MUNICIPAL BROADBAND WIRELESS NETWORKS

"...people lack many things: jobs, shelter, food, health care and drinkable water. Today, being cut off from basic telecommunications services is a hardship almost as acute as these other deprivations, and may indeed reduce the chances of finding remedies to them."

UN Secretary General, Kofi Annan,
in a keynote address to the International Telecommunication Union,
Oct. 9, 1999.

In the global information society, the availability of Internet access has become critical for the world's citizens and organizations. Nevertheless, certain geographical areas and populations lag behind others in terms of Internet access, and a number of communities and governments around the world are actively seeking solutions to speed up the process of universal broadband Internet availability [4]. Municipal wireless networks (MWNs)[1] represent a new option for providing broadband access to the Internet.

MWNs are needed because private sector Internet service providers tend to focus their services toward more financially attractive markets and consumers,

[1]A MWN is defined as a wireless Internet access network that is created with active local leadership and involvement. MWNs are typically based on a point to multipoint link between base station and subscriber equipment. A base station is an outdoor antenna connected to a wired Internet backbone that sends data wirelessly to subscriber equipment such as laptops. Typical usage of a MWN involves using the built-in wireless card included in most laptops to connect to the Internet.

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and thus tend to neglect certain constituencies [10]. According to economic theory, it is appropriate for government to intervene in the provision of a service if the service utilizes public goods and has the potential to result in significant positive externalities [1]. Arguably, wireless Internet service fulfills these requirements because it utilizes the publicly owned radio spectrum, and can increase the potential for new innovations and societal benefits as more citizens get connected.

MWNs are also more feasible today because recent developments in standards and technology have made broadband wireless more convenient, effective, and a viable alternative to cable, DSL, and other wired technologies [11]. There is also an expectancy that municipalities will find it relatively easy to set up wireless networks because they have ready and free access to physically dispersed assets such as lamp posts and traffic lights that are ideal for installing base stations [11]. Declines in prices have made the necessary network infrastructure increasingly affordable. In the U.S. estimates for deployment range from $40,000 to $74,000 per square mile [2], this is a small fraction of the costs of other public undertakings such as road maintenance and law enforcement.

MWNs also provide visionaries with a means to realize dramatic changes in society. New applications based on ubiquitous and affordable broadband Internet access can have a significant positive impact on the socioeconomic health and status of entire regions. Concepts such as e-government and e-healthcare could set in motion radical ideas such as changes in the political process, delivery of health care, or more specific changes such as control of automobile traffic patterns through wireless mesh networks [9]. Proponents are also driven by the idea of digital convergence where traditional telephony and broadcast entertainment systems are superseded by a wireless Internet pipeline that delivers all network and broadcast services at a lower cost to the consumer [8].

It is therefore not surprising that since 2003, more than 200 communities around the world are actively seeking to build MWNs. These range from small communities such as Grand Haven, MI to large metropolitan areas such as Paris, France. In summary, MWNs are interesting because they represent a feasible alternative to Internet access, there is already a worldwide grassroots effort to create MWNs, and it is likely that new emergent applications will follow widespread deployment.

There is little research-based guidance available on the core issues and challenges that must be addressed

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by a community during the process of implementing a MWN [7]. In this article, we offer recommendations based on our experience as participants in an expert group[2] that, under assignment from the city's Mayor's office, developed a proposal for a MWN for one of the largest cities in the U.S.—Philadelphia [6]. The recommendations are presented in the form of a stage-based implementation framework (see Figure 1). The framework can guide communities that seek to implement new MWN projects and assist researchers in identifying emerging issues. The investigation included a diverse array of projects and therefore our findings are likely relevant globally. Nevertheless, non-U.S. readers should also consider findings that are regionally proximate.[3]

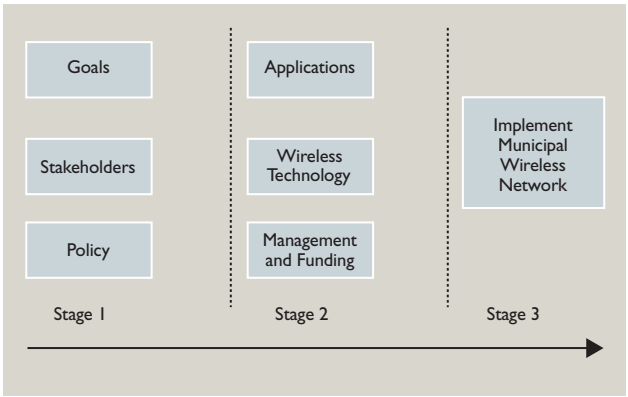

Figure 1. MWN framework.

