resolve a connectivity problem immediately, though, Guifi.net members are likely to hire one of the self-employed

Guifi.net installation. Image credit: http://guifi.net/node/18907.

technicians in the area who now earn a living servicing network participants. "If you are a large business like a super market, you hire someone who is always available for you to fix a problem," the initiative leader said.

Guifi.net has exceeded the expectations of its founders by most measures. For instance, in 2007 a group of urban broadband activists began expanding Guifi.net into the city of Barcelona—increasing both its national profile and its utility. Long-time members are also proud to have shared networking knowledge with residents of developing countries, thus helping to close the global digital divide. However, Guifi.net is "failing" by two key measures, according to the initiative's primary founder. One of the biggest challenges is reducing the network's reliance on public funds, which may not be available in the future. He is also disappointed that ubiquitous connectivity in rural Catalonia remains elusive. This is because Guifi.net is growing "like a

spot of oil," with access points densely concentrated in areas that lack connectivity to one another. Uneven coverage is also evidenced by the fact that bandwidth speeds vary from 1 Mbps to 20 Mbps, depending on the number of nodes in a particular area.

In response to this reality, Guifi.net members are planning to deploy a fiber infrastructure, following the same open model used for its wireless network. Rather than fiber to the home, the connections will originate from the homes. Transmission speeds are expected to exceed 1 Gbps. Assuming Spanish regulators approve the build-out, the network will remain free and open for everyone who financially contributes to the infrastructure. "I think it is an exciting moment if we can start deploying fiber connections in an open format," the Guifi.net founder said.

UNITED STATES CASE STUDIES

Austin Wireless City Project and Less Networks

PREPARED BY BENJAMIN LENNETT

In 2002, an ad-hoc coalition of volunteers from Austin Wireless User Group, small technology companies, the local community technology center, AustinFree.net and EFF-Austin began to take shape around an effort to bring free Wi-Fi to Austin.[82] The city was fertile ground for such efforts as it was home to more than 80 wireless networking start-ups. Among the early volunteers and enthusiasts was Richard MacKinnon, whose employer, a high-tech networking start-up, served as an initial stakeholder and corporate sponsor of the initiative. The stakeholders and user groups eventually merged to create the Austin Wireless City Project. The Austin Wireless City Project (AWCP) was established as a non-profit group to improve the availability and quality of public free Wi-Fi in Austin and set-out to develop a "free Wi-Fi business model." The model they conceived relied on local business venues to pay for the Internet connection and an inexpensive Wi-Fi access point. AWCP would provide the volunteer labor to install and maintain the community wireless hotspot network.

MacKinnon and others envisioned an "enhanced software-hotspot" that would create a community of users as well as provide the venue itself with useful tools to enhance their business. Although it was clear there was a free Wi-Fi business model, it was unclear who would pay for the gateway software needed to manage the Internet connection and the use of the network. MacKinnon felt that non-profit and volunteer organizations could typically not afford such software. As a solution, he formed Less Networks, a company that would give gateway software away for free to these organizations, subsidized by selling the software to venues outside of Austin. The company began as 10 Wi-Fi enthusiasts, "more resembling a garage band than a corporation." To develop a cost-effective solution, the company relied heavily on open source software such as Linux, Apache, MySQL, Perl, NoCatAuth and PostNuke. To run the gateway software, venues needed a dedicated PC, but because the hardware requirements were so low, a used PC would suffice. AWCP solicited the local community for donations of used PCs and before long had more donations than they needed.

The first hotspot came online in April 2003. In the first three months of operation, AWCP's network extended to more than a dozen restaurants, coffee shops and bookstores in Austin and registered more than 1,500 users. Although some of the stakeholders in AWCP had jobs in the city, at first the project did not engage directly with the city of Austin. They were then invited to meet the CIO of the city who asked how the city could get involved. This resulted in deploying hotspots in all 22 of the city's libraries and in four downtown squares.

Meanwhile, MacKinnon was looking for ways to make the project more efficient and spur expansion of the Austin Wireless model. Normally, incumbent providers have not been favorable towards community wireless or municipal projects. However, because the AWCP model increased the uptake of broadband services by small business, it was not seen as a competitive threat by the incumbent provider. Time Warner, the local cable franchise, was an early partner in the project, co-branding at Austin venues. Less Networks partnered with Time Warner to market and sell wireless routers with Less Networks software for $20 to local businesses.

[82] Unless otherwise noted the case study is based upon a phone interview with Richard MacKinnon, CEO of LessNetworks conducted by the author on May 15, 2009.

In addition to the cost of the broadband connection and Wi-Fi router ($149 if purchased from Less Networks), participating businesses pay $25-55 per month to purchase Less Networks' service plan. The service plan includes access to a customizable splash page for users to log into, technical support, security features, and various monitoring and outreach tools to boost the venue's business. Among those features is a weekly report on usage that provides the usage change compared with the previous week and compared with historic usage.

The networks are open and free to all users of the establishment. Users must register with Less Networks, where they create a user name and password and provide a valid e-mail address. Users then have the option to create a profile page and join the Less Networks social network, where they can interact with other users at hotspots around the U.S. and the world. Less Networks has 25 free Wi-Fi hotspots in the Austin area, with 217 total hotspots in 102 cities and 6 countries.[83] Over 400,000 unique users have logged into a Less Network hotspot.

All users are required to accept a Terms of Use statement when signing up. The Terms of Use statement is necessary to limit the liability of the venue and Less Networks. It explicitly prohibits certain activities such as the transmission of illegal or obscene material. Specific venues on request can also ask for content filtering tools to block specific web pages. For some corporate venues this is a requirement to prevent the exposure of obscene material to minors.

