THE FUTURE OF MUNICIPAL BROADBAND

BUSINESS, TECHNOLOGY AND PUBLIC POLICY IMPLICATIONS FOR MAJOR U.S. CITIES

civitium

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Preface, Scope and Acknowledgements

This report is the result of an unprecedented collaboration between three of the nation's leading cities; Boston, Chicago and San Francisco. These cities have led pioneering efforts to develop and implement broadband policies and programs aimed at improving the efficiency of their government operations, fostering sustainable economic growth, promoting digital inclusion, and making their cities more competitive on a national and global basis.

During this collaborative process, we first sought to consider the lessons learned by major U.S. cities during the intense period of municipal wireless projects - from 2004 through 2007. We then reviewed and analyzed the factors that most contributed to the market correction occurring in the second half of 2007. And finally, we attempted to forecast how the municipal broadband market would evolve going forward, and to formulate conclusions that would help to inform decision-making by major cities in this area in the future.

Our report attempts to strike a balance between the key issues facing major cities in the domains of broadband business, technology and public policy. This is based on the author's viewpoint that it is the collective alignment of these three domains that ultimately determines whether a city's vision can be realized and its goals met in a way that is sustainable over time. To achieve this balance, we occasionally had to sacrifice depth of analysis in one area in order to maintain an appropriate breadth of focus across all three domains.

We placed a primary emphasis on municipal wireless, and more specifically on citywide Wi-Fi initiatives. However, we recognized the need to also consider the emerging "big broadband" issue facing major cities; particularly as it relates to achieving an extensive, next-generation fiber optic infrastructure.

While digital inclusion policies and programs remain a driving factor and an area of intense focus for major cities, a detailed analysis of that topic went beyond the scope of our report. Based on the amount of innovative work being performed in this area, we propose digital inclusion practices as an appropriate topic for further study.

We extend our deepest gratitude to the cities who sponsored this report; Boston, Chicago and San Francisco. We also wish to thank the many anonymous persons and organizations who shared their knowledge and insights during the process.

Market Background

Beginning in 2004, several major U.S. cities began experimenting with the use of Wi-Fi mesh technology to improve their local broadband markets. Specifically, these cities envisioned blanketing their communities with a low-cost wireless alternative to existing broadband services (cable modem and DSL) to promote digital inclusion, stimulate economic growth, and provide a cost-effective broadband alternative for certain non-critical public safety and municipal applications.

By early 2007, more than 300 U.S. cities had launched municipal wireless initiatives,[1] and eight of the top ten U.S. cities (by population rank) were involved in some stage of studying, planning, evaluating, negotiating or deploying municipal wireless networks, either for municipal use, commercial use, or both.[2]

The majority of major cities adopted a business model calling for private ownership of a citywide wireless network, with cities providing or facilitating access to public rights of way and facilities, occasionally committing to be "anchor tenants" by making revenue assurances to their private partners, in exchange for these partners' commitment to provide certain community benefits such as revenue sharing and subsidized prices for low-income subscribers.

NOTABLE QUOTE

"The benefits of this ruling will ripple across our communities by encouraging greater investment in and a wider rollout of broadband networks."

James Smith, senior vice president at SBC, following the FCC's 2005 decision to deregulate ISP access to telephone networks

While this was occurring, important changes were underway in the overall broadband market. In 2005, the U.S. Supreme Court overturned a federal court decision that would have forced cable companies to share their infrastructure with Internet service providers (ISPs).[3] Following this, the Federal Communications Commission (FCC) moved quickly to "establish regulatory parity between telephone companies and cable companies" by rolling back DSL line sharing provisions from the 1996 Telecommunications Act.[4] The net result: ISPs could no longer be guaranteed access to incumbent telephone and cable networks.

At least one large ISP that was left frustrated by these developments – EarthLink Corporation – researched options to build a "third pipe to the home," ultimately deciding on Wi-Fi mesh as a suitable technology.[5] EarthLink began making aggressive investments to pursue partnerships with major U.S. cities and to construct citywide Wi-Fi mesh networks, ultimately being selected by Philadelphia, Houston, San Francisco and others.

By the end of 2006, it appeared that major cities had found a way to align their economic and social policy goals with a motivated segment of the broadband market – competitive ISPs. Armed with a potentially disruptive technology, expectations were high on both sides - the promise of revenue and profits for ISPs and the promise of community benefit for cities.

The Market Correction

NOTABLE QUOTE

"After thorough review and analysis of our municipal wireless business we have decided that making significant further investments in this business could be inconsistent with our objective of maximizing shareholder value."

Rolla P. Huff, EarthLink CEO, November 2007

By early 2007, numerous major cities and their candidate partners found themselves bogged down in lengthy negotiations, difficult procedural challenges, and in some cases, political opposition to issues ranging from public ownership to consumer privacy. Reports had also begun to surface that some early, large-scale build outs were seeing higher-than-expected deployment costs and lower-than-expected commercial usage.[6] In addition, questions were being raised about the stability and indoor coverage characteristics of many of these early networks.[7]

In June 2007, EarthLink appointed a new CEO,[8] who immediately began a process to review the viability of the company's growth initiatives, including its municipal Wi-Fi business unit. In August, he announced a company-wide restructuring, which included terminating approximately half of the company's work force and pulling back planned investments in municipal Wi-Fi.[9]

The changing market conditions also affected AT&T's investments in this area. The company called off its municipal Wi-Fi plans with St. Louis, reportedly due to an expensive retrofitting that would have been required to the city's street lighting infrastructure.[10] AT&T and Chicago were also unable to reach an agreement to form a public private partnership for citywide Wi-Fi.

By the time EarthLink had begun its strategic review in 2007, MetroFi – another mid-sized wireless ISP pursuing municipal partnerships – had already transitioned its business model to only build networks and provide free Wi-Fi access in communities where the city agreed to anchor tenancy commitments.[11]

Private investment in municipal Wi-Fi networks continued to decline. Kite Networks deployment in Tempe and Chandler, AZ was reportedly shut down[12] and Azulstar backed out of a commitment with Winston Salem, NC.[13]

This rapid decline in private investment had an immediate and direct impact on at least a dozen U.S. cities, which now found themselves without a motivated and/or capable private partner. It also had an indirect impact on dozens of smaller cities that were attempting to partner with local or regional ISPs. Many of these smaller ISPs, who required debt or equity financing to cover the cost of building networks, immediately found the financial markets' confidence level reduced, impacting their ability to execute as planned.

By the end of 2007, the prospect of major cities using a low-cost wireless technology to solve a wide range of economic, social and internal needs, while at the same time introducing new broadband competition and openness to their markets, under a business model that presented little taxpayer risk – appeared to be, as many had suspected - too good to be true.

Major City Reaction

Following the market correction, the majority of major cities halted or delayed efforts to seek a new private partner for citywide Wi-Fi, and many increased their focus on targeted pilot projects and digital inclusion initiatives. The table below summarizes the activities of major U.S. cities since the market correction occurred.