Our investigation was based on:

- An analysis of the expectations and requirements of more than 110 stakeholders and future consumers of the proposed MWN,
- A comparative analysis of 25 MWN projects, primarily in the U.S.,
- A review of the related academic and professional literature, and
- An evaluation of pilot implementations specific to the Philadelphia MWN.

The process of MWN implementation can be understood in terms of three distinct stages. During the first stage, a community and its local government need to simultaneously consider the needs of diverse stakeholders, identify manifold goals and address challenging policy issues. The second stage involves simultaneously thinking through potential applications, selecting the appropriate wireless technology, and planning the management and funding of the MWN. The last stage involves actual MWN implementation. Each stage will require a process of evaluation and reflection to rationalize potentially competing visions and imperatives. Here, we further elaborate each stage.

Stage 1: Identifying MWN Goals

In this stage, a community identifies and sorts out competing goals, considers the needs of diverse stakeholders, and addresses key policy issues.

Goals. The 25 different MWN projects analyzed for this study address a range of goals.[4] These typically take the form of a primary goal and several accompanying secondary goals. Primarily, MWNs are envisioned as a solution to address the "digital divides" in Internet access. Because digital divides will not disappear simply from providing access to the Internet, MWN projects often also incorporate education and workforce retraining programs. For example, a social service agency in Philadelphia called the People's Emergency Center has set up wireless networks in homeless shelters, and provides training to enable residents to learn about welfare-to-work programs and acquire technology-related life skills.

Among secondary goals, local governments want to

[2]The expert group was formed in the spirit of a public-private partnership, and was composed of members from the government, the non-profit sector, the corporate sector, and the academic community.

[3]There is thriving MWN activity in Europe, for example, the Legible City Initiative in Bristol, U.K. and the Intelligent Bus Project in Paris, France [5].

[4]Due to space constraints, a detailed analysis and listing of all these projects has been omitted from this paper. The sidebar "Grand Rapids, Michigan" presents one illustrative example. See [6] for details on the Philadelphia project.

save on Internet access costs by eschewing Internet service providers (ISPs) in favor of the MWN. By ensuring everyone has Internet access, municipal governments aim to eventually improve service and save costs through electronic delivery of municipal services to citizens. MWNs are expected to boost the attractiveness of communities for prospective visitors because tourists and convention attendees can benefit from on-demand access to local information. A long-term objective is that citizens will be empowered to participate more fully in the political process by organizing, debating political issues, and acquiring information via the Internet. MWNs are also considered a tool for urban renewal, for if they deliver the expected economic and social benefits it should lead to an improvement in the economic health and social well-being of served communities.