The Less Networks model depends on generating return on the investment for business members. In a case study of Quacks Bakery in the Austin area, MacKinnon estimated the bakery generated $413,380 in revenues from Wi-Fi customers since it started utilizing SmartWiFi™ in 2004.[84] Beginning in February 2004, their usage was 802 customer connections per month. A year later, the usage grew to 1,835 connects and increased again the following year to 2,216. Today, that number is 2,273 monthly connects, resulting in a total of 82,636 since January 2004.[85] MacKinnon suggests "that if each customer connection represents a customer who spent approximately $5 on food and drink during the visit, then we can estimate that Wi-Fi customers generated $413,180."[86] Quack's also generated business for its new location. Using the built-in marketing tools, Quack's was able to send a custom-designed e-mail to each Wi-Fi user at the original location and present them with a special offer redeemable at the new location.

Still, it can be difficult for businesses to see a return of the cost of providing free Wi-Fi. David Ostrowe, the owner of several Burger King Franchises in the Oklahoma City area, believes in the benefits of providing free connectivity. "Personally, as a consumer, I get irritated by having to paying for Internet. Wi-Fi should be everywhere."[87] However, he acknowledges that it is difficult for him to measure the return of investment for providing the service. "Will consumers come to his Burger King restaurants instead of going to McDonald's or Starbucks?"[88] To further his return, Ostrowe is experimenting with marketing e-mail to users and HTML coupons and other features to increase sales at his restaurants.

See http://www.lessnetworks.com/
http://www.austinwirelesscity.org/hotspot-list.php

---

83 *See* "Hotspots Directory," Less Networks, https://auth.lessnetworks.com/v099/app?service=page/Home.

84 *See* "Comparative Study of WiFi Solutions at Quack's 43rd Street Bakery, Austin Texas," Less Networks, http://auth.lessnetworks.com/static/case.study.html.

85 *Id.*

86 *Id.*

87 David Ostrowe, O&M Restaurant Group, Interview by Author, May 21, 2009, via phone.

88 *Id.*

Lawrence Freenet

Prepared by Benjamin Lennett

Lawrence Freenet began as an effort by Joshua Montgomery and a small group of technology geeks to get Internet service out to a friend living in a rural area.[89] After working with wireless technology, the group saw how cheap and easy it would be to deploy a much larger wireless network. In 2005, the group began to explore building a citywide network. "We had no luck in finding a suitor," offered Montgomery, "we struggled to develop a sustainable business model where a non-profit could run and build the network and offer a return on investment." The solution for Montgomery was two separate entities: Lawrence Freenet, Inc. a 501(c)4 not-for-profit company, works with city government, service providers and members of the community to further the project's mission. Community Wireless Communications Co., a for-profit company, manages the network and develops the required technologies, financing the project exclusively through private capital. "We wanted to make sure there was no cost to taxpayers," offered Montgomery.

Although they received unanimous support from the city council for the project, the business community has not been as supportive. Lawrence at the time was served by a single broadband provider, Sunflower Broadband, which also provided cable television services to the community. Sunflower Broadband is owned by the local newspaper, the Lawrence Journal Herald. In addition, Lawrence has no local television affiliates, except one local cable television channel, also owned by the cable company and the newspaper. Sunflower Broadband and related companies have opposed the broadband project from the beginning. Despite the opposition from the business community and a challenging media environment, the project was able to move forward. The city made access to the water towers available at a significantly reduced rate, in return for providing free service to residents below the poverty line. Montgomery was able to secure $2.2 million in private capital from about 30 investors to fund the build-out and initial operational costs of the network.

The initial build-out of the network was completed in October 2005. It now consists of 550 online nodes and 9 wireless backhaul points. The network provides speeds up to 7 Mbps down, 512 Kbps up. The network's technology allows for symmetrical connections; however, they have tweaked it to make it asymmetrical. Speeds vary depending on the distance from the node. If they are no more than one hop from a node, customers are likely to get access speeds of 3 Mbps down and 1 Mbps. If connected to backhaul node, a customer can access speeds of 5 Mbps down to 3 Mbps up.

Lawrence Freenet offers residential access for $23.98 per month. Those living in the surrounding rural areas with line of sight to the network can get slower access, up to 1 Mbps down and 128 Kbps up for $44.98. This includes a $25.00 survey fee and $149.98 equipment installation fee.[90] Currently, the network has approximately 1,500 customers and has created 4,500 accounts since its citywide launch in 2007, as well as a 3 to 3.5 percent take rate in the community. Lawrence Freenet does not require any contracts; many customers come and go from month to month. Even though there is no partnership with University of Kansas, which has its own network on campus, students are the largest

Even though there is no partnership with University of Kansas, which has its own network on campus, students are the largest users of the network.

[89] Unless otherwise noted the case study is based upon a phone interview with Joshua Montgomery, co-founder of Lawrence Freenet and founder of Community Wireless Communications, by the Author on May 20, 2009.

[90] *See* "Rates" Lawrence Freenet, http://www.lawrencefreenet.org/rates.php.

users of the network. The service is very popular among students, because it does not require a contract and they like being able to access it all around the city. Fraternity and sorority off-campus housing located near the city water towers is well served by the network. Sixty percent of users of the network are between 20 and 30 years old.

The network is an open access network and allows consumers to connect any Wi-Fi capable device. They have even developed an authentication process for smartphones that does not require them to log into the service's splash page. Subscribers can bring smartphones into the Freenet offices to enter the MAC address into the system and allow users to connect automatically when in range of the network. The network management practices of the network do not block or limit specific content. However, the network will discriminate against what are considered "abusive applications," such as those that prevent users from injecting routes into the network and limit the throughput available to users of BitTorrent and other peer-to-peer applications.

The real operating costs to run the network are just $24,000 per month, with four full-time and four part-time staff. Such a lean operation was the result of forced layoffs of just over 50 percent of the staff, allowing the network to break even in October 2008. Community Wireless Communications has also benefited from licensing its customer relations management software designed for Kansas Freenet to Ohio State University and University of Wisconsin.

Lawrence Freenet, a 501(c)3 non-profit, does not own the backbone or the wireless access equipment. It instead pays 90 percent of the fees it collects from users to Community Communications Corporation for the use of the network. For example, from a $23.98 subscription, they pay Community Wireless Communications $19. They use the remaining 10 percent markup to provide free service to low-income families. Freenet provides 90 percent of qualified low-income residents with free service and equipment, while another 10 percent just pay to rent equipment, including wireless modems that are provided to regular customers. In total, Freenet provides broadband access to over 100 low income families. In addition, volunteers also help refurbish donated computer equipment to provide to low-income residents.

