



Localizing the Internet: Five Ways Public Ownership Solves the U.S. Broadband Problem

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Executive Summary

Local governments have taken the lead in U.S. broadband policy. Hundreds of communities of all sizes are making decisions about how to best deliver universal, affordable access to high-speed information networks. Many are offered seemingly attractive arrangements with no upfront cost to the city. They do themselves and their households and businesses a disservice if they do not seriously explore the costs and benefits of a publicly owned network.

In this report, we highlight five arguments for public ownership.

1. High-speed information networks are essential public infrastructure.

Just as high quality road systems are needed to transport people and goods, high quality wired and wireless networks are needed to transport information. Public ownership of the physical network does not necessarily mean the city either manages the network or provides services. Cities own roads, but they do not operate freight companies or deliver pizzas.

Information networks are technologically sophisticated and the technologies involved are rapidly evolving. However, fiber optic cables are to this century what copper wires were to the last, and their capacity is essentially unlimited. While wireless networks are experiencing rapid advances, the initial investment is so low and the payback period so short that rapid upgrades are part of both private and public business plans.

2. Public ownership ensures competition.

A publicly owned, open access network can be open to all service providers on the same terms, thereby encouraging the entry of new service providers. Customers can choose broadband service providers according to the combination of price, speed and service that fits their needs. This is particularly important given that consolidation in the telecommunications industry and a hands-off policy by the federal government have combined to lessen competition among private suppliers.

Cities establishing new, privately owned citywide networks can require the owner to allow fair access. But it is unclear whether these contractual obligations will be enforceable in the future.

3. Publicly owned networks can generate significant revenue.

Telecommunications networks are different from traditional public works like roads because they can be self-financing both in terms of initial construction costs and ongoing upgrades. They can also generate revenue for local government, reduce the cost of government services, or keep more money in residents' pockets with lower prices.

4. Public ownership can ensure universal access.

Publicly owned road, water and sewer, and sidewalk networks connect all households without discrimination. All have access to the same services, though they may purchase different amounts. Private companies, on the other hand, have incentives to upgrade their networks only where it will be the most profitable.

5. Public ownership can ensure non-discriminatory networks.

With publicly owned networks, customers can be sure that any traffic management mechanisms are necessary and not simply to improve profitability. Communities can insist on neutrality from any service provider that uses the network. Or, if the market is large enough to support multiple service providers, a publicly owned network can leave neutrality to the market, knowing that unhappy customers can easily change service providers.

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Introduction

Ten years after the 1996 Telecommunications Act, which was supposed to accelerate the introduction of high-speed communications systems, the U.S. has dropped from first to 15th in the world for the percentage of residents with high-speed Internet access.

Increasingly, local governments are stepping in where the private sector and federal government have failed. Hundreds of cities are currently debating strategies to develop citywide broadband networks. They share common goals – universal coverage, equitable access, increased competition, and more effective use of the new communications systems for municipal services, especially those related to public safety.

Their discussions often ignore or give short shrift to a crucial issue: who will own the information network?

Ownership matters. As we will argue in this report, public ownership of the physical infrastructure may be the only way to guarantee future competition. It is clearly the only way that communities can influence the design of their future information systems. And public ownership can allow a community to tap into the growing exchange of information to generate significant revenues while enabling all households in the city to have affordable access.

As of mid-2006, more than 650 cities own telecommunications systems.¹ These range from downtown fiber optic networks that connect public buildings and major businesses, to citywide Wi-Fi networks that offer retail service to all residences and businesses. These publicly owned networks have proved remarkably successful in meeting the community's need for advanced services at fair prices.

This first wave of public ownership largely occurred in cities that already owned their electricity networks. That ownership was born a century ago out of public frustration at privately owned utilities' refusal to ex-

tend service beyond larger cities. Today, municipal electric utilities are expanding into broadband telecommunications, born of a similar frustration at telecommunications companies' slow response to the needs of small and rural communities.

More recently, communities without municipal electric utilities have begun exploring a governmental role in accelerating the deployment of high-speed information networks. These urban and suburban communities already have some level of high-speed Internet access through cable and telephone company networks.