Stakeholder	Interest
State or City Government	Build the image of the area and address the needs of political constituents such as voters who live in low-income neighborhoods. Use the network to save on the cost of internet access for government employees.
Municipal Services	Reduce communication costs and deliver improved services such as real estate assessors using hand-held wireless computers to submit reports.
Underserved/ Disadvantaged Individuals	Free or low-cost Internet access and related computing and training programs associated with a MWN may provide lifestyle, education, and job-related improvements.
Community Residents	Provide a low-cost alternative to ISPs. Ubiquitous access may improve lifestyles, enable grassroots projects for urban renewal, and enable electronic interaction between and among citizens and government. Residents are also concerned about the potential tax burden, and may have ideological reservations about the advisability of a municipality offering high-tech services when there might be problems with basic services such as trash collection.
Local Tourist Industry	Tourists and business visitors such as convention attendees would benefit from on-demand broadband access and may also use the network to access tourist data about the local community. A MWN could thus help communities to market themselves as a desirable destination.
Small and startup businesses	Provide a lower-cost alternative to for-fee services. In addition, entrepreneurs could market new services and applications based on the MWN. For example, given an extant wireless infrastructure it is much more feasible to implement ideas that depend on ubiquitous Internet access such as providing content on PDAs for museums or zoos.
Large and mid-sized corporations	Will likely use private networks because of security and reliability concerns but see a MWN as a tool to enable telecommuting. They may support MWN efforts to promote community goodwill and potential improvement in community human capital.
Telecoms and ISPs	A MWN is a potential threat to existing network service providers, though their expertise is likely to be needed for the construction of any MWN. Some firms are seeking legal protection against MWN.
Non-profit and community groups	Serve as a catalyst for delivery of services and information and can be used for training and work force development programs.
Utility / Transportation / Health care	Such organizations often have staff out in field locations and could design new applications, such as for reading utility meters or for providing access to patient records to nurses providing hospice care.
Higher Education	Colleges and universities often have their own wireless networks but could further improve student services or provide new curricula by taking advantage of low-cost broadband off-campus access.
Public Schools	Could realize significant cost savings by avoiding investment in telecommunications infrastructure. Schools could also start experimenting with parent-driven and/or at-home student learning initiatives.
Outside the municipality	Adjacent areas may jump on board to extend the "zone" and/or may feel competitive pressure to provide comparable services.

Table 1. MWN stakeholders.

In addition to the social objectives listed here, MWN projects can earmark quotas for local entrepreneurs to help with building the MWN or to provide services that utilize the MWN. In this way MWNs may substantially reduce the barriers to entry in such markets that are now dominated by a few large firms. For businesses, MWNs are a way to extend or differentiate their services without having to worry about building network infrastructure. For example, many hotels already provide wireless access for customers, and a MWN will allow them to take advantage of economies of scale and offer their customers a far wider range of services without having to build underlying infrastructure.

There is no clear evidence that the digital divide can be successfully addressed by MWNs. Further research is needed to assess whether the stated benefits can be realized and whether the secondary goals are sufficient to justify the investment.

Stakeholders. It is important to recognize that different stakeholders may have diverse and sometimes contradictory goals they wish to achieve via a MWN. As part of the Philadelphia project we organized 13 focus groups with a total of 110 participants that represented a diverse set of interests. Table 1 presents the results in a framework that categorizes and analyzes interests of different stakeholders. The framework is generic and should prove useful in identifying potential conflicts and contradictory goals in advance.

The stakeholders in Table 1 range from beneficiaries of a MWN to those needed to build, sustain, or fund the MWN. The MWN thus potentially offers an environment that can enable us to better understand how new forms of "grassroots" or "community-based" technology initiatives are formed and sustained. Implementers will need to carefully manage the communication with such diverse partners and incorporate their issues and needs in the initial planning.

Policy. There is a policy question about whether—and under what conditions—government entities should get involved in the creation of MWNs. Internet service providers have started mounting legal challenges. For example, in the state of Pennsylvania,

telecommunication providers successfully lobbied for the establishment of a law that forbids municipalities in most of the state from creating a MWN. However, after considerable debate, the city government of Philadelphia was able to receive an exemption from this law. So far, telecoms (such as the Baby Bells) and ISPs have successfully lobbied 14 states in the U.S. to pass laws prohibiting municipalities from building wireless networks because they are considered unfair competition [3]. The threat to entrenched interests goes beyond telecoms and ISPs because wireless Internet is seen as a disruptive technology that can displace traditional wired telephony, cellular service, and broadcast entertainment by delivering equivalent services at a lower cost to the consumer [8]. The telecoms and ISPs may have a point because municipalities in general have an advantage over them as they have ready and free access to public assets that can be used to mount network infrastructure equipment.