Rank	City	Recent activities
1	New York	Moving to the construction phase for a large-scale wireless network for public safety. No citywide plans for a commercial-use network being considered.
2	Los Angeles	Recently completed a feasibility study, which concluded that citywide Wi-Fi is not feasible at this time.
3	Chicago	Increased focus on comprehensive digital inclusion efforts. Opportunities for community broadband access being investigated. No citywide Wi-Fi network planned.
4	Houston	Leveraged a $5 million EarthLink payment to the City to increase focus on digital inclusion efforts. Released a new RFI in February 2008 to expand the City's downtown Wi-Fi network to targeted low-income areas.
5	Phoenix	Evaluating RFP responses for the construction of a Wi-Fi network in the downtown area for economic development. No citywide plans being considered.
6	Philadelphia	~80% of the network build-out completed. After failing to find a buyer for the network, EarthLink announced its intent to terminate services over the network on June 13. EarthLink also petitioned a federal court to grant it the right to remove its equipment and cap its liability to the city at $1 million.
7	San Antonio	Negotiations with AT&T halted in late 2007. No citywide plans being considered.
10	San Jose	Issued an RFP to conduct a feasibility study in 2007. RFP was later withdrawn.

NOTABLE QUOTE

"There is nothing so annoying as a good example."

Mark Twain

Rank	City	Recent activities
14	San Francisco	Initiated planning process for a government-use wireless network. Commenced work with organic ad-hoc Wi-Fi providers to promote community wireless deployments in targeted low-income areas.
24	Boston	City-designated nonprofit openairboston failed to secure financing for a citywide build-out. The City and openairboston have continued efforts to launch pilot projects in targeted neighborhoods.
30	Portland (OR)	~25% of the network build-out completed by the City's private partner, MetroFi. MetroFi stated that it would be unable to proceed with further deployments unless the city committed to substantial anchor tenancy. MetroFi later announced in May 2008 that it would seek a buyer for its networks in nine cities, including an offer to sell its Portland network to the city for $894,000.

As the data above shows, Houston is the only major city that decided to move forward by releasing a new Request for Information (RFI) in February 2008 to "expand [the City's] municipal network to further advance City operations, public safety, bridge the digital divide, and promote economic opportunities." Houston's enthusiasm and ability to continue investing in this area may be in part due to the $5 million payment it received from EarthLink following the company's failure to begin construction of the network it had agreed to build.[14]

Many small and mid-sized cities have also continued to move forward with hot-zone deployments and with public-financed projects to support municipal and non-critical public safety applications.

What about Minneapolis?

One of the few cities to make substantial progress towards a citywide Wi-Fi deployment under a public-private-partnership (PPP) business model after the market correction has been Minneapolis. Despite the negative press surrounding municipal Wi-Fi projects in general, the Minneapolis project has been touted as succeeding with a model that most others failed at.[15] For this reason, we chose to analyze what may have contributed to the ongoing progress of Wireless Minneapolis.

In 2006, Minneapolis selected U.S. Internet (USI), a local ISP, to construct a citywide (60 mi^2) Wi-Fi network for municipal and government use.[16] The city made substantial anchor tenancy commitments to USI, amounting to approximately $1.25 million per year for ten years. Originally scheduled for completion in the fall of 2007, the deployment was delayed by approximately six months, but is rumored to be near completion.[17]

Our analysis identified three important differences between the Wireless Minneapolis project and most other major city initiatives; 1) USI deployed Wi-Fi mesh equipment from BelAir Networks, whereas EarthLink had standardized on equipment from Tropos Networks; 2) EarthLink, MetroFi and other providers pursued aggressive, multi-city expansion plans, whereas USI remained intensely focused on its deployment in Minneapolis, and 3) the city of Minneapolis committed to a relatively high level of anchor tenancy.[18] Given that EarthLink and other operators cited the difficult economics of the municipal Wi-Fi business as the driving factor for their troubles, and not the technical capabilities of the network, we chose to perform more detailed analysis on the anchor tenancy terms.

Since there is no standard for an "appropriate level" of anchor tenancy in municipal Wi-Fi partnerships, we chose to consider the total amount of committed anchor tenancy based on its relationship to 1) the number of city government employees, 2) the estimated capital cost to construct the network and 3) the number of subscribers (citizens) passed by the network.

Our analysis estimated the net present value (NPV) of the City of Minneapolis' commitment of $1.25 million per year for ten years to be slightly more than $10 million.[19] This amounts to the city paying USI approximately $20/month, for ten years, for every one of the city's more than five thousand employees. And assuming a capital cost of $150,000/mi2 for the network, our analysis also suggests that the city's commitment provided USI with future revenue assurances equal to some 124% of the capital cost to construct the network.

The table below estimates the commitments that would have been required for Boston, Chicago and San Francisco were they to have duplicated the terms of the Minneapolis/USI agreement.

Assumptions	Minneapolis	Boston	Chicago	San Francisco
Land area in square miles	55	48	227	49
Estimated capex to build network (at $150,000/mi2)	$ 8,178,000	$ 7,200,000	$ 34,050,000	$ 7,350,000
Annual anchor tenancy commitment	$ 1,250,000	$ 4,658,021	$ 9,769,111	$ 6,515,957
Number of full time gov employees	5,311	19,791	41,507	27,685
Annual anchor tenancy commitment per full time gov employee	$ 235.36			
Monthly anchor tenancy per full time gov employee	$ 19.61			
NPV of anchor tenancy commitment	$10,138,620	$ 37,780,724	$ 79,236,243	$ 52,850,252
Ratio of anchor tenancy commitment to capex	124%	525%	233%	719%
Population	369,051	596,638	2,833,321	744,041
Anchor tenancy commitment per citizen	$ 27.47	$ 63.32	$ 27.97	$ 71.03

FIGURE 1 - ANALYSIS OF MINNEAPOLIS TERMS APPLIED TO BOSTON, CHICAGO AND SAN FRANCISCO

Our analysis of Minneapolis' anchor tenancy commitment on a per-city-employee basis does not take into account municipal uses of the network that may be measured by the number of facilities connected, or by remote devices such as video surveillance equipment, parking meters, etc. Regardless, based on the city's size, we were unable to determine how the city could reasonably consume $1.25 million in Wi-Fi services on an annual basis.

Our analysis also does not consider the community benefits that may result from the introduction of a new broadband provider and the construction of a citywide network.[20]

From our analysis, we conclude that Wireless Minneapolis is an anomaly in the municipal Wi-Fi market, and that attempts to duplicate the terms of the partnership between Minneapolis and USI in other major cities would have resulted in a compelling case for those cities to adopt a public ownership model (building) instead of a public private partnership (buying). In a public ownership model, the city may have likely 1) incurred roughly the same capital costs, 2) had full control over pricing and other terms of services for public access, and 3) had essentially unlimited access to the network for municipal use, avoiding the $1.25 million annual payment *ad infinitum* for being an anchor tenant.

It is possible that Minneapolis intended to leverage the network for applications well beyond its mobile workforce, assigned substantial community benefits to the deployment of the network, and/or decided that the risks of ongoing operational losses outweighed the government and community benefits that would have resulted from a public ownership model. Regardless of its motivations, Minneapolis has provided a clear example for how financial commitments from the city can strengthen the overall business case for citywide Wi-Fi.

Lessons Learned

NOTABLE QUOTE

"Hindsight is always 20/20."

Billy Wilder, Polish born U.S. film director

There was at least one great benefit that resulted from the intense period of activity related to municipal Wi-Fi projects over the past three years; it produced a wealth of data that can be looked back on and mined to identify lessons learned.