The incumbent suppliers vigorously oppose any municipal involvement, either through public ownership or by facilitating a competitive network. At the same time, companies that had been leasing space on incumbents' networks view municipal involvement as an opportunity to build their own networks, with public support. They offer cities what appear to be very attractive arrangements if the city grants them an exclusive contract.

Large cities – Philadelphia, San Francisco, Minneapolis, Boston, Houston, Seattle, and others – have become the front lines in the battle for affordable, high-speed information and communication networks.

So far, these larger cities have tended to choose privately owned, for-profit networks. They choose expedience over security. They choose the comfort of dependence rather than the risks and rewards of independence. They choose a small, guaranteed income via a franchise fee over the potentially large benefits, financial and otherwise, that stem from public ownership. We believe such a choice does a disservice to their households and businesses, as well as the local government itself.

An Astonishingly Brief History of Telecommunications Regulation

That Was Then

For the first century of telecommunications in the United States, the public sector was deeply involved in the introduction and elaboration of both wired and wireless systems. Telephone networks were regulated monopolies. Companies received an exclusive franchise for a specific geographic location and a guaranteed profit, in return for

What is Public Ownership?

Public ownership means ownership by citizens, customers, or the community. It comes in many different forms.

Municipal Networks are owned by a local government entity. This may be the city itself, as in Saint Cloud, Florida, or a municipal utility, as in Moorhead, Minnesota.

Cooperative Networks are customer-owned, as is the case with the Mountain Area Information Network in North Carolina.

Non-profit Networks often are a partnership between a number of public and non-profit entities. OneCommunity (formerly OneCleveland), for example, is owned by a non-profit organization established through a partnership between a number of public and non-profit entities.

Community Networks consist of individual users owning the hardware and voluntarily participating in an ad-hoc network. Some are sponsored by non-profit organizations. Typically these networks offer free access. SoCalFreenet, NYCWireless, Seattle Wireless, and Ile Sans Fil in Montreal are all community networks.

Hybrid Networks. Many networks are hybrids, building on the strengths of multiple partners. For example, REA-ALP Internet Services is a partnership between Runestone Electric Association, a rural electric cooperative, and Alexandria Light and Power, a municipal utility. The Urbana Project is a partnership between Champaign-Urbana Community Wireless Network and the City of Urbana. Austin Wireless is a community wireless network, but operates some portions of its network in cooperation with the City of Austin.

which they had to provide universal coverage at affordable, fixed rates. Telephone and telegraph wired networks were declared common carriers, that is, open to all users on equal terms.

The wireless spectrum, used for radio and TV broadcasts, also was regarded as a public asset and regulated by the federal government. Companies received licenses to use specific frequencies in defined areas based on a determination of "best public use." In return they had to abide by certain rules that protected the public interest, rules such as the "fairness doctrine" that required stations to allow access for opposing viewpoints. Broadcast licenses were limited in duration. Renewal depended on the licensees' living up to the rules, and their continuing demonstration that they served the "public interest, convenience and necessity." Congress also promoted competition by limiting the number of radio and TV stations a single company could own and the cross-ownership of newspapers and broadcasting stations in the same market.

When cable television was introduced as a way to deliver better reception and more channels than could be carried over the airwaves, companies received exclusive franchises to deliver non-broadcast television from local governments. In exchange they agreed to provide public benefits in the form of franchise fees and local programming.

The first computer networks emerged in the late 1960s, a result of federal research investments.² The Federal Communications Commission (FCC) issued its first regulation related to computer communications in 1971, when it ordered AT&T to allow competitors to use the telephone network for data services without interference.³ That order also prohibited AT&T itself from getting into the business, out of concern that the company would use its ownership of the network as an unfair advantage over competitors.⁴ In 1980, the FCC allowed AT&T to begin offering data services, but still required the company to carry competitors' traffic on equal terms and without interference.⁵

These regulations facilitated a competitive and innovative market for services like voice mail, computer bulletin boards, and other "enhanced services."⁶ Further public investment took computer networks to the next level. What we now know as the Internet began as a federal project, the National Science Foundation Network, in the mid-1980s.⁷ The national backbone and regional networks it connected were developed with billions of state, university and federal dollars.⁸

This is Now

Over the last two decades, both the regulation and structure of wired and wireless telecommunications changed dramatically. The definition of public interest has been severely curtailed, as has the authority of local, state and federal governments to assert the public interest.