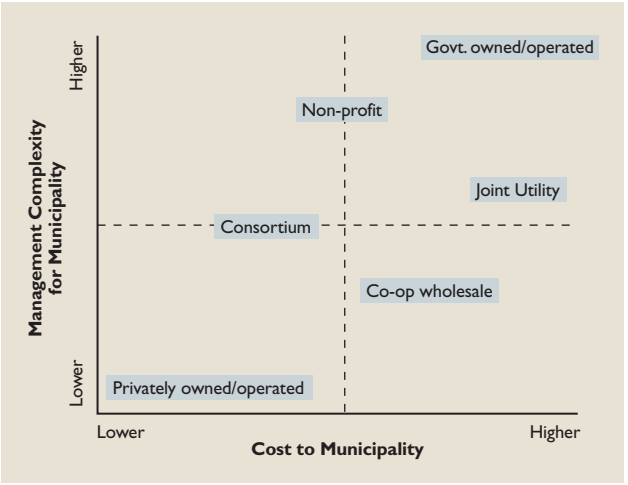

Figure 2. Comparing MWN management and funding models.

A major policy challenge for a municipality is that MWNs come with an assortment of legal implications, involving matters such as who bears the responsibility for data security, related liabilities, operational performance, and customer service management. Finally, since MWNs operate over the public radio spectrum, they may face governmental regulatory constraints and licensing requirements.

There remain fundamental unresolved policy questions such as:

1. Are MWNs an example of the government competing with private business?
2. Does free access to public facilities provide municipalities with an unfair advantage in competing with ISPs?
3. Should public funds be used to support MWNs when the stakeholders are often entities such as state or city governments and other community groups that do not have experience in providing Internet service?
4. Is there a need for new uniform legislation to handle the often-competing goals among MWN stakeholders? Clearly, implementers should first seek to understand and assess the legislative landscape in their community before embarking on the creation of a MWN.

Stage 2: Fleshing out MWN Infrastructure and Funding

Once the goals, stakeholders, and policy issues surrounding a MWN are resolved in Stage 1, managers must identify the kinds of applications a MWN will support. Managers must also select appropriate wireless technologies, obtain sites for installing the receivers, and plan the management and funding. Moreover, ongoing evaluation and reflection is needed to rationalize competing visions, maintain public interest, and to stay abreast of new technologies.

Applications. The most common and compelling application of a MWN has been to create free or low-cost Internet access. There are also several secondary types of applications. For example, public safety institutions such as police, fire, and ambulance departments could be provided with a back-up communication network or with mission-critical information. Police in San Mateo, CA, for instance, can access law enforcement databases through MWN-enabled car laptops. Voice communications and value-added applications are especially relevant in underdeveloped areas where landline telephone service is poor, and in countries where mobile operators charge high rates for voice and data communications. For example, voice-over-Wi-Fi telephone service is now available in Rio Rancho, NM, through a MWN developer. In Houston, the city government is working on a system that will allow citizens to read, monitor, and update payments in parking meters via the Internet.

Given the many different applications of a MWN, researchers must assess how end users will adopt this new technology, what forces determine its usefulness, and what the MWN is ultimately most useful for. MWNs also offer visionaries a new "sandbox" to envision applications that are based on ubiquitous Internet access. Even if MWNs fail as Internet access mechanisms, the pilot projects may produce new innovative social service or entrepreneurial applications because this will be the first time in history that