Through this assessment, we conclude that the major city municipal Wi-Fi movement was negatively impacted by business, technology and policy forces. Blame for the outcome of this movement cannot be placed on any one of these forces, or on any one party. Below are the key lessons that we found in our analysis that contributed most to the market correction and pullback of private investment:

- Irrational exuberance – Almost all of the parties involved in the pursuit of municipal Wi-Fi projects were inevitably swept up by the great promise of using a low-cost, seemingly disruptive technology to break down duopoly control and unleash economic and social improvements for communities. This can best be compared to the dot-com era where the Web was perceived as so radically different that it would obsolete the way in which company's were valued, and even the way the economy functioned.

- Overestimation of the market opportunity by ISPs – The companies who sought to build these large-scale networks overestimated their revenue potential (whether from access, advertising or other sources), the prices consumers would be willing to pay for services, the cost of acquiring new subscribers and numerous other demand-side assumptions.

- Overconfidence in an unproven architecture – While Wi-Fi as a core technology was viewed as robust and stable by 2004, there was no precedent for how it might actually function and perform on such a massive scale, and in such dense urban environments. How would laptops and handheld Wi-Fi devices function in an outdoor network? How well would the system deal with interference in a license-exempt frequency? What kind of devices would consumers need to get indoor coverage?

- Underestimation of incumbent's competitive response – While it may never be clear whether incumbent providers introduced promotional-rate pricing for DSL and cable modem services as a strategic response to the perceived threat of municipal Wi-Fi, or whether this was simply coincidence, it is clear that incumbent providers were in a good position to "skim the cream" off of a market where a competitor was planning to enter with a product targeted at price-sensitive subscribers.

- Over-reaching by cities – While cities were soliciting for, and negotiating with ISPs to build these networks, our experience and analysis suggests that they were in many cases "competing against prior cities" to get more community benefits, higher revenue shares, stricter service level agreements, and a range of others concessions from their partners. This was often due to pressure from community activists, bloggers and even special interest groups, some of whom seemed motivated to "take out their frustrations" over what they perceived as prior abuses by cable companies, private electric utilities and other industry players on whoever the city's chosen partner may have been.[21] Wireless ISPs were routinely agreeing to be regulated at a local level in ways that their stronger and better capitalized competitors (the incumbent telephone and cable companies) were not.

None of these factors alone was likely the sole cause of the market correction with municipal Wi-Fi in major cities, but together they created substantial pressure on an already fragile experiment.

Despite the fact that most major city municipal Wi-Fi projects did not result in citywide deployments, we conclude that the overall experience contributed to cities' understanding of their local broadband markets and their knowledge about the business, technology and public policy issues they would face going forward. This understanding and knowledge will inevitably be valuable to cities in the future as they embark on other technology-related initiatives.

The municipal fiber landscape

While wireless initiatives dominated the broadband agenda of many large cities since 2004, a number of leading cities were also studying whether and how they could achieve the goal of "big broadband" within their communities. Experts agree that fiber to the premise (FTTP) represents the "holy grail" for big broadband, and therefore we chose to consider developments in this area in more detail.

Fiber broadband services allow data signals to be sent over an optical fiber; a glass strand designed to guide light along its length. These networks offer an almost unlimited amount of bandwidth which enables providers to offer the "triple play" of voice, data and video services.

Private sector investments in fiber

AT&T and Verizon are currently engaged in upgrading their telephone network facilities in various parts of the country to fiber based systems; in some cases all the way to the customers' premise (FTTP) and, in other cases, to the "neighborhood or node" (FTTN). U-verse is an AT&T fiber service that can be deployed using either FTTN - where it runs fiber-optic cable to within 3,000 feet of a customer's home and existing copper lines the remainder of the way - or FTTP, where it runs fiber all the way to the home. FiOS (Fiber Optic Service) is a FTTP service offered in some areas of the U.S. by Verizon.

NOTABLE QUOTE

"Comcast would love to know our advance [FiOS deployment] plans for the District [of Columbia], and we're not inclined to help them any sooner than we have to."

Verizon Spokeswoman, September 2007

Telephone companies are not required to disclose the detailed deployment plans for their fiber networks, which has been a source of frustration for many communities.[22] While the timing of fiber deployments in major cities will inevitably vary by provider and by city, dense urban markets appear to be lower on their priority list than their suburban counterparts. Higher construction costs, lengthier permitting processes and ultimately lower consumer demand are often cited as contributing factors.[23]

Boston's situation is a classic example, and we believe is indicative of the outlook for most major cities. Despite Verizon's commitment to invest $200 million this year in Massachusetts for its FiOS rollout, the City of Boston was not listed as one of the cities where it planned to deploy.[24] This has led some to visualize Boston and other major cities' future as that of "a copper hole in a fiber doughnut."

On May 20, Verizon told the New York City Franchise and Concession Review Committee (FCRC) that "the company is ready, committed and eager to install its advanced fiber-optics network throughout all five boroughs of [New York City] and provide real TV choice to some 3.1 million households."[25]

While this seems to speak well for the prospect of a fiber deployment in at least one major city, critics point out that Verizon has until 2014 to complete this

rollout. And the contract allows extensions of up to three more years if Verizon's citywide market share does not exceed certain annual targets, known as "video penetration rates."[26]

Others have criticized whether the companies who make these commitments actually have a history of honoring them. In 1994, Verizon (then Bell Atlantic) struck an agreement with the state of Pennsylvania in which it received sizable financial incentives if it met certain broadband rollout criteria. It was estimated that those incentives were worth an estimated around $2.1 billion dollars to Verizon. The consumer advocacy organization TeleTruth later filed complaints with the Pennsylvania Public Utility Commission, claiming that while Verizon promised to provide 45 Mbps broadband access across the state, what they actually delivered was ADSL over their existing copper network - and then only in limited areas.[27]

It also remains to be seen whether these fiber deployments will result in meaningful competition for cable providers in the Internet and television market - even once they are deployed. Mark Cooper, director of research at the Consumer Federation of America, put it this way. "There is a little [price] jostling [between telephone and cable providers] at the beginning, but it's not like classical competition where you have 10 guys trying to figure out how to steal each other's customers. When you have just two players, they realize it's not in their best interests to have a price war."[28]

In summary, we conclude that private investment in next-generation fiber optic networks, particularly in dense urban cities, will likely proceed at a pace largely determined by these shareholder-owned companies. The issue for major cities is whether these schedules are adequate to meet their policy objectives, and whether the risk of relying solely on private investment for the next decade is a risk that can be tolerated.

Major city municipal fiber initiatives

The bleak outlook for private sector deployment in major markets has led several leading cities to consider various forms of market intervention, with the most aggressive scenario being public financing and ownership of a FTTP system.