In 1984, Congress limited local authority to enforce cable franchise agreements. In 1987, the FCC eliminated the fairness doctrine. In 1994, the FCC began auctioning spectrum to the highest bidder, and the Internet backbone was turned over to private companies. In 1996, the Telecommunications Act lifted many of the restrictions on the concentration of media ownership, deregulated cable prices, and substantially deregulated the Baby Bells.

One of the few remaining areas of public involvement was the requirement that phone companies allow competing Internet service providers (ISPs) to connect to their customers via their networks. The 1996 Telecommunications Act contained this requirement. Its intent was to spur broadband infrastructure deployment. Cable companies were not covered by the same rules. They were not required to offer equitable access to their networks to ISPs.

As people began moving from dial-up to broadband, the different regulatory regimes for phone and cable companies became important. Local governments tried to rectify this inconsistent treatment of companies offering the same service – high-speed, always-on Internet access – by requiring their cable franchisees to become like the phone companies, that is, common carriers, and to allow other service providers to use their copper lines at a fair price.

Courts consistently struck down these local efforts, even when cities made open access a condition for renewing a cable franchise. The courts agreed with the FCC's position that Congress had preempted local authority on this issue. The U.S. Supreme Court upheld the FCC's position in its 2005 Brand X decision.⁹

Before the Supreme Court issued its decision, in 2003, the FCC ruled that telephone companies did not have to share the fiber optic portions of their networks. It left to state governments to determine whether wholesale access rates for competing ISPs should be regulated. Most states chose not to regulate rates.¹⁰ Almost immediately after the Brand X decision, the FCC extended its exemption from common carrier requirements to phone companies' data networks as well.

Today, neither cable nor phone companies are required to allow competing Internet service providers to use their networks (though some choose to do so).¹¹

Meanwhile, technology is moving us into an era in which text, voice and video are carried over the same broadband networks. The incumbent communications companies are now trying to be everything to everyone with "triple play" packages. The FCC has used this as a further justification for deregulation, arguing that the existence of cable, phone, and satellite networks, and the emerging technologies of broadband transmission over power lines and terrestrial wireless, creates an adequate level of competition between network owners.

Such an argument is, at best premature. Approximately 98 percent of high-speed Internet connections come from cable or phone companies.¹² For most households, even in larger cities, the market is dominated by one cable company and one phone company. Many neighborhoods do not even have two choices, since not all areas of phone company networks are equipped to offer DSL. If they do offer DSL, it is at speeds of 1.5 Mbps or less, compared to 3 to 6 Mbps from cable, and with no capacity to support video.

Some ten percent of households do not have access to broadband from any provider at any price.

At the national level, the telecommunications industry is consolidating. Only slightly more competition exists in the telephone sector than in the days of Ma Bell. In 1984, AT&T was broken into eight regional "Baby Bells." Ensuing mergers and acquisitions have left us with just three: Verizon, AT&T,¹³ and the much smaller Qwest. The two largest cellular phone companies, Verizon Wireless (majority owned by Verizon), and Cingular (soon to be wholly owned by AT&T) currently command more than half the market. Two cable companies, Comcast and Time Warner, control 47 percent of the cable television market.¹⁴

The lack of competition has slowed the expansion of the U.S. broadband market. We are 15th in the

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world in broadband penetration, according to the International Telecommunications Union, down from 4th in 2001. We perform even more poorly in the ITU's "digital opportunity" index, which considers price and capacity as well as other factors, coming in 21st.¹⁵ Broadband subscribers in the U.S. pay twice as much as customers in Asia and Europe for one-twentieth the speed.

Local governments tried to rectify this inconsistent treatment of companies offering the same service – high-speed, always-on Internet access – by requiring their cable franchisees to be common carriers. Courts consistently struck down these efforts.