The non-profit also bought a local monthly newspaper, *The Lawrencian*, and Larryville.com, a web-based community forum. They have combined the two properties in a local online news and information resource. Despite limited funding, they are still publishing and have 12,000 users on the online forum site. Lawrence Freenet also has control of an FM spectrum license, 89.9 FM (full-power license). The ultimate goal is to establish commercial free radio station and with substantial community involvement in news and programming.

In total, Freenet provides broadband access to over 100 low income families.

The city does not use the network, except for the water department. As part of Freenet's agreement to use the water towers, the department pays a small monthly fee to carry data back to their facility. At first this was just for a transmitter to tell the elevation of the water, but then Freenet offered to install TCP/IP digital cameras at the water tower sites. The cameras, along with electronically controlled gates, allow operators back at the plant to simply push a button to provide a contractor access to a water tower. The cost savings for the department have been considerable. Rather than having to send out an employee to the site at upwards of $50 to $60 per visit, "Now operators previously taking 20 to 30 minutes to go out to a site and open the gate, now spend one minute pushing a button," said Tim Will, Water Treatment

Maintenance Manager.[91] There are also additional cost savings from eliminating dedicated phone lines at towers for contractors to call the plant. The cameras further help to prevent vandalism.

The network also provides free service to the O'Connell Youth Ranch, a boy's residential facility for troubled youth, set on 120 acres just outside of Lawrence. Previously, the facility could only get access to dial-up. Cable was going to cost them between $10,000 and $15,000 for Sunflower Broadband to extend cable out to their facility. Freenet came out and set up all three houses and offices with Wi-Fi for free. The Executive Director of the Ranch calls the service "a godsend."[92] The ranch uses the connectivity for daily business, and the kids use it for their homework.

See http://www.lawrencefreenet.org/index.php, http://www.civicWi-Fi.com/

[91] Tim Will, Water Treatment Maintenance Manager City of Lawrence Utilities Department, Interview by Author, May 21, 2009, via phone.

[92] Deanie Hayes, Executive Director of O'Connell Youth Ranch, Interview by Author, May 21, 2009, via phone.

St. Cloud, Florida

Prepared by Benjamin Lennett

About six years ago the city of St. Cloud, a small (pop. 30,000) suburb of Orlando, Florida, did something completely unique.[93] As part of the development process of a large, vacant parcel of property the city had purchased, it decided to incorporate services such as broadband. This in turn inspired plans for providing similar connectivity to the entire community.

In 2005, many of the small businesses in the city's downtown area had no access to broadband connections. Furthermore, surveys of St. Cloud residents had revealed that over 70 percent of households had computers linked to the Internet, mostly through dial-up connections. The average cost of these connections, approximately $450/year, constituted more than the approximately $300 the average household paid yearly in municipal taxes. The city government figured that providing wireless broadband access to its residents would save more than they paid in taxes and ensure that whatever public funds were spent on Internet connectivity would cycle back into the community in the form of increased economic activity for the city. "If a consumer utilized a local service rather than a non-local private one, the money would stay in the local area and contribute to local economic growth," offered Howard De Young, St. Cloud's Director of Information Technology.

They began citywide deployment in August 2005. At the same time, legislation driven by cable and telephone companies was moving through the Florida legislature that would limit the ability of municipalities to offer broadband services that competed with private sector offerings. The legislature enacted a law in 2005 to place restrictions on governmental entities proposing to provide communications services. Fortunately for St. Cloud, the network was already underway before the law passed. However, the law forced them to eliminate an initial model for the network that would provide a first tier of slower service for free, and charge for a second, faster tier, in favor of a completely free service.

The citywide Cyber Spot launched in March 2006, about three months behind schedule. "No one else in the country was doing this at the time," De Young noted. "The model was built from the ground up. There were definitely some learning experiences. The technology and deployment were more complex than originally thought." Three years the later the network was providing 100 percent free wireless broadband to residents and visitors. The average connection to an end-user was somewhere between 1.5 and 2 Mbps down and half that up, with data rate varying depending upon the quality of Wi-Fi signal. The latest survey completed by the city provided that one-third of residents used the network exclusively for their broadband service; one-third used it in conjunction with a paid service; and one-third did not use it at all.

St. Cloud's network covers the entire city, approximately 17 square miles. The network utilizes approximately 365 Wi-Fi mesh nodes from Tropos Networks, operating on the 2.4-GHz unlicensed spectrum band. Almost 100 percent of radios are attached to city-owned light poles. The mesh nodes are connected to backhaul at City Hall using either fiber connections or Motorola wireless routers operating on 5.2 GHz and 5.8 GHz. City Hall serves as the network operations center and is connected to two separate fiber metro-Ethernet

[93] Unless otherwise noted the case study is based upon a phone interview with Howard De Young, Director of Information Technology for the City of St. Cloud, conducted by the author on June 1, 2009.

connections.

The network allows outdoor connectivity for both residents of and visitors to St. Cloud. Because the city cannot guarantee that connectivity will extend inside all homes and businesses, it encourages potential business and residential users to install an inexpensive wireless bridge device to bring the signal indoors, since the signals do not penetrate foliage or outside walls of houses very well. As De Young explains, "It's the household's responsibility to connect the house to the city water's system running along the street. Similarly, it's the individual's responsibility to get wireless signals from the street into their home." He compares it to rabbit ears for your TV. "It's exactly the same thing with a wireless connection; the better the antenna, the better your connection speeds." He often uses the analogy at the monthly public workshops the city holds to explain the network to residents, which first began back in November 2005.

The network is open access, allowing any 802.11 standard devices to connect with it. Users can connect once via the network splash page, putting in their name, e-mail address and phone number. The network stores the MAC address of their device, and their registration is good for one year. At the end of each year they purge the MAC address, and users are required to re-register. This is especially useful for smart-phones. The network does employ some limited bandwidth throttling controls. The controls are built-into the Tropos radios and will slow down the priority of a connection based upon exceeding a certain bit-rate over a certain period of time.