The City and County of San Francisco commissioned one of the most comprehensive feasibility studies on FTTP in early 2007. The report evaluated "the feasibility of city ownership of a 21st Century fiber network to spur private-sector innovation and competition -- and thereby offer revolutionary bandwidth and services to businesses and residents."[29]

The San Francisco report recommended a "market-friendly" business model in which the city would deploy a city-owned FTTP network in phases at a total up-front cost of more than $500 million. The report recommended the city use the network to meet its own internal needs, and provide wholesale access to communication companies who would compete for commercial services. While San Francisco has continued to expand its fiber assets to connect additional facilities (one of the recommendations made in the report), no decision has been made by its elected body to pursue the more aggressive piloting of fiber in neighborhood zones.[30]

The City of Seattle has also been actively pursuing a FTTP strategy for several years. A mayor-appointed broadband task force was formed in 2005. The task force first asked private companies about their current plans to offer the level of broadband that would meet the city's long-term needs. The responding companies did not present plans to provide this level of service. The task force then concluded that "market forces, left alone, probably will not provide the broadband networks and services Seattle needs" and it established the following goal:

> *"[By 2015] all of Seattle will have affordable access to an interactive, open, broadband network capable of supporting applications and services using integrated layers of voice, video and data, with sufficient capacity to meet the ongoing information, communications and entertainment needs of the city's citizens, businesses, institutions and municipal government."*

NOTABLE QUOTE

"[Incumbent telephone and cable companies] are national firms -- as they do develop high-speed technologies and applications, the companies will first deploy them in markets where they must maintain a competitive edge, not necessarily in Seattle."

Seattle Broadband and Telecommunications Task Force Report, May 2005

The incumbent telephone and cable companies in Seattle – Qwest and Comcast, respectively – objected to the findings of the report and questioned whether there was sufficient demand in the Seattle market to justify such an upgrade. Despite the fact that Qwest allegedly told the task force that "they had no plans in the near future to offer Internet connections to Seattle residents that exceed seven megabits per second," they suggested that Seattle could help expand broadband by "removing permitting hurdles." In a letter to the task force, a Comcast senior vice president said "the city would be better served by providing incentives to existing network operators instead of building an entirely new system."[31]

In May 2006, Seattle issued a Request for Interest (RFI) to "gather comments, conceptual frameworks, and indications of interest and to identify partnership teams from private parties interested in and capable of partnering with Seattle to create a competitive fiber to the premises broadband (FTTP) network serving the City, its citizens, businesses and institutions." The city concluded its discussions with 10 of the RFI respondents in October 2006, but it appears little progress has been made since those discussions.

Finally, in March 2008, it was reported that Seattle Mayor Greg Nickels was now "looking to invite private companies to do that work – perhaps with taxpayer help [to finance the estimated $380-500 million cost of network construction and electronics.] Mayor Nickel's Information Technology Office also asked City Council to approve $185,000 to prepare a request for proposal (RFP), but that request has not yet been approved.[32]

NOTABLE QUOTE

"Our utility supplied water, sewer and electric. We figured three more utilities would not hurt anything."

Jim Kelley, vice president of operations for BVU/Optinet

Smaller cities are succeeding with fiber

Municipal FTTP projects have succeeded in a number of smaller markets. Bristol, Virginia, a city of 17,300 at the southwestern tip of Virginia, often refers to itself as "the birthplace of municipal fiber."[33] The city's utility department, BVU/Optinet, after winning a lawsuit against the state of Virginia, and introducing a bill in the state legislature that was signed into law in April 2002, began an aggressive expansion of its core fiber network. Today, BVU supplies a full triple-play of services over a FTTP system to 8,100 customers, with 7,200 telephone, 4,000 data and 1,600 television lines. The fiber infrastructure spans eight counties with 250 miles of fiber backbone installed and 675 total miles in the fiber plant infrastructure.

BVU/Optinet secured funding for its system through a mixture of city investment ($46 million) and federal and state grants ($30 million).

BVU is but one example of municipal fiber initiatives underway in smaller cities across the U.S. The City of Palo Alto (CA), the Truckee Donner Public Utility District in Truckee (CA), the EPB municipal utility in Chattanooga (TN), the Accelplus municipal provider owned by the city of Crawfordsville (IN), and the Jackson Energy Authority municipal utility in Jackson (TN) are just a few others that are in some stage of development.[34]

One observation we had from this review of the progress made with FTTP projects by smaller communities is that almost all were led by municipal electric utilities. Clearly, ownership of a municipal utility provides certain assets that can be leveraged to ease the process of designing, deploying and managing a communications infrastructure business. This may suggest that the ability for major cities to duplicate the approaches used and achieve similar levels of success will be more difficult than in smaller communities, given that the vast majority of major cities do not operate their own municipal electric utilities.

The Wireless Broadband Market

The wireless broadband market in the U.S. is one of contrasts. On the one hand, it can be viewed as fast-paced, dynamic, highly innovative and intensely competitive – with multiple providers using a wide range of existing and new technologies. On the other hand, it is often criticized for being a closed, proprietary, overly-priced oligopoly that limits consumer's choice and locks them into abusive contract terms and conditions. The truth may be somewhere in between.

For this report, we chose to consider developments in emerging areas of the wireless broadband industry that we felt would most impact major cities in the future; WiMAX, organic Wi-Fi and commercial 700 MHz.

The WiMAX Wild Card

The next-generation wireless technology referred to as WiMAX has been the subject of tremendous hype over the past few years.[35] While WiMAX has often been referred to as "Wi-Fi on steroids" due to the fact that it is standards-based, has the support of Intel Corporation and other leading technology firms who seek to embed it in mobile computing devices, and is designed to provide high-speed wireless data services over metropolitan areas, WiMAX is actually more of a complement to Wi-Fi than it is a competitor. The fact that Wi-Fi had evolved from home/office local area networks (LANs), to coffee shops and other public venues, to enterprise and university campuses, and finally to metropolitan areas - just as WiMAX providers were beginning to deploy large-scale networks - caused a great deal of confusion over the appropriate role for each technology.

WiMAX can be used to deliver a wide range of services, including fixed data services for residents and businesses, backhaul of Wi-Fi hotspot and cellular base stations for operators, and even high-speed mobile data services for consumers. WiMAX also differs from Wi-Fi in that it is, technically at least, spectrum independent – meaning that it can be operated over a variety of licensed or unlicensed frequency bands. Even though WiMAX products can be built to operate over various frequencies, the WiMAX forum has chosen to define several "profiles" that encourage equipment manufacturers and operators to build networks that will interoperate on a global scale. Adoption of these profiles also has a profound effect on the economics of a WiMAX business case, since mass manufacturing and economies of scale can result in dramatically lower costs for end user terminal equipment, thereby reducing the provisioning burden on consumers and the subsidy burden on operators.

Despite the hype and promise of WiMAX, and the fact that there have been more than a hundred technology and market trials conducted around the world, there

are no large-scale WiMAX networks in operation in the U.S. today, and the prospect of getting to that point remains cloudy.

More than 75% of the licensed spectrum (2.5 GHz) suitable for deploying WiMAX in the U.S. is controlled today by two companies; Sprint-Nextel and Clearwire. Sprint tends to own or control these licenses in larger metropolitan areas and Clearwire in tier-2 and below markets.

Clearwire currently operates in more than 40 markets in the U.S. where they have deployed a proprietary, fixed wireless technology often referred to as pre-WiMAX. The company is currently engaged in an effort to transition these deployments to a true mobile WiMAX (802.16e-2005) solution.

Sprint "soft launched" its WiMAX service under the brand name Xohm in three markets in 2007; Baltimore, Chicago and Washington DC. Since that time, its core voice business has struggled, beginning with a 77 per cent drop in third quarter 2007 net income, causing many to question whether it could commit the estimated $5 billion required to complete a nationwide deployment on its own.

NOTABLE QUOTE

"This [new WiMAX consortium] is a spaghetti-like mess of conflicts and self-interests."