The Internet was invented in the U.S., but other countries are now taking the lead. For example, the private companies that own the Internet backbone in the U.S. have resisted upgrading to a new version of the Internet address system (IPv6) for nearly a decade. IPv6 greatly expands the pool of Internet addresses, allowing everything from cars to thermostats to have unique addresses, and allows for increased network security. This year, China converted to IPv6, and now the U.S. will have to follow its lead.¹⁶ American high-tech companies like Google are setting up research facilities in Asia, because U.S.

broadband subscribers do not have the capacity to use new applications under development.

FCC Commissioner Michael J. Copps recently wrote in the *Washington Post*:

America's record in expanding broadband communication is so poor that it should be viewed as an outrage by every consumer and business person in the country. Too few of us have broadband connections, and those who do pay too much for service that is too slow. It's hurting our economy, and things are only going to get worse if we don't do something about it.¹⁷

Broadband Access and Competition: Truth and Fiction

Do Americans have choices when it comes to broadband? Reports from the Federal Communications Commission would make you think so. A July 2006 Washington Post editorial cites statistics from the Commission. "More than 60 percent of Zip codes in the United States are served by four or more broadband providers that compete to give consumers what they want," they argue. Anyone who has tried to shop

around for high-speed Internet access will find this assertion surprising.

In 1996, Congress required the FCC to report statistics on broadband penetration. Every other year, the FCC reported to Congress that the U.S. was making progress toward the goal, set forth in the 1996 Telecommunications Act, of making broadband available to all Americans. Yet each year, in international comparisons, the U.S. was falling further and further behind.

Finally, a frustrated and confused Congress asked the Government Accountability Office (GAO) to evaluate the FCC's methodology. In 2006, the GAO issued two reports confirming the conclusion consumer advocates had reached years before: The FCC statistics are so flawed as to be useless in gauging broadband availability and competition.¹⁸

The FCC, for example, does not distinguish between business and residential services. It counts a provider as offering service in the zip code even if it is offered only to businesses. If an ISP (Internet Service Provider) has a single business customer in a zip code, it is recorded as serving the entire community.

The FCC counts as competitive providers those ISPs who lease lines from the incumbent telephone company at retail rates. Given current federal rules, this is nonsense.

The FCC counts the ISPs who lease access to incumbents' facilities as competing service providers even though it is structurally impossible for them to compete on price. For example, an independent ISP in Minneapolis charges \$20 per month for its services (i.e. email accounts, customer support), plus a "Qwest DSL monthly circuit rate" of \$22 per month for a 1.5 Mbps/896 kbps connection. Qwest offers the same package for an introductory price of \$32. Qwest imposes the same terms of service on all who use its lines, whether retail customers or resellers. Thus an independent ISP cannot compete, for example, by allowing customers to share its connection through a wireless router (something Qwest prohibits).

In removing common carrier requirements from phone and cable networks, the FCC argued that competition will come from so-called inter-modal, or network based, competition. They assume satellite, broadband over power lines (BPL), and terrestrial wireless will create more competition over time. But satellite represents just two percent of the broadband market, a figure that has changed little over time.¹⁹ BPL is useful for power grid management and within building networking; there are only a handful of de-

poyments providing Internet access to a few thousand homes in the U.S.²⁰ Both have limited potential to provide high-capacity connections.

Terrestrial wireless has emerged as the strongest competitor to wired networks. But whether it will be a competitor depends a lot on how it is deployed.

WiMAX,²¹ which is being promoted as the future of wireless, relies on licensed spectrum that is auctioned to the highest bidder. Large companies like AT&T, Sprint, and Clearwire hold most of the spectrum in the bands most likely to be used for WiMAX in the U.S. Deploying WiMAX is not an option for anyone, including municipalities, who does not hold spectrum in these bands.

Increasingly, incumbent phone companies are also using unlicensed wireless. Local phone incumbent Embarq, a spin-off of Sprint, has a citywide Wi-Fi network in Henderson, Nevada. AT&T will soon be providing citywide Wi-Fi in Springfield, Illinois, where it is also the incumbent, on an exclusive franchise. Comcast, which controls about one-third of the U.S. cable market,²² is an investor in Bel-Air Networks, which builds municipal wireless networks.