The city controls the network and has staff members to oversee the operation of the network and handle all repairs and radio replacements. As part of the support for the equipment, they utilize a remote monitoring service that monitors the operation of mesh. They have outsourced customer service. The service will pass questions and issues they cannot deal with to the network operation center. If the operation center cannot handle a question, then it is passed on to the city's IT department.

The network cost the city $2.75 million in initial capital costs, which include both deployment of the network as well as the first year operational costs. No debt was accrued on the project, with the funds taken from the city's economic development fund. The network's ongoing yearly operational costs are approximately $500,000, which are paid for from the city budget.

The network is open access, allowing any 802.11 standard devices to connect with it.

The city makes up the operational costs of the network through efficiencies to its internal city operations. The police department, fire department, building inspectors, and code enforcement officers all use the network. The city's building inspectors, for example, are using tablet PCs to schedule inspections and file reports remotely, thereby increasing the number of inspections they are able to perform and reports they are able to file. Each year when the city buys new vehicles for the police department, it also budgets funds to outfit vehicles with Tropos mobile radios. Eventually, every patrol car will have a radio and the city can eliminate the use of wireless air cards from private providers. The city is also looking at advanced meter reading (AMR) solutions for water and reuse.

Despite the benefits of the Cyber Spot network to residents of St. Cloud, in September 2009 city leaders decided to shut down the service.[94] Faced with a $1.3 million budget shortfall, the city council

[94] Etan Horowitz, "St. Cloud shutting down the nation's first citywide free Wi-Fi network," *Orlando Sentinel*, Etan on Tech, September 28, 2009, http://blogs.orlandosentinel.com/etan_on_tech/2009/09/st-cloud-shutting-down-the-nations-first-citywide-free-wifi-network.html. *See also* Esme Vos, "St. Cloud shuts down free citywide WiFi service," MuniWireless.com, September 28, 2008.

voted to eliminate the public portion of the wireless network to save $370,000 in maintenance and operational costs. After the vote, angry residents packed the commission chambers at a council meeting, demanding the city not shut down the service.[95] The council voted 3 – 2 to extend the free citywide Internet access for 120 days. In December, even with $1.9 million in cuts from the previous year's budget, three councilmen voted against continuing to fund the service.[96] The network will still be used for city services.[97]

See http://www.stcloud.org/index.aspx?NID=402

[95] Jeannette Rivera-Lyles, "St. Cloud will keep free Wi-Fi -- for now," *Orlando Sentinel,* October 2, 2009, http://articles.orlandosentinel.com/2009-10-02/news/091001018o_1_free-wi-fi-cloud-wi-fi-service.

[96] Juliana Torres, "St. Cloud says 'no' to Cyber Spot," *Around Osceola,* December 11, 2009, http://oscnewsgazette.com/index.php?option=com_content&task=view&id=5257&Itemid=6.

[97] Horowitz, "St. Cloud shutting down the nation's first citywide free Wi-Fi network," *supra note* 1.

Lompoc, California

Prepared by Benjamin Lennett

In 2003, Lompoc, a small city of 42,000, was not particularly well served by the local cable and telephone providers.[98] According to Richard Gracyk, Wireless Service Administrator for Lompoc's Municipal Utility, half the town lacked access to broadband, and the other half only had access to limited DSL. To remedy the problem, the city had considered deploying a citywide fiber-to-the-home (FTTH) network to provide high-speed Internet, TV, and VoIP services. In part because of the substantial cost of deploying FTTH and in part because the incumbent providers suddenly announced plans to upgrade and expand their broadband service offerings, the city settled on a wireless network as a way "to get something up, quickly and cheaply" and provide service to an unmet market.

Like many early municipal Wi-Fi projects, the whole network was conceived and constructed by consultants as a turnkey package to blanket the city with wireless. When beta testing of the network began in 2005, the network encountered several problems and was completed six month behinds schedule. "The technology on this scale was in its infancy," Gracyk offered. "Unfortunately, there was not a whole lot of practical information from on the ground testing; it was all engineering studies and assumptions. There was too much emphasis on engineering than actual usage and outcomes."

With the initial network in place, the city began beta testing. In the next three years, they did a lot of infill, immediately adding another 50 wireless nodes. They also realized that the Wi-Fi signals could not penetrate the stucco exteriors of most of Lompoc's house and thus required the use of customer premise equipment (CPE) or wireless bridges to bring the signal indoors.

But even after four years of beta testing, they still were not sure what kind of network they had. Unfortunately, the beta testing did not include a feedback loop for users. "There was no way to assess the end-user experience," Gracyk noted. For the third revamp of the network, Gracyk decided to focus on the end-user. They continued with more infill, adding another 40 nodes to bring the total up to 238 nodes. They provided more backhaul capacity, including virtual LANs (VLANs) for police and fire users. The network today uses 182 Tropos mesh nodes and 33 Tropos gateways, Aptilo's gateway/network management software, and Motorola Canopy (35 base stations) for backhaul. It covers 6.2 square miles and provides around 2 Mbps down and 1 Mbps up to most users.

Image credit: Logo from http://www.cityoflompoc.com/LompocNet/

The municipal utility seeks to make it as easy as possible for customers to sign-up. They offer subscriptions at $15.99 per month (includes a CPE from Pepwave) or short-term subscriptions of $9.99 for 30 days or $4.99 for 48 hours (paid via credit card). It costs utility customers nothing to sign up, and they can have the $15.99 charge added right to their utility bill.[99] Also, as Gracyk points out, "One

[98] Unless otherwise noted the case study is based upon a phone interview with Richard Gracyk, Wireless Service Administrator for the City of Lompoc, conducted by the author on May 27, 2009.