Om Malik, GigaOm

In November of 2007, Sprint and Clearwire announced that they were terminating plans for the joint development of a nationwide WiMAX network.[36] The Wall Street Journal then reported on May 7, 2008 that Sprint, Clearwire, Comcast, Time Warner Cable, Google and Intel had reached an agreement to invest a total of $3.2 billion to build such a network.[37] Under the terms of this agreement, a new company – also called Clearwire – will be formed; Sprint will hold the majority interest; Clearwire will retain operational control; and the cable companies will market services under their own brand.

What does this mean for municipalities and their broadband policy goals and internal needs? Our analysis suggests that WiMAX, even if deployed on a nationwide basis over the next few years, will fail to produce substantial improvements to the availability, affordability or richness of wireless broadband services in major markets. This is due to a number of factors:

- Third-generation (3G) wireless services already provide near ubiquitous (universal) coverage today throughout most major cities. While these services are widely available, they remain priced at a substantial premium (typically in the $60/month range) over most other broadband options.

- A single provider (the new Clearwire) controls the licensed spectrum suitable to deploy WiMAX nationwide. This casts doubt on whether there will be sufficient competition to reduce pricing. Pricing for mobile WiMAX services have not been announced at this stage, but we estimate they may be in the range of current 3G data services.[38]

- The bandwidth provided to a typical WiMAX subscriber will be only a modest improvement over what is available on 3G networks today. While Mobile WiMAX can theoretically support an asymmetrical throughput of greater than 20Mbps downstream and 8Mbps upstream, the actual downstream throughput for each subscriber is expected to be in the 2-4 Mbps range.[39]

- Initially, through most of 2008, users will be required to purchase and install a WiMAX PC Card in their laptop, driving up the activation cost for early adopters. Intel has announced plans to provide an embedded WiMAX chipset (similar to the way Wi-Fi is embedded today) in laptop devices beginning in mid-2008, but until that happens, the process to access a WiMAX network will still have more "friction" than the Wi-Fi-like provisioning scenario it seeks to emulate.

- WiMAX faces stiff competition from another fourth generation (4G) wireless technology. The two largest mobile/wireless providers in the U.S. – AT&T Mobility and Verizon Wireless – have both committed to build their 4G networks on a competing technology called Long Term Evolution (LTE). This may have the effect of further fragmenting the U.S. wireless market and limiting the amount of interoperability between carriers.

Even with the challenges WiMAX is facing, the fact that Intel and other component providers have committed to embed it in mobile computing devices, and that the Clearwire consortium (namely through Google's participation) appears committed to a more "open" business model for WiMAX than that of rivals AT&T Mobility and Verizon Wireless, WiMAX could still succeed in creating positive changes in the wireless broadband market. It is simply too early to tell.

Innovations in Community Wireless

As prior initiatives by city governments to deploy traditional Wi-Fi mesh networks have faltered, new business models and technology innovations have also been emerging. One of the most promising has been the growth of organic (sometimes called ad-hoc) wireless networks by volunteer groups, and in some cases, in partnership with city governments.

Organic wireless networking involves consumers purchasing (or building) and deploying wireless access points on their premises, connecting these access points to the Internet in some way, and engaging in various schemes to share the resulting Internet service with others.

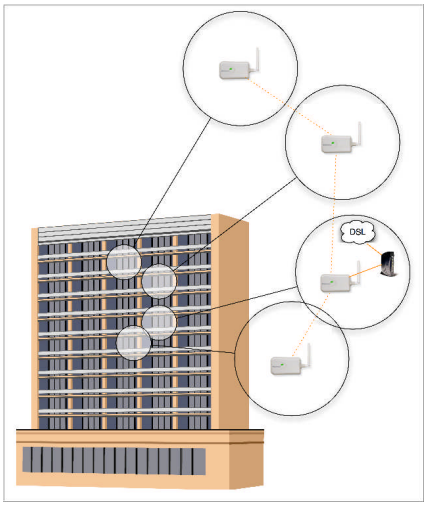

FIGURE 2 SAMPLE ORGANIC WI-FI DEPLOYMENT

Organic wireless networking grew out of various academic research projects including the Champaign-Urbana Community Wireless Network (CUWiN)[40] and Roofnet[41] at the Computer Science and Artificial Intelligence Laboratory of the Massachusetts Institute of Technology (MIT). More recently, organic wireless solutions have been commercialized by companies such as FON[42] and Meraki.[43]

While organic wireless networks do not necessarily introduce new technologies (they rely on commodity-based Wi-Fi equipment), they do present new and innovative business and deployment models that may have relevance for cities' broadband policy goals. Fundamentally, organic wireless networks promote a business and deployment model whereby the costs, ownership, management and other issues for the network are addressed not by a single service provider or city government, but rather by individual residents and businesses. One could think of this as Wikinomics[44] applied to the broadband access market.

San Francisco has been engaged in an innovative program to promote the growth of these organic wireless networks and create a "network of community networks." The role of San Francisco is one of an orchestrator; as opposed to partner or provider – coordinating with neighborhood organizations, facilitating access to facilities, and providing backhaul Internet services in targeted areas when computer use and Internet access is low.

Given the capital constraints that exist in the private-sector municipal Wi-Fi market today, and cities' desire for community involvement and empowerment, organic wireless solutions can and should be a substantial part of major city strategies going forward. While these organic networks may not be suitable today for mainstream municipal, public safety and other government or enterprise applications, they still may hold great promise in promoting digital inclusion, economic development and grass-roots innovation.

Organic wireless networks ultimately require Internet connections to be provisioned at some point(s) in the network in order to support the sending and receiving of data from users who connect to the shared access points. This is most often accomplished using a DSL or cable modem connection provisioned by the consumer who is sharing their Wi-Fi node. In this context, DSL and cable services become the "backhaul" for these organic Wi-Fi networks.

Telephone and cable companies have historically discouraged this type of bandwidth sharing over their networks, typically through restrictions in the terms of service for their offerings[45]; however we are not aware of any case where any user sharing an Internet connection has had their DSL or cable modem service terminated.

In some cases, telephone and cable companies have embraced ad-hoc Wi-Fi sharing over their networks. This is most often done after partnerships are struck between the telephone or cable companies and suppliers of ad-hoc Wi-Fi solutions, a trend that will be addressed in more detail below.

It seems clear that these organic Wi-Fi networks will continue to grow with or without involvement from local governments, and city infrastructure (e.g. street light poles, fiber and electricity) have not been required to support their growth. Despite this lack of dependence, there may be creative approaches that cities can use to promote further growth. One such option would be for a city-owned wireless network to provide a free or discounted, and possibly rate-limited tier of service, which could be used as an entry-level backhaul for organic Wi-Fi users (providing the consumers with a low or no-cost alternative to DSL or cable). This strategy could also mitigate the challenge organic users have of breaking their terms of service agreements with wired providers.

The remainder of this section will describe in more detail the two most common commercial organic Wi-Fi solutions in the market today; FON and Meraki.

FON

FON Wireless Ltd. "FON" is a company that runs a system of organic Wi-Fi networks. The company was founded in 2005 an Argentinean/Spanish entrepreneur.