Unlicensed spectrum can be used by everyone. Thus, Wi-Fi is more open to competition than WiMAX. But the potential for interference between Wi-Fi networks, and other factors may give the first company into a community a de facto exclusive franchise.²³

Why Public Ownership?

The stakes are high. Local governments are stepping in where state and federal policies of privatization and deregulation have failed. Despite a brief backlash against municipal broadband projects, it is increasingly accepted that cities have the authority to develop telecommunications plans. In elaborating such plans, they must take into account many factors, but the one that will have the greatest effect on competition, equity, and public benefits is the decision about who will own the network.

We propose five arguments for public ownership.

1. High-speed information and communication networks are essential public infrastructure.

Much of the infrastructure of the country – water, sewer, roads, airports, seaports – is publicly owned. Indeed, virtually all economists and economic development experts believe that public infrastructure is essential for improving productivity and maintaining competitiveness. Just as high quality road

systems are needed to transport people and goods, high quality wired and wireless networks are needed to transport information. Both networks allow individuals and businesses in a community to connect to each other and the outside world.

For over 100 years, cities have successfully built and managed public infrastructure like roads and water and sewer systems. Information networks are new kinds of infrastructure, but they are not outside the competencies of local government.

Some apprehensiveness on the part of policy makers is understandable. Computers and related technology seem to be evolving far faster than government can keep pace. But while technological change is constant, in this case it does not make today's technology obsolete. For example, the DSL technology available to most U.S. households has not changed for a decade, even though faster alternatives are in use in other countries. A future-proof technology is one for which the useful life exceeds the payback period.²⁴

The fundamentals of high-speed information networks are actually quite established. Optical fiber cables are to this century what copper wires were to the last, and their capacity is essentially unlimited. When the electronics that “light up” the fiber can no longer support the level of traffic on the network, they can be replaced without replacing the fiber. Wireless has a shorter life-span, but also a shorter payback period. Rapid upgrades are part of both private and public wireless business plans.

Public ownership of the physical network does not necessarily mean the city either manages the network or provides services. Benton Public Utility District in Washington State contracted for the construction of a fiber and wireless network, which it now manages as a wholesale only network. A half-dozen private companies sell retail services, including multiple ISPs and a home security company. UTOPIA (the Utah Telecommunications Open Infrastructure Agency) is financed and owned by a consortium of cities that contracted with a private company to build and manage the network, and has several providers of video, voice and Inter-

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net services, including AT&T. (For more information, see the Case Studies below.)

Cities own roads, but they do not operate freight companies or deliver pizzas. Modern information infrastructure easily allows the transport layer (the road, or in this case the network hardware) to be separated from the service layer (the pizza delivery, or in this case Internet access or video services).²⁵

A publicly owned network would not be a monopoly. Other networks would continue to exist. In-

Public ownership of the physical network does not necessarily mean the city either manages the network or provides services. Cities own roads, but they do not operate freight companies or deliver pizzas.

deed, as is explained in more detail below, the existence of publicly owned networks can raise the quality of services and the level of competition. As Franklin D. Roosevelt said, “the very fact that a community can, by vote of the electorate, create a yardstick of its own, will, in most cases, guarantee good service and low rates to its population. I might call the right of the people to own and operate their own utility something like this: a ‘birch rod’ in the cupboard to be taken out and used only when the ‘child’ gets beyond the point where a mere scolding does no good.”²⁶

2. Public ownership ensures competition.

Tens of thousands of miles of fiber optic backbone cable have been laid by the private sector, but there is little incentive for the private sector to bring high-speed connections the “last mile” to homes and businesses (sometimes called the “first mile”, to emphasize the fact that users are creators of content as well as consumers of content).

Owners of existing cable and phone networks have strong incentives to make use of their existing infrastructure for as long as possible. What’s more, consolidation in the industry means that companies serving hundreds of markets make choices based on what is most advantageous for the corporation as a whole rather than any individual community.

Potential service providers seeking to compete with the incumbent cable and phone companies cannot use existing networks, or obtain access at rates that allow them to offer competitive services.²⁷ Thus, to reach customers, they must build their own network infrastructure. But here they face a significant barrier to entry. An overbuilder²⁸ faces the difficult

challenge of having to simultaneously repay capital expenditures and compete for market share against incumbents that have already amortized their major capital investments.