Attributes / Model	Sample Key Issues	Government owned and operated	Government owned and privately operated	Joint power authority or public utility	Non-for-profit owned and operated	Cooperative wholesale model	Enterprise/ Private Consortium owned and operated	Privately owned and operated
Overall Description		Municipality owns and operates the infrastructure	Municipality owns the infrastructure; subcontracts operation to a private party	Similar to a utility which operates on a for-profit mission	Organization takes advantage of tax regulations governing non-profits	Municipality owned, and capacity is sold at wholesale to private providers	Owned and operated by private enterprise, fees shared with government	Owned and managed by private enterprise
Governance								
Ownership	Who owns the infrastructure (antenna)	Municipality	Municipality	Utility	Not for profit organization	Municipality	Private organizations/ consortium	Privately owned
Policies	Who has access? What is appropriate usage?	Commission sets and implements policy	Commission sets policy that is implemented by private party	Regulatory guidelines from municipality, operational policies set by utility managers	Regulatory guidelines from municipality, operational policies set by managers	Commission sets and implements policy	Commission sets policy that is implemented by private parties	Commission sets policy that is implemented by private enterprise
Management	Who is responsible for connection problems?	Municipality	Private parties, with oversight from municipality	Utility managers with oversight from municipality	Organization managers with oversight from municipality	Municipality	Private parties with oversight from municipality	Private enterprise with no or minimal oversight from municipality
Finances								
Startup funding	Who will pay for the startup costs?	Grant, donation, government allocation, loan/bond	Grant, donation, government allocation, loan/bond, private funding	Grant, donation, government allocation, load/bond	Grant, donation	Grant, donation, government allocation, loan/bond	Grant, donation, government allocation, loan/ bond, private funding	Loan, private and/or equity funding
Continuing "Profit / Costs"	How will the profits/deficits be handled?	Invested in municipality and upgrades	Divided between profit taking and investment in infrastructure	Invested in upgrades to the system	Invested in upgrades to the system.	Invested in upgrades to the system.	Profits shared between operators and upgrades	Operated no different from any private business
Upgrade	How will upgrades be implemented and funded?	Funded through selectively applied fees	Funded through profits	Funded through profits	Funded through profits	Funded through sale of excess capacity	Funded through profits	Funded through profits

Table 2. MWN management and funding models.

so many different people will have ubiquitous, untethered Internet access.

Wireless technology. Applications require supporting infrastructure, and there are several wireless technologies available for creating a MWN including Wi-Fi, Mesh, and WiMAX. The sidebar "Wireless Technology Tutorial" provides a glimpse of the available technologies. The development of standards is both pushing and in some ways hindering MWNs. The low-cost widespread availability of 802.11b demonstrated the potential and stimulated demand, but the slower spread of newer, more robust standards may stifle further growth. Standards have often been the catalyst of widespread adoption of new Internet technologies; in the wireless network space, the real innovators and drivers may be homegrown "standards" being developed by the grassroots efforts of early adopters. Implementers in the short-term should keep a careful watch on both current and future standards to avoid premature obsolescence.

Management and funding. The rapid evolution of technology, and the fact that the management of such projects is not a core competency of municipalities, creates significant risk and challenges for the management and funding of MWNs. Complicating factors include dealing with arbitrary and inflexible budgetary, regulatory, social, ideological, and political constraints such as "the project must be completed at zero cost to the taxpayers" or "the project must

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Wi-Fi. Includes products based on the IEEE 802.11 specifications. The 802.11b standard is widely available today in laptops and other wireless devices. Wi-Fi hotspots are spreading rapidly and Wi-Fi will continue to dominate the last few meters of delivery infrastructure.

Mesh. Consists of multiple interconnected nodes where at least one node is connected to the Internet. Data is transmitted across multiple short hops for high bandwidth and can be rerouted through alternate nodes if that node fails. The upcoming IEEE 802.11s (estimated 2008) will provide standardization for Mesh.

WiMAX. Worldwide Interoperability for Microwave Access products are based on the 802.16 standard. The Fixed WiMAX standard can provide very high throughput point-to-point connections wirelessly as far as 30 miles for several hundred users at different quality of service levels. The new mobile WiMAX (IEEE 802.16e) standard (estimated 2007) will likely address concerns of standardization while improving connectivity.

include computer training for the third district." Moreover, there are very few successful projects available to emulate.

Table 2 presents a comparison of different management and funding models currently being considered in the projects analyzed for this study [4]. Figure 2 provides a map that compares the models based on cost and management complexity.

The key advantage of the *government owned and operated* model is that the municipality can directly ensure provision of services in digital divide areas and preserve other "social consciousness" aspects. However, the project could become a drain on tax funds and will not benefit from the discipline created by the private industry focus on the bottom line and equity markets. Municipalities are also typically not best practice leaders on project management and technology implementation, and wireless standards are evolving so rapidly that a poor or slow decision could cripple a project. Conversely, a completely municipality-led project will likely be simpler to manage and implement and may be ideally suited for small communities.