FON's customers (which they refer to as Foneros) purchase a small Wi-Fi access point - which is called a La Fonera – install it in their home, and connect it to their DSL or cable Internet connection. The La Fonera access point splits the resulting Wi-Fi connection in two: an encrypted channel for the Fonero and a public channel for neighbors or passers-by. Foneros can decide how much of their bandwidth to share with the public

and can log on to any other Fonero's network without charge. "Aliens," as FON calls nonmembers, can register on a Web page and pay $2 or $3 for a day's worth of access.

In October 2007, FON and British Telecom (BT) announced that they had jointly created the BT FON Community by flashing FON's software on all of BT's DSL/Wi-Fi routers in the U.K. [4] The agreement allows for 3 million of BT's broadband subscribers to opt into the FON service, share their Wi-Fi at home and roam across all of the BT FON hotspots in the UK and everywhere else in the world. Foneros will also have free access to all of the FON hotspots in the U.K.

The announcement with BT came shortly after FON and Neuf Cegetel (in France) launched a similar service whereby 600,000 Neuf Wi-Fi routers throughout France were flashed with FON software.

In April 2007, the Associated Press reported that Time Warner Cable, Inc. would let its home broadband customers turn their connections into public wireless hotspots, presumably though a partnership with FON.[46]

Meraki

Meraki is a network equipment manufacturer that provides devices and software for wireless community networks. Based in Mountain View, CA, the company was founded by Sanjit Biswas and John Bicket, who were both involved in a Ph.D. program at Massachusetts Institute of Technology (MIT) and the Roofnet project. Meraki is venture capital backed in part by Google and Sequoia Capital.

Meraki is similar to FON in the sense that both companies market Wi-Fi access points, which are installed on the customers' premises and the resulting Wi-Fi connection is shared with others. Despite these basic similarities, the companies' business models and technology approaches are quite different.

- Each La Fonera from FON must be connected to an Internet service, typically using an Ethernet connection to a DSL or cable modem. Meraki has chosen to build mesh routing support into its access points, which allows some nodes to function as "gateways" and others as "repeaters." This has the effect of allowing more than one provisioned Meraki node to use a single cable, DSL or other Internet connection.
- Meraki sells both an indoor and outdoor version of its access points, whereas FON only provides an indoor model. Both companies' indoor

products are typically attached with suction cups to a window on an exterior facing wall.

- Both companies generate revenue through the sale of their access points, but their business models suggest that the margin on these equipment sales is low. FON's recurring revenue model is based on the splitting of access fees that Foneros charge to aliens (non Foneros). While Meraki's solution allows consumers who are hosting a Meraki node to charge fees for non Meraki users to access their node, it promotes sharing that is free of access charges for all users. Meraki's has a banner-message component for "network operator" use, and Meraki is doing a trial effort to integrate a small advertising banner into the users' experience, and generate revenue through advertising. Meraki also offers network management services as a paid service for sponsored Meraki networks.

  One could imagine Meraki's nodes becoming similar to Internet websites that host syndicated advertising through advertising networks like Google's AdSense. To the extent that each node has the ability to display targeted advertisements, and be targeted by AdSense advertisers, the nodes begin to resemble Internet websites that display "Ads by Google" today. This approach may provide the added benefit of being able to display locally-relevant – and presumably higher-valued – advertisements, since the location of each node is known to Meraki through its registration process. For a managed Meraki network, the message platform could also provide educational, community, or emergency messages.

Commercial 700 MHz

The Federal Communications Commission (FCC) held an auction in early 2008 for more than 60 MHz of wireless spectrum in the 700 MHz band. This spectrum was previously used for analog television broadcasting, specifically UHF channels 52 through 69. The FCC ruled that the impending switch to digital television would make these frequencies no longer necessary for broadcasters, due to the improved spectral efficiency of digital broadcasts.

The 700 MHz frequencies - which were split into five bands, lettered A through E - were often described as "the last remaining beachfront property" for licensed wireless spectrum in the U.S., due in part to the amount of spectrum available and its superior propagation characteristics (its ability to transmit through walls and other barriers).

The so-called C-block spectrum (22 MHz of spectrum between 746–757 and 776–787 MHz) was the most coveted band due in part to the fact that a handful of

regional licenses would be awarded, and these regional licenses would allow the winner to construct a nationwide network.

After 261 rounds of bidding over more than seven weeks, the auction ended, with proceeds amounting to almost $20 billion, nearly double what the FCC had forecasted. Verizon and AT&T won the lion's share of the high-valued spectrum. But despite this windfall for the U.S. Treasury, many open questions remain about the long-term impact of the auction results. While some had hoped that the C-block spectrum would be used to create a new "third pipe to the home," the fact that AT&T and Verizon both operate DSL networks throughout the country makes it unlikely that this spectrum will be deployed in such a way as to disrupt or compete with their legacy businesses.

In the end, the 700 MHz auction accomplished the primary goal of Congress and the FCC; to maximize auction proceeds for the U.S. Treasury. However our viewpoint is that the outcome of the auction will have little if any positive impact on broadband market conditions in the U.S. for the foreseeable future.

Wireless Solutions for Government Use

There are various wireless technologies designated for government-use only and, in some cases, for more specific use by public safety agencies. These technologies hold great promise for meeting the needs of major cities, even though they are not appropriate for commercial use by residents or businesses.

4.9 GHz

In 2003 the FCC allocated 50 MHz of wireless spectrum (4940-4990 MHz) for Public Safety use. 4.9 GHz is a licensed band available for use by public safety agencies, which generally includes all government entities, private companies sponsored by a government entity (such as private ambulance services) and any organization with critical infrastructure (power companies, pipelines, etc.) 4.9 GHz may be used for any terrestrial based transmission including data, voice, and video. Point-to-point and point-to-multipoint operations are both permitted.

4.9 GHz permits public safety agencies to implement on-scene wireless networks for streaming video, rapid Internet and database access, and transfers of large files such as maps, building layouts, medical files, and missing person images. It also allows these agencies to establish temporary fixed links to support surveillance operations. This allocation gives every jurisdiction in the country access to spectrum for deployable, interoperable, broadband communications.

Licensees must fulfill all three (3) of the following requirements:

1. Have as their sole purpose the protection of life, health, or property;

2. Be a state or local government entity or non-government entity authorized by a local or state public safety entity; and

3. Provide services that are not commercially available to the public.

4.9 GHz uses a geographic licensing scheme for mobile applications. A public safety agency can use all 50 MHz of spectrum within its legal jurisdiction whether that jurisdiction is a state, town, city, or county. However, fixed point-to-point operations require an individual license for each station. Licensees who are adjacent are responsible for interference prevention, mitigation, and resolution coordination.

Numerous vendors provide 4.9 GHz solutions today, including Cisco, Motorola, PacketHop, Terabeam Wireless and others. Many Wi-Fi mesh vendors have also integrated 4.9 GHz support into their multi-radio solutions.

Public Safety 700 MHz

As part of the 700 MHz auction process described above, the FCC had allocated 10 MHz, referred to as the D-block for construction of a nationwide, interoperable wireless network for use by public safety agencies. The innovative licensing scheme would have required that a private company construct the network at its own expense, adhere to certain requirements and timelines, and make it available to public safety agencies. Under the FCC's rules, the winner of the D-block could use the spectrum for commercial purposes, but would have to give public safety groups priority use during an emergency.