[99] *See* Utility Department, "Broadband Division," City of Lompoc, http://www.cityoflompoc.com/lompocnet/.

of the big differences in the service offerings between the city's network and private providers is no fine print." The short-term options are popular with many contractors who work for Vandenberg Air Force Base or the federal prison, where they are unable to get DSL or cable without long-term contracts. The utility also provides better customer service, because it is right in the community, rather than at an offsite service center. The utility company now handles all customer service at its offices from 8 to 5 PM. Plenty of customers come to the utilities office with connectivity or computer issues. They even do house calls. The network had 1,450 subscribers as of January 2009, which amounted to a take rate of 10 percent of the households in the city.

Lompoc police also utilize Tropos mobile Wi-Fi routers in their cars. The city has installed wireless meter for automated meter reading (AMR) of electric meters in over half of the households and are moving forward with plans to install similar meters for water.

The network is open access for any devices that is compatible up to 802.11G. Although smart phones are allowed on the network, they may not connect well, because of the low-power radios in the devices. Gracyk admits that the network is not truly mobile, but serves as a much more affordable substitute for other fixed broadband offerings. There are currently no content filtering, bandwidth caps, or QoS, although they have the tools available for bandwidth shaping. "One of the things we have found is that capacity issues are not bandwidth related, as much as airtime related. It's not the amount of data moving, but the amount of airtime a transmission consumes," Gracyk noted. They are working with Tropos on airtime control, including software and hardware that are intelligent enough to facilitate airtime congestion management.

The network cost about $4 million to deploy, including the cost of equipment. Gracyk offers, "It is cheaper to deploy a similar network today because

Lompoc, CA: City of Arts and Flowers. Image credit: ipontific8 (Flickr)

equipment costs have dropped and people have learned a lot about deploying these networks." The network is funded from the utility company through user fees and reserve funds. It has annual operating costs of $800,000.

The low operating costs are due in large part to the utility eliminating most of its outside contracts, though it retains a service contract with Tropos. Gracyk offers that in order for the network to continue to be successful, the utility will have to look for new uses of the network. "A network cannot be successful based on any one facet service. You cannot expect to recoup your money just focusing on subscriptions. You have to look at all facets at what the network can do for you," he said. "Putting on city services was not originally envisioned, nor was it part of the business plan. But it is now increasingly seen as integral to the success of the network." But the true success of a network is measured by resident views. A recent survey conducted by the city asked users to rate the value of the service on a scale of 1 to 5, with 5 being the best; the average score users gave the network was 4.65.[100]

See http://www.cityoflompoc.com/lompocnet/

[100] See *Esme Vos, "Update on Lompoc municipal wireless network," MuniWireless.com, February 5, 2009, http://www.muniwireless.com/2009/02/05/update-on-lompoc-network/.*

Wireless Minneapolis

Prepared by Benjamin Lennett

In November 2004, the Minneapolis City Council directed its Business Information Services department (BIS) to issue a Request for Proposals (RFP) to deploy, manage and administer a ubiquitous Citywide Broadband Wireless Internet Service.[101] The City would serve as an anchor tenant on the network, paying for wireless services as well as wired information and communications services for city departments, schools and libraries. In addition to exclusive rights to the City's business, the private partner would have the non-exclusive right to place wireless equipment on and in city facilities, access to the city's institutional fiber network and the opportunity to build out the city's wired infrastructure as necessary to support the city's need for wired and wireless services.[102]

Residential and business broadband services were considered "desired services," so the RFP asked applicants if they could provide high-speed, fixed and mobile secure broadband IP data connectivity for residents and businesses. [103] The RFP also desired that respondents support community technology issues in the city and interact with existing programs, such as the community technology empowerment program (CTEP).[104]

After the RFP was released, public criticism of the project began to emerge. Editorials in community newspapers and letter writing and e-mail campaign by activists to the city council expressed support for either a city-owned and operated network or investment in a fiber network.[105] In addition, a coalition of community organizations and individuals engaged in digital inclusion efforts did not feel the needs of low-income residents or small-businesses were adequately addressed in the RFP.

The city was looking for a network it could utilize for city services.

The concept of Community Benefit's Agreement first emerged in a meeting with the Minneapolis Foundation, Alliance for Metropolitan Stability and the Community Computer Access Network, directed by Catherine Settanni (who would later participate in the final contract negotiations representing community and coalition interests). Settanni and the two other organizations worked to develop a larger, more diverse coalition that included new immigrant groups, neighborhood organizations, independent media organizations, and community technology advocates.[106]

In October 2005, BIS announced the two finalists; EarthLink and U.S. Internet, from nine proposals submitted. Its business case analysis determined that the public/private partnership business model was the most appropriate model for the City to pursue.[107] Under the public/private partnership model the City would continue to own all existing

---

101 *See* "Request for City Council Committee Action," November 1, 2004, http://www.ci.minneapolis.mn.us/council/2004-meetings/20041105/docs/23_Wireless-Broadband-Inertnet-Services.pdf.

102 *Id.*

103 *See* "Request for Proposals to Provide Broadband IP Data Access Services," City of Minneapolis, April 13, 2005, http://www.ci.minneapolis.mn.us/procurement/docs/wireless-rfp.pdf

104 *Id.* at 30.

105 For example *see* David Morris and Becca Vargo Daggett, "Public owned broadband would serve the city best," *Minneapolis Star Tribune,* August 1, 2005. *See also* "Ten Myths About a Public Owned Information Network," Institute for Local Self Reliance, August 2005, http://static.newrules.org/info/mplswireless/mpls10myths.html.

106 *See* Catherine Settanni, "From Conflict to Collaboration: The "Wireless Minneapolis" Community Benefits Agreement, December 14, 2007, http://www.digitalaccess.org/pdf/Conflict_to_Collaboration.pdf.

107 *See* Wireless Minneapolis, "Municipal Broadband Initiative Business Case," Version 5, February 16, 2006, http://usiwireless.com/pdf/Wireless-Minneapolis-Business-Case.pdf.

and new fiber-optic network assets, contribute use of utility poles and serve as an anchor tenant for network services. The private partner would fund, build and operate the wholesale and retail wireless network, in addition to coordinating the required applications' development and integration. The City also offered to fully enforce a Community Benefits Agreement.