A publicly owned, open access network could be open to all service providers on the same terms, thereby encouraging the entry of new service providers.²⁹ It would allow competing service providers to lease capacity on the network in order to sell services to customers. Customers could then choose Internet service providers according to the combination of price, speed and service that fits their needs. Competition would ensure fair rates, and if any service provider restricted what could be done with its connection, customers could choose a different service provider.

Cities establishing new, privately owned citywide networks can require the owner to allow fair access. But it is unclear whether these contractual obligations will be enforceable in the future. His-

The Last Mile Problem

One reason the U.S. has fallen behind in broadband is that the federal government has rolled back provisions of the 1996 Telecommunications Act that were meant to encourage a competitive market for Internet access. The resulting lack of local competition has allowed companies to become complacent about upgrading and extending their infrastructure.

A common claim is that we have an oversupply of network capacity. Adam L. Penneberg, a professor at New York University, wrote in the March 2006 issue of *Fast Company*: “After all those [pre-dot com crash] years of laying fiber-optic cable, DSL, and other high-speed lines, we have almost more capacity than we know what to do with—so much that we use only a fraction of it, perhaps 1% or 2%.”

This is a misunderstood statistic that applies, to the extent it is true, only to long haul fiber networks. It does not apply to first mile connections – the local transport infrastructure that connects people’s homes and places of work to the long haul networks that make up the Internet – such as DSL and cable networks.

A network is only as fast as its slowest link. An 8-lane freeway 2 miles away does not help someone stuck in traffic in mid-Manhattan. The bottleneck for U.S. broadband network is in local infrastructure.

tory indicates they may not. Cities negotiated cable franchise agreements that were later preempted by state and federal laws. Thus public ownership, which allows the public to establish the rules for using that infrastructure, may be the only way to ensure a network will provide open, nondiscriminatory access in the future.

3. *Publicly owned networks can generate significant revenue.*

Telecommunications networks are different from traditional public works like roads because they can be self-financing both in terms of initial construction costs and ongoing upgrades. Indeed, a growing body of data suggests an information network can be a very profitable investment, for the city and for its households and businesses.

Cities should welcome this prospect, given the strain on municipal budgets from increasing costs of public safety, health, welfare, and aging infrastructure.³⁰

Saint Louis Park, Minnesota's publicly owned fiber network that connects public buildings has a five year payback period because it dramatically lowered operating costs below what the City was paying for leased T-1 lines. In three years, the publicly owned wireless network of Buffalo, Minnesota (population 10,000) generated over \$150,000 in profits from a \$750,000 investment.³¹

We offer the case of our hometown, Minneapolis, to demonstrate both the potential profitability of a publicly owned network and as a cautionary tale for cities tempted to use the public purse to allow private firms to capture those profits.

In April 2005, the City of Minneapolis issued a request for bids for a citywide wireless network. The City ruled out public ownership from the outset, insisting that given its weakened financial state, it

could not afford the capital investment. In September 2006, the City announced the winning bidder, a small local company with gross sales of around \$10 million in 2005.³²

Since the company itself was far weaker than the City in terms of being able to finance a \$10 million system, the City, under the terms of the 10-year franchise, agreed to purchase a minimum of \$1.25 million in services each year, and likely much more. Part of this commitment, \$2 million, will be prepaid before the network is launched.

The prepayment and the City's ongoing commitment to purchase services will enable the small, privately held company to finance the build-out. Indeed, the \$2 million prepayment for services will cover about one-quarter of the cost of building the wireless network.³³

In other words, the City, which previously declared it lacked the financial wherewithal to finance the network, *is* financing the network. For the same amount of money the City could have owned the network, used subscriber revenues to pay operating expenses, and provided free services to itself.