The *government owned and privately operated* model leverages the capabilities of current private providers while still retaining final control over direction and service. Internet service providers who are not made partners may be disadvantaged and may initiate both political and legal challenges against the idea of using public funds to sustain Internet services. Moreover, a single source (monopolistic) arrangement may not provide enough incentive to maintain customer service levels and upgrades. Clearly, the *private ownership and operation* model will have the discipline of the bottom line and will free the municipality from the burden of embarking on a risky new venture. The disadvantage is that the social consciousness aspect of the initiative may get lost and the project could be shuttered for purely financial reasons, and that may not be acceptable. The *joint power authority or public utility* model can address the funding challenges created from municipality ownership and can also provide the discipline of a profit motive. Such an organization may be well suited to handle the complex logistics associated with large infrastructure projects, but may, over time, become inefficient and resistant to change. A failure may still place the burden back on the municipality to bail out the initiative.

The strategies of private providers and municipalities continue to evolve. Deals where the government-side assumed little risk are disappearing and private providers are looking for greater balance in risk exposure. Current trends also point toward a splintering of municipal strategies. Whereas larger cities are more likely to outsource development, small communities are developing MWNs on their own. Several small communities have been successful in obtaining community development grants from the state and federal government to jumpstart MWN projects. Such projects typically include social improvement and digital divide goals, which are less attractive to private providers. Some cities are also encouraging projects that cater to different constituencies. For instance, in Marquette, MI, the city government supported a university effort to cater to off-campus students in the college town, and also supported a purely commercial project.

MWNs may eventually disappear and become absorbed into the larger telecommunications landscape. Before that happens though, SUCH NETWORKS WILL ALTER OUR NOTION OF UNIVERSAL BROADBAND INTERNET ACCESS.

Management researchers and policymakers face challenging questions: How should the MWN be best managed and organized given diverse goals, legal constraints, potential for innovation, and rapidly evolving technology? Which model will lead to social improvement, regional development, and/or profit?

City	Grand Haven, Michigan
Population	Approximately 12,000
Physical Size	Approximately six square miles
MWN built in year	2004
MWN built by	Azulstar Networks (formerly named Ottawa Wireless)
Objectives	Improve quality of life, augment safety, attract businesses, boost tourism, assist education
Cost	Approximately $40,000/sq. mile
Business Model	Azulstar Networks has five-year non-exclusive license to install, operate and maintain network. Board of Light and Power granted permission to use its utility poles for installing radios. City gets five percent of revenues every three months.
Pricing Model	Available service plans: the first four are for individuals, the last two are for businesses:
Detailed Tech	A single fiber supplies Internet traffic to several hundred WiFi radios (802.11a, b, g) located around the city. Each of these repeaters contains a five-foot-high antenna, and has a range of two to three blocks. Customers mount an antenna outside their windows to pick up the signals.
Speed	Average download rate of 1.5Mbps
Network Reliability	Claimed to be greater than 99.7%—even under poor conditions (rain, fog, snow, high winds)
Other Benefits	Point-to-point dedicated VPN connections, access available 20 miles into Lake Michigan (custom-built ship-to-shore marine Wi-Fi radio), video surveillance
Sources	www.azulstar.com www.muniwireless.com/article/articleview/4263/1/23/ www.walkersands.com/Grand-Haven-First-Citywide-WiFi.htm

Monthly Plans	Base Monthly Price	Download Speed (bits/sec)	Upload Speed (bits/sec)	Daily Usage
Free	Free	256k	60k	1 hour
Entry	$14.95	512k	200k	Unlimited
Extreme	$29.95	1.5M	300k	Unlimited
Pro	$49.95	3M	400k	Unlimited
Sym 1.5M	$249.95	1.5M	1.5M	Unlimited
Sym 3M	$479.95	3M	3M	Unlimited

Stage 3: Implementing the MWN

In the final implementation stage, the network is built and made available to subscribers and the results are evaluated against the goals. A "build it and they will come" strategy could fail if potential users choose to ignore a municipal-led effort, or lack the resources needed to take advantage of it. MWNs are outside the core competency of most municipalities. Can a municipal-led implementation deliver acceptable quality of service and customer service levels? To ensure success, a MWN implementation will require a parallel marketing and education campaign to counter widely held negative perceptions about the competency of municipalities. Municipalities should also consider outsourcing arrangements for handling management and operational aspects of MWNs.