After the business case was released, a report from Minneapolis-based Institute for Local Self Reliance argued for a publicly owned information infrastructure including fiber and wireless.[108] The paper argued the City had not addressed the question adequately. To date, there had been no public meetings, nor public hearings on the initiative or the public ownership option. The only external working group consisted of representatives of the business sector.[109] Later that month, the City Council finally sponsored an open public forum to solicit comment on the Wireless Minneapolis Initiative. Over a dozen people testified in support of the City sponsored plan – but only if it included an enforceable community benefits agreement.[110]

In February 2006, the city council voted 11-1 to approve the amended Business Case,[111] and in May of 2006, BIS directed by the City Council established the Wireless Minneapolis "Digital Inclusion Task Force" (DITF) to directly engage City residents and businesses in developing a formal community technology agenda. On July 28, 2006, the council approved the adoption of the Wireless Minneapolis Digital Inclusion Task Force Final Report.[112] Included among the recommendations of the report were the following: 1) an ad-supported service option that is free of charge to the public—in addition to the subscription based service or, at minimum, subsidized accounts and free service that provides limited, selected community services; 2) 7 percent of gross revenue allocated for a Digital Inclusion Fund; 3) $500,000 up front to support the Digital Inclusion Fund; 4) guaranteed network neutrality; 5) infrastructure for local content development; and 6) a location-specific portal as well as a basic website content management system.[113]

In August 2006, BIS moved forward to finalize contract negotiations with U.S. Internet.[114] The final

[108] *See* "Act Now for a Democratic Information Network in Minneapolis," Institute for Local Self Reliance, December 2005, http://static.newrules.org/info/mplswireless/mplswirelesspacket.pdf.

[109] *Id. See also* Aaron Neumann, "Ryback's Great Giveaway: The Selling Out of Public Wi-Fi," *Southside Pride,* February 2006, http://www.southsidepride.com/2006/2/articles/rybak.html.

[110] *See* Settanni, "From Conflict to Collaboration," *supra note* 11.

[111] *See* Peter Fleck, "Muni Wi-Fi: Minneapolis City Council Agenda," February 24, 2006, PF HYPER Blog, http://www.pfhyper.com/weblog/archive/2006_02_01_archive.html. *See also* "Wireless Minneapolis Business Case," Wireless Minneapolis, Version 3.0, http://www.ci.minneapolis.mn.us/wirelessminneapolis/MplsWireless_BusinessCase_V3.pdf.

[112] *See* "Ways & Means/Budget Committee Agenda," City of Minneapolis, August 28, 2006, http://www.ci.minneapolis.mn.us/council/2006-meetings/20060901/WMagenda20060828x.asp.

[113] *See* "Final Report," Wireless Minneapolis Digital Inclusion Task Force, July 17, 2006, http://www.digitalaccess.org/documents/MDITF%20complete.pdf.

[114] *See* Peter Fleck, "Minneapolis Wireless: US Internet Chosen for Wi-Fi Deployment," August 29, 2006, PF HYPER Blog, http://www.pfhyper.com/weblog/archive/2006_08_01_archive.html.

terms of the contract required the City to pay $ 2.2 million in advance for services and make a minimum annual commitment for the first 10 years of the contract to pay no less than $1.25 million per year.[115] Terms of the contract also included the following community benefits:[116]

- $500,000.00 up front to a new digital inclusion fund
- 5 percent annually of ongoing pre-tax net income to the same fund
- 2 percent of additional profits from adjacent community contracts to the fund
- Subsidized services to over 100 CTCs, and vouchers for trial accounts to CTCs to distribute to volunteers
- A free "walled garden" of content, available to everyone who can access the signal, that includes neighborhood portal pages, city websites, and public safety information[117]
- 100 percent of portal page advertising revenue will be directed to the digital inclusion fund
- A content management system and community server for the use of neighborhood and community groups
- A guarantee of network neutrality

Like many similar municipal Wi-Fi projects, there were significant issues with signal coverage, especially in neighborhoods with many trees and dense foliage. This and other overruns cost the city an additional $1 million. Currently, the mesh network has about 3,000 Bel-Air antennas and covers about 59 square miles.[118] US Internet had difficulty getting permission from various organizations (Minneapolis Parks and Recreation, Xcel Energy, and private property owners) to install equipment on poles. They also had difficulty getting power to the poles, as they could not tap into the city's power and must run their own separate power lines.[119] The majority of the problems occurred in park areas and neighborhoods near lakes with decorative polls. The company had to replace the decorative poles with stronger poles to support the installation activities.[120]

USI Wireless completed construction of phase four of the network in May 2008. As of January 2010, the network covers 95 percent of the city's required service area of 59.5 miles, and its performance meets the City's expectations, according to the city's Chief Information Officer, Lynn Willenbring.[121] There are currently 16,500 private subscribers, according to Joe Caldwell, marketing vice president of US Internet, which owns and operates the network. The company hopes for 30,000 individual customers.[122] US Internet offers 1 Mbps, 3 Mbps, or 6 Mbps (symmetrical) speeds at $17.95/month, $24.95/month, and $29.95/month.[123] Residential consumers are recommended to install a Ruckus wireless modem for indoor use in order to receive maximum signal strength and bandwidth rates at a rental cost of $4.95/month or purchase price of $79.95.[124]

---

115 *See* Wireless Minneapolis History, "Request for City Council Committee Action," Wireless Minneapolis, August 28, 2006, http://www.ci.minneapolis.mn.us/council/2006-meetings/20060901/Docs/BroadbandWirelessInitiative_CR.pdf.

116 *See* Wireless Minneapolis History, "Wireless Broadband IP Data Access Network-Term Sheet," Wireless Minneapolis, August 24, 2006, http://www.ci.minneapolis.mn.us/council/2006-meetings/20060901/Docs/WirelessBroadbandTermSheet.pdf.

117 *See* "Minneapolis Civic Garden," http://www.wirelessminneapolis.org/.

118 Tiffanie Gothman, US Internet, Interview by Author, June 16, 2009, via phone.

119 *Id.*

120 *Id.*

121 Peter Fleck, "Minneapolis Unwired: The network is just about as complete as it's going to be," PF HYPER Blog, January 5, 2010, http://www.pfhyper.com/blog. *See also* Steve Alexander, "US Internet hopes to have 30,000 individual customers in three years, as growing city use," *Star Tribune*, January 4, 2010.