Frontline Wireless, a company co-founded by former FCC chairman Reed Hundt, originally sought to build a nationwide public safety network using 12 MHz of public safety spectrum, and 10 MHz from the commercial spectrum. Prior to the auction, Frontline backed out of the bidding process, and the D-block ultimately failed to reach the reserve price that had been set by the FCC.

Following the auction process, the FCC proceeded to "de-link" the D-block to release it from the auction's anti-collusion rules. On May 16, 2008, the FCC unanimously approved a notice of proposed rule-making (NPRM) for the re-auction process. Comments on the NPRM are due by June 20, and reply comments are due by July 7. Most experts predict that the FCC will make a final rulemaking in late July or August to enable a re-auction of the commercial D Block in the fall.[47]

NOTABLE QUOTE

"Absent a very unlikely large funding source from Congress, such a public-private arrangement [for the D-block auction] represents the last best hope we have for a nationwide network being built for public safety."

FCC Commissioner Michael Copps

Conclusions

Wi-Fi will continue to face pricing pressures

A business model that offers Wi-Fi mesh as an unbundled, consumer-paid alternative to existing broadband services across a major city is likely to be revenue-strained, whether publicly or privately financed. Given the current state of Wi-Fi mesh technology and the market in general, business models that provide free Internet access over Wi-Fi and attempt to achieve a return through some other value-add will be preferable over models that are dependent on consumer-paid access.

NOTABLE QUOTE

"When the marginal cost of producing something trends close to zero, the smart thing to do is to treat it as zero and get ahead of the competition, by giving it away for free in order to sell something else."

Chris Anderson, Editor in Chief, Wired Magazine – The Economics of Abundance

This may seem like an odd assertion; that Wi-Fi has a better chance of succeeding if it is free than if it is paid. The best way to explain this reasoning is to first consider the evolution of another breakthrough technology innovation, the Internet browser.

The graphical Internet browser was introduced in the early 1990s as a breakthrough innovation, resulting in the largest technology IPO in history at that time for Netscape. Of course Netscape attempted to, and was dependent on, monetizing the sale of the browser software itself. Ultimately, Microsoft recognized the browser's potential to disruptive its business, and it chose to "embrace and extend the Internet" by not only integrating its own browser into its Windows platform, but making its browser available for free. The rest is history as they say - especially as it relates to the impact of Microsoft's strategy on Netscape's business over time.

But how is that relevant for the evolution of Wi-Fi? Think of the characteristics of the Internet browser today, after almost 15 years of evolution; it is ubiquitous (there is almost no device that isn't pre-loaded with a browser), it is indispensible (no one can imagine being able to function without a browser), and it is free (no one could imagine actually having to pay to download a browser). We can also say that no single company ever made a fortune on the discrete sale of browser software. This seems strikingly similar to how Wi-Fi is evolving as a technology.

In more straightforward terms, Wi-Fi will likely be the next "zero billion dollar industry" - but like the browser, it may still unlock immeasurable benefits in the broader marketplace and society during this lengthy process.

The future of WiMAX is highly uncertain

With all of the uncertainty about the future of WiMAX in the U.S., local governments should avoid assuming these networks will be commercially available for at least the next one or two years. Of course an exception to this may be the

cities of Baltimore, Chicago and Washington, DC, where soft-launches have already occurred, and where commercial launches may happen more quickly.

Major cities will be left behind in the fiber race

Our analysis concludes that, without some form of intervention by local government, there is little chance that major cities will see substantial investment by the private sector in high-capacity, next-generation FTTP systems over the next decade. Given how "time is compressed" through technology and innovation, one could argue that being a decade behind other cities in FTTP deployments may become the equivalent of 30 years behind in 20th century infrastructures like roads, airports, utilities and other essential services.

As national broadband policy has moved to deregulate telephone and cable companies and video franchising has moved from local to state governments, local governments can no longer afford to assume that any single form of regulatory action will be suitable to ensure FTTP systems are deployed in a timely manner.

Government-use wireless systems are becoming critical

Faced with aging wireless systems to support public safety, high prices for commercial (3G) services, and an uncertain future for the nationwide 700 MHz network for public safety, we believe it is imperative that local governments "prepare for the worst" in this area by investing in efforts to evaluate, design and deploy wireless broadband infrastructure to support municipal and public safety needs of the future.

Numerous technologies exist today that can be applied to various critical and non-critical application needs. These include Wi-Fi mesh for low-cost non critical services, 4.9 GHz for fixed video capture and mobile connectivity, and microwave systems - for both ultra high-capacity point-to-point core networks, and point-to-multipoint services for connecting fixed facilities.

Policies need to address the demand side

The majority of broadband policies at a local level have focused on supply-side issues; promoting private investment in new networks, reducing barriers to adoption; creating PC purchase programs and so on. While these are important focus areas, our analysis concludes that policies and programs going forward will benefit from an increased focus on the demand side of the market.

Examples of demand-side policies might include aggregating demand for broadband services across city government with that of sister agencies, nonprofits, education, and the healthcare community; increasing investments in computer literacy programs for segments of the community where computer and Internet use is low; and engaging large enterprise in activities to leverage their buying

leverage and assets. Many of these align with existing digital inclusion programs, but we conclude that demand creation only in the margins of a low-income population may not be enough to tip the scales for dramatic increases in private investment.

A renewed push for big broadband is needed

There is little debate over the impact that big broadband has and will have on major cities' ability to attract and retain businesses, promote knowledge-based jobs, and compete globally in the 21st century. The intense focus on municipal wireless initiatives over the past few years has dominated the resources available to many local governments, in many cases to the detriment of longer-term planning efforts for fiber systems.

Major cities should renew a push for achieving the goal of a FTTP infrastructure within the next decade, through whatever public, private or cooperative models may be available. With estimates from prior FTTP studies suggesting an average cost of $1,400 per housing unit passed, and deregulation resulting in less and less local control over incumbent providers, this may seem daunting, if not nearly impossible.

There are monumental challenges to achieving such a goal. Beyond the enormous cost estimates, major cities must also confront declining property and sales taxes during a possible recession, uncertainty about the true demand for such a system, issues of regulatory authority, opposition from incumbents and special interest groups, an absence of precedent for success in other major cities - not to mention the fact that a decade-long FTTP initiative may have to sustain political support through turnovers in mayoral administrations and city council elections.

Despite these many challenges, the stakes could not be higher for major cities. It is inevitable that a certain "leap of faith" will be required to commit to such an ambitious goal and work towards it over time.

Major cities have a role to play in national policy

While many of the recommendations above translate to major cities exercising more "local control," these cities may also have an untapped resource for influencing national broadband policy. In the past, local government influence in this area might have occurred through lobbying Congress or the FCC directly on important issues or working with local government organizations such as NATOA and NLC to develop and support various broadband policies.

We conclude that in addition to these efforts, major cities have a new opportunity to advance their positions; that is the political voice of their elected officials. While broadband policy may not become a platform issue for most major city

mayors, and they may be unlikely to engage in detailed public debates over network neutrality, open access, structural separation and issues at that level, we propose that a simple, concise message from one or more major city mayors acknowledging the desperate need for a strong national broadband policy could elevate the importance of this issue dramatically. This may be particularly true during a national election cycle like the one going on in 2008.

Balancing business, technology and public policy is key

As we note earlier in our report, successful major city broadband programs going forward need to strike a balance across business, technology and policy domains.