Conclusion

The convergence of need and availability has created the driving force behind the municipal wireless network. Social advocates see a low-cost, highly feasible solution that can have communitywide impact; technologists see the potential for new applications based on ubiquitous Internet access; civic leaders and politicians see an opportunity to dramatically impact the image of their constituent regions; and entrepreneurs see the potential for participating in the lucrative telecommunication industry. Parts of Philadelphia's network are now operational, but the long-term impacts remain to be studied. For researchers, there are compelling questions related to assessing the role of government intervention, understanding adoption issues, and gauging economic and social impacts.

MWNs may eventually disappear and become absorbed into the larger telecommunications landscape. Before that happens though, such networks will alter our notion of universal broadband Internet access. We believe that every municipality worldwide should explore MWNs because many social benefits are attainable and the costs are relatively low and can be externally funded. Implementation of MWNs has significant potential to create new economic opportunities and spur technological innovation. However, there is a danger that municipalities will react to vocal interest groups and change their direction, create new "state monopolies," and stifle new innovation to preserve investments. We recommend that implementers should identify the key stakeholder constituency (such as underserved populations), and create organizational structures to avoid a loss of focus, create organizational and financial structures that will help prevent monopolistic tendencies, and allow identification and adoption of new technological innovations (such as new higher bandwidth wireless standards) and, form creative partnerships with diverse entities to underwrite costs and bring in relevant expertise.

The stage-based framework presented in this article

represents an experienced-based first-step in understanding issues related to MWNs, provides guidelines for practitioners to act on, and presents issues for future research. C

References

1. Cornes, R. and Sandler, R. *The Theory of Externalities, Public Goods, and Club Goods*, Cambridge University Press, Cambridge, 1986.
2. Earthlink Wins Phila. WiFi Contract. *The Atlanta Business Chronicle*, (Oct. 4, 2005).
3. Fisher, S. Legislative Barriers Against Municipal Wireless (WiMax): And You Thought This Was About Technology?! www.Informit.com, (Oct. 21, 2005); www.informit.com/articles/article.asp?p=418865&rl=1.
4. Gillett, S.E., Lehr, W.H. and Osorio, C. Local government broadband initiatives. *Telecommunications Policy 28*, 7/8 (Aug./Sept. 2004), 537–558.
5. Hallett, T. Public sector rewarded for wireless innovation. Silicon.com, (Apr. 21, 2005); networks.silicon.com/lans/0,39024663,39129740,00.htm.
6. Jain, A., Mandviwalla, M., and Banker, R. Government as catalyst: Can it work again with wireless internet access? *Public Administration Review*, Nov./Dec., 2007.
7. Jain, A., and Mandviwalla, M. Preprototype perceived usefulness of a municipal wireless network: sources of variation among prospective users. In *Proceedings of the Twelfth Americas Conference on Information Systems* (AMCIS-12), Aug. 4–6, 2006, Acapulco, Mexico.
8. Kessler, A. When brotherly love goes wireless. *The Wall Street Journal*, (Sept. 1, 2005).
9. Mackie, K. PacketHop debuts mobile mesh solution. *Broadband Wireless Online*, (Nov. 10, 2003).
10. Rao, B. and Parikh, M.A. Wireless broadband networks: The U.S. experience. *International Journal of Electronic Commerce 8*, 1 (2003), 37–53.
11. Sirbu, M.A., Lehr, W.H., and Gillett, S.E. Evolving wireless access technologies for municipal broadband. *Government Information Quarterly* 23, 3–4 (2006), 480–502.
12. Wireless Philadelphia Business Plan. The Wireless Philadelphia Executive Committee, Feb. 9, 2005.

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DOI: 10.1145/1314215.1314228