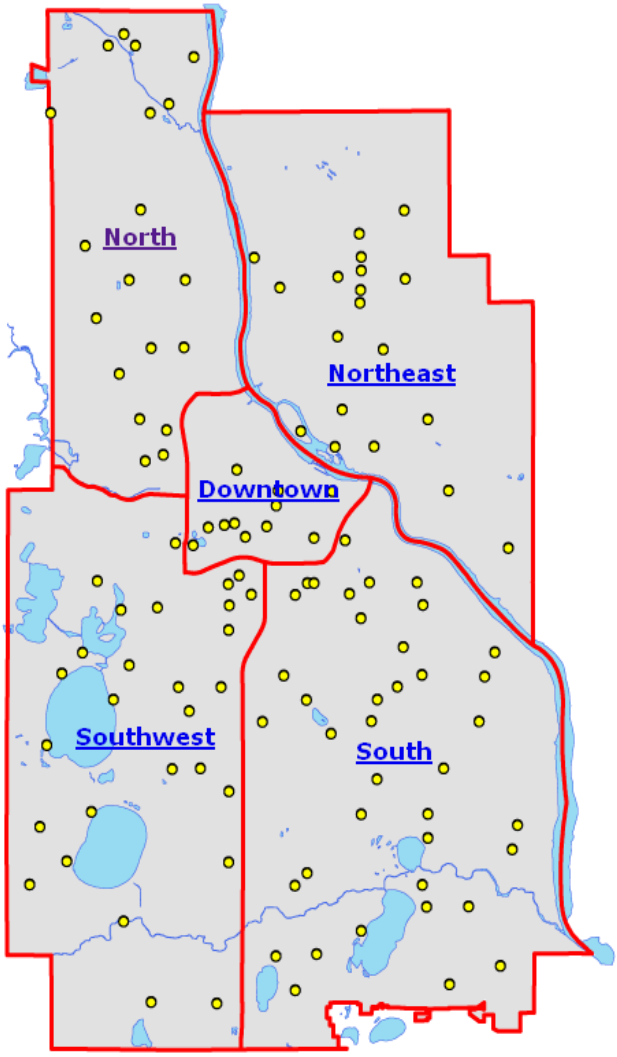
122 *Id.*

123 *See* "Promotional Pricing Information," USI Wireless, http://www.usiwireless.com/service/pricing.htm.

124 *Id.*

The city is paying $1.5 million/per year to USI Wireless for access to the network. However, it is only using the network on a limited basis, nowhere near the level that was anticipated. "No one is using the network from the city," offered Chris Mitchell from the Twin Cities-based Institute for Local Self Reliance.[125] This is a problem as the city expected to make up in outlays after two years through greater efficiency and by allowing departments such as public safety to eliminate their contracts with other wireless providers. However, public safety does not trust the network and does not want to replace their existing communication technology with the USI network. During 2010, both the fire and police departments will spend an extensive amount of time testing the Wi-Fi network to make sure the computers in department vehicles can travel throughout the city and still access critical databases.[126]

http://www.ci.minneapolis.mn.us/wirelessminneapolis/



Map of Wi-Fi locations in Minneapolis. Image credit: http://www.ci.minneapolis.mn.us/wirelessminneapolis/map.asp

[125] Christopher Mitchell, interview by author, May 19, 2009, via phone.

[126] *Id.*

Wireless Philadelphia

Prepared by Benjamin Lennett

Philadelphia became the first major U.S. city to explore the idea of building a citywide wireless broadband network. But sometimes being first has its disadvantages. After a lengthy RFP process in 2005, Philadelphia announced it had negotiated a contract with EarthLink for the creation of a citywide wireless network. [127] Although initially the city's executive committee had recommended non-profit ownership of the network, EarthLink would own and operate the city network. When build-out began in late 2006, Philadelphia seemed like the model for cities across the country, but less than two years later EarthLink announced its intention to dismantle the network. Beset by construction cost overruns due to poor coverage and EarthLink's own financial issues, the network attracted less than 15 percent of the subscribers it expected.

Philadelphia's network began in June 2004 as a municipal Wi-Fi hotspot in Love Park in Philadelphia's downtown, launched by the mayor and the city's CIO. [128] In December 2004, an executive committee formed by the Mayor recommended a combination of two models, adopting a "Cooperative Wholesale" model.[129] In April 2005, the mayor announced the results of the executive committee's work, the release of a request for proposals (RFP) to build the wireless network, and the formation of Wireless Philadelphia (WP) to fill the nonprofit role outlined in the committee's business plan. The RFP detailed requirements for

the network, including a coverage area of 135 square miles; support for access from desktop PCs, laptop PCs, handheld devices, mobile phones and other Wi-Fi devices; speeds of one megabit per second (1 Mbps) upstream and downstream; and its availability: 90 percent indoor and 95 percent outdoor, including constant connectivity while moving at up to 60 miles per hour.[130] Wireless Philadelphia received 12 proposals and worked with a number of the bidders to set up pilot projects.[131] Eventually, the cities chose the proposal by EarthLink, which, in contrast to both the original Wireless Philadelphia business plan and to all of the other bidders, proposed that the company would build and maintain the network at its own expense and own the network outright.[132]

The main points of the 10-year agreement included payments by EarthLink to the city of $74 per year, per light pole for 4,000 to 5,000 light poles for 10 years, with two-thirds of the total payments ($2 million) coming in the first year to provide startup funding for Wireless Philadelphia. The agreement also provided for a revenue sharing agreement wherein Wireless Philadelphia would receive greater than 5 percent of subscriber fees or $1 per subscriber. WP would also receive 25,000 reduced rate subscriptions of $9.95/month to hand out to

[127] The profile for Wireless Philadelphia was largely adapted from a 2008 New America report "The Philadelphia Story: Learning from a Municipal Wireless Pioneer." *See* Joshua Breitbart, "The Philadelphia Story: Learning from a Municipal Wireless Pioneer," New America Foundation, 2008, http://www.newamerica.net/files/nafmigration/NAF_PhilWireless_report.pdf.