For example, a program based on sound policy, with a bulletproof business model, but incorporating technology that isn't viable will likely fail. Similarly, the same business model combined with a perfectly-suited, breakthrough technology, may fail if it is either over or under-regulated by local government.

Endnotes

[1] Source: Muniwireless.com

[2] Source: Civitium analysis of major city municipal Wi-Fi projects.

[3] See http://www.news.com/Cable-wins-Supreme-Court-battle/2100-1036_3-5764120.html

[4] See http://www.pcworld.com/article/id,122136-page,1/article.html

[5] Source: Civitium and Baller Herbst Law Group interview with Donald Berryman, EVP and President of EarthLink Municipal Networks, July 2006

[6] See http://arstechnica.com/news.ars/post/20071119-earthlink-decides-theres-no-money-to-be-made-in-municipal-wifi.html

[7] See http://www.news.com/Wi-Fi-lessons-learned-in-Tempe/2100-7351_3-6088661.html

[8] Rolla P. Huff was appointed to the CEO position at EarthLink following the sudden death of Gary Betty in early 2007. Mr. Betty had been one of the nation's most visible advocates of municipal Wi-Fi, and had promoted municipal Wi-Fi investment as a growth strategy within EarthLink.

[9] Source: EarthLink Corporation Press Release. See http://www.earthlink.net/about/press/pr_elnk_restructure/

[10] See http://www.betanews.com/article/Another_MuniWiFi_Deal_Ends_as_ATT_St_Louis_Part_Ways/1193680197

[11] MetroFi signaled a change in its business model in mid-2007 when it failed to reach an agreement on anchor tenancy commitments with Anchorage, AK. See http://wifinetnews.com/archives/007777.html

[12] See http://wifinetnews.com/archives/008111.html

[13] See http://www.bizjournals.com/triad/stories/2008/03/03/daily26.html?ana=from_rss

[14] Houston Mayor Bill White stated in December 2007 that "One of the goals of the WiFi plan was to bridge the digital divide, and because of the city's good contract, we have substantial money to invest in that." See http://www.chron.com/disp/story.mpl/tech/news/5352555.html

[15] See http://www.twincities.com/ci_8525968

[16] Source: U.S. Internet Press Release. See http://www.usinternet.com/press-releases/Minneapolis-Selects-US-Internet.htm

[17] Joe Caldwell, U.S. Internet's marketing vice president stated that "some dead spots in the network -- primarily from Lake of the Isles to Loring Park and Lowry Hill -- will persist until summer [of 2008.]" Minneapolis city officials attributed these dead spots to "decorative poles in those areas aren't tall enough or strong enough [to support the mounting of Wi-Fi equipment.]" Mr. Caldwell also stated that "Excluding the dead spots, US Internet has installed Wi-Fi equipment in all parts of the city except a three-square-mile area near Lake Nokomis." See http://www.startribune.com/business/16583416.html

[18] Source: Civitium analysis of major city public private partnership agreements.

[19] Standard Net Present Value (NPV) calculation using a 4% discount rate and $1.25 million each year for ten years.

[20] The city documents on its website a variety of community benefits it expects to result from the USI partnership, including $500,000 to create a "digital inclusion fund," a minimum of five percent of the network's net profits, free limited-time service in some public locations, a free "walled garden" level of service for neighborhood, government, and community information, and free wireless access for designated community technology centers. See http://www.ci.minneapolis.mn.us/wirelessminneapolis/commbenefits_wireless.asp

[21] See http://www.civitium.com/archives/2007/02/municipal_wi-de.html

[22] See http://www.washingtonpost.com/wp-dyn/content/article/2007/09/26/AR2007092602468.html

[23] Render, Vanderslice & Associates, a market research firm stated that "building underground fiber networks in highly congested urban areas can cost $100 or more per foot of cable installed. By contrast, placing fiber underground in the suburbs costs $7 to $25 a foot." See http://www.nytimes.com/2006/08/14/technology/14verizon.html?pagewanted=1&ei=5090&en=9543bc769334ba6e&ex=1313208000&partner=rssuserland&emc=rss

[24] See http://www.multichannel.com/article/CA6536391.html?nid=2734&rid=301793425

[25] See http://newscenter.verizon.com/press-releases/verizon/2008/verizon-ready-and-eager-to.html

[26] See http://www.nydailynews.com/ny_local/2008/04/25/2008-04-25_verizon_tv_proposal_needs_tuning.html

[27] See http://www.teletruth.org/docs/PENNCOMPLAINTFIN.doc

[28] See http://www.nytimes.com/2008/05/27/nyregion/27verizon.html?_r=1&ref=technology&oref=slogin

[29] See http://www.sfgov.org/site/uploadedfiles/dtis/tech_connect/SFFiberFeasibility.pdf

[30] The San Francisco report dealt extensively with the cost, timing and other implications of constructing fiber in concert with other public works projects (e.g. sewers, sidewalks) and it is unclear whether and how those issues will affect any decisions to appropriate funds to move the project forward.

[31] See http://seattlepi.nwsource.com/business/227127_qwest04.html

[32] See blog.seattlepi.nwsource.com/seattlepolitics/archives/134669.asp

[33] See http://www.lastmileonline.com/index/webapp-stories-action?id=103

[34] Source: Fiber Deployment Roundup: Municipal Deployments Gather Steam - Marsha Zagar, Broadband Properties, September 2007, See http://www.gscbn.com/UserFiles/0065/0124/File/Fiber_Deployment_Roundup.pdf

[35] The term WiMAX is actually a certification mark for products that pass conformity and interoperability tests for the IEEE 802.16 standards.

[36] See http://gigaom.com/2007/11/08/clearwire-sprint-call-their-deal-off/

[37] See http://online.wsj.com/article/SB121010437224271501.html

[38] Intel Corporation, a principal backer of WiMAX, has been pushing for what it calls "30/30" – a $30 [radio/modem] cost and a $30 monthly service cost.

[39] A Computerworld article quoted "several Sprint executives" as "hav[ing] described Xohm WiMax speeds that are expected to be 2Mbit/sec. to 4Mbit/sec., although the technology is capable of 10Mbit/sec." See www.computerworld.com/action/article.do?command=viewArticleBasic&articleId=9039281

[40] See en.wikipedia.org/wiki/Cuwin

[41] See en.wikipedia.org/wiki/Roofnet

[42] See www.fon.com

[43] See www.meraki.net

[44] Based on the book *Wikinomics: How Mass Collaboration Changes Everything,* by Don Tapscott and Anthony D. Williams, Wikinomics is based on four ideas: Openness, Peering, Sharing, and Acting Globally. In their book, Tapscott and Williams put forth a framework for how collaboration and peer-production of information, ideas and content (e.g. wikis, blogs, photo sharing,) together with the networks to distribute this peer-produced content, can transform markets and society. See www.wikinomics.com

[45] AT&T's DSL Service Subscriber Agreement: Section 8.a states that "You cannot create a network (whether inside or outside of your residence) with AT&T DSL Service using any type of device, equipment, or multiple computers unless AT&T has granted you permission to do so." See http://worldnet.att.net/general-info/terms-dsl-data.html

[46] See http://www.freepress.net/news/22702

[47] See http://mrtmag.com/policy_and_law/news/comment-period-dblock-0523/