[128] *Id.* 9.

[129] *Id.* 14.

[130] *Id.* 16.

[131] *Id.* 21.

[132] *Id.*

needy residents and non-profits. WP also could purchase wholesale accounts for $11 to $18, depending upon volume, and EarthLink would provide non-discriminatory wholesale access to other retail service providers. In return, WP was also required to pay half of EarthLink's electricity bill, up to half of its share of the gross revenue from the network. Base service speed was expected to be 1 Mbps symmetrical with availability throughout 95 percent of the city outdoors, with nearly two dozen free areas in city parks and community centers.[133]

Although on the surface the agreement seemed to provide generous benefits to Wireless Philadelphia, as well as free up the non-profit to focus exclusively on digital inclusion efforts, EarthLink negotiated a key provision obligating WP to pay a portion of the electricity bill for operating the network. The agreement required WP to pay EarthLink's electricity bill with up to half of its income from revenue, thereby limiting a vital revenue stream for the organization's digital inclusion efforts.[134] In addition to promoting digital inclusion, Wireless Philadelphia was tasked with overseeing the network and EarthLink's implementation and operation. This created conflict, as among WP's key roles was promoting buy-in from community organizations, soliciting donations from the wealthy, and marketing subscriptions to lower-income households, meaning Wireless Philadelphia had to be an advocate for EarthLink.[135]

In February 2007, WP announced its first community Wireless Internet Partnerships (WIPs) with People for People and Impact Services Corporation, with the goal of distributing WP's digital inclusion package of computers, training, and Internet access through existing agencies using preexisting neighborhood relationships.

In February 2007, WP announced its first community Wireless Internet Partnerships (WIPs) with People for People and Impact Services Corporation, with the goal of distributing WP's digital inclusion package of computers, training, and Internet access through existing agencies using preexisting neighborhood relationships.[136] In June 2007, WP delivered its first computers to Digital Inclusion Participants and announced an aggressive plan to reach 2,800 recipients in its first year and 6,000 over three years.[137]

However, by November EarthLink was increasingly looking to get out of the municipal wireless business. The company had estimated it would spend around $10 million to build the network and another $10 million to maintain it for the first 10 years.[138] It expected to sign up at least 50,000 customers at approximately $20 a month, yielding gross revenues of $12 million a year.[139] But the cost to EarthLink to build the network turned out to be close to $24 million to cover 80 percent of the city's households.[140] And despite lowering its rate for its base 1 Mbps service from $21.95 to $19.95, with an introductory rate of $6.95 for six months, no more than 7,000 residents subscribed to the network.[141] Further, WP had signed up only 440 households for the "Digital Inclusion" program for low-income residents, well below the goal for June of 1,000.[142]

133 *Id.* 20

134 *Id.* 23.

135 *Id.*

136 *Id.* 27.

137 *Id.* 28.

138 *Id.* 21.

139 *Id.*

140 Hiawatha Bray, "The trouble with hooking up," *Boston Herald*, August 2, 2009, http://www.boston.com/business/technology/articles/2009/08/02/the_trouble_with_hooking_up/.

141 *Id.*

142 Deborah Yao, "Philly Wi-Fi network hits snags,, delays," *Associated Press*, November 19, 2007.

In May 2008 EarthLink announced that it wanted to start dismantling the system on June 12. They went to federal court to ask a judge for permission to pull down its equipment and to limit its financial liability to Wireless Philadelphia to $1 million, as part of the city's contract with company.[143] Community Activists led by the Media Mobilizing Project successfully pressured the mayor to have someone take over the network. EarthLink was willing to give away the network, just to be free of its 10-year contract with the city.[144] Finally, a group of local investors agreed to take control of the network. Ownership of the network was transferred to Network Acquisition Co. LLC, a Philadelphia company formed by some local telecom and Internet veterans.[145] Network Acquisition made the network available for free to anyone who could access it, and usage soared to 150,000 visitors per month.[146] The company was in talks with city government and private businesses, hoping to convince them to pay to use the network; this would subsidize public use. Without paying customers, it is not clear how the company will finance its operations once it has burned through its initial capital.[147]

Wireless Philadelphia managed to raise about $1 million in the fiscal year ending June 2008 and provided about 1,200 digital-inclusion packages.[148] It is planning on continuing those efforts and is in the process of implementing a set of pilot programs with community-based nonprofits that will enable it to track the effect of its digital-inclusion packages. Participants would get a refurbished computer, training, Internet access for a year, wireless equipment and tech support.[149]

143 Chris Brennan, "Earthlink to Dump Wireless Philadelphia," *Philadelphia Daily News*, May 13, 2008, http://www.philly.com/philly/blogs/cityhall/BREAKING_NEWS_EarthLink_To_Dump_Wireless_Philadelphia_Next_Month.html.

144 Chris Brennan, "Wi-Fi Wondering: Is a Deal with Local Investors in the Works?," *Philadelphia Daily News*, June 12, 2008, http://www.philly.com/philly/blogs/cityhall/Wi-Fi_Wondering_Is_A_Deal_In_The_Works.html.

145 Peter Key, "Wireless Philadelphia reboots to bring Wi-Fi to the masses," *Philadelphia Business Journal,* January 2, 2008, http://philadelphia.bizjournals.com/philadelphia/stories/2009/01/05/story8.html.

146 Bray, "The trouble with hooking up," *supra note* 20.

147 *Ibid.*

148 *Ibid.*

149 Marguerite Reardon, "Was Earthlink's failed citywide Wi-Fi a blessing in disguise," *CNET News*, September 5, 2008.

[PAGE INTENTIONALLY LEFT BLANK]

Main Office
1899 L Street, NW
Suite 400
Washington, DC 20036
Phone 202 986 2700
Fax 202 986 3696

California Office
921 11th Street
Suite 901
Sacramento, CA 95814
Phone 916 448 5189

New America Foundation

WWW.NEWAMERICA.NET