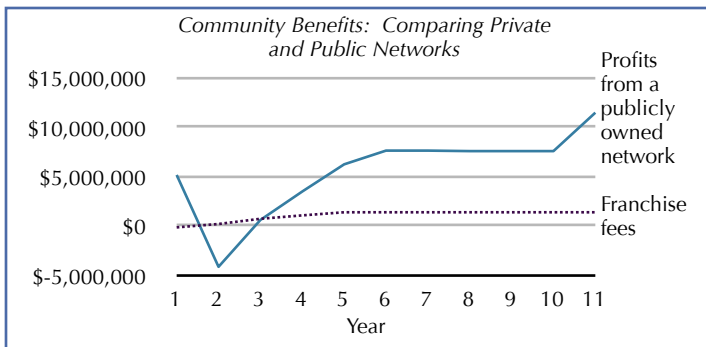
As part of the agreement, five percent of net pretax revenue (that is, revenue after operating and debt expenses but before taxes) will go into a digital inclusion fund.³⁴ City officials expects \$4000 in the first year of operation and \$1.7 million in the tenth year. The total value of cash and in-kind donations (i.e. free Internet access for Community Technology Centers) is expected to be \$11.5 million over ten years.

The company will receive 95 percent of the net income, over \$32 million in pretax profits in the tenth year alone. The company will likely realize profits upwards of \$130 million over ten years.

A city-owned, wholesale access only network would not have been as profitable as a private retail network. Our analysis of the City's numbers concludes that a publicly owned network might earn the City about \$51 million over ten years, or roughly four times what it will receive from the contractual agreement.³⁵

Some cities see public ownership not as an opportunity to make money, but as a way to strengthen the

A publicly owned, open access network could be open to all service providers on the same terms. Customers could then choose Internet service providers according to the combination of price, speed and service that fits their needs.



local economy. They view the city not narrowly as a municipal corporation trying to balance its internal books, but as a public corporation trying to maximize the total benefit to its community owners.

Saint Cloud, Florida, for example, chose to invest in citywide wireless in part to keep more money in their citizens' pockets. The \$3 million capital expenditure is just 7 percent of the city's outstanding debt; its \$300,000 annual operating costs represent just 1.5 percent of the city's general fund expenditures in 2006.³⁶ The free, city supported service is saving the average household \$450 per year – the amount they previously paid for broadband Internet access. That's more than the average household pays annually in local property taxes.³⁷

A publicly owned system can spur private competitors to lower their rates or improve their services, which will benefit all city households and businesses. The Clarksville, Tennessee Department of

A publicly owned system can spur private competitors to lower their rates or improve their services, which will benefit all city households and businesses.

Electricity (CDE), for example, is asking local voters to approve a bond for \$25 million to install a fiber to the home network. At launch, CDE's price will be lower than the current Internet provider, Charter. CDE fully expects that Charter will respond by lowering its rates, perhaps below that of the City's. And that's fine with the City. "That's not a bad thing," CDE General Manager Ken Spradlin says, "because not all our customers are going to choose to do business with us, but they are all our customers."³⁸

4. Public ownership ensures universal access

Society as a whole benefits when information and communication networks are accessible to everyone. More people on the network means more participants in online communities, and more customers for online products and services.

Private companies balance the price they charge against the number of households willing to subscribe at any given price. It makes no difference to the companies whether they generate \$100,000 from 1000 people paying \$100 per month, or 100,000 people paying \$1.

Publicly owned road, water and sewer, and sidewalk networks connect all households without dis-

	Years 1-5	Years 6-10	Year 11
Potential Net Revenue to a Privately Owned Retail Network	\$55,110,000	\$111,610,000	\$30,950,000
Digital Inclusion Fund Share of Net Revenue to a Privately Owned Retail Network (5 percent of Net)	\$2,755,500	\$5,580,500	\$1,547,500
Potential Profits from Publicly Owned, Wholesale Network	\$12,175,300	\$38,835,000	\$14,641,600
Lost Public Revenue	\$9,419,800	\$33,254,500	\$13,094,100

Estimates based on Wireless Minneapolis Business Case.

crimination. All have access to the same services, though they may purchase different amounts of these services based on household economics and need. A publicly owned telecommunications network similarly can choose to make a basic level of access available to everyone at a low cost, or offer free or subsidized access to some households.

Cities may be able to negotiate such requirements in initial contracts. But as pointed out above, federal and state intervention in cable franchises over the years demonstrates that local governments cannot count on retaining the authority to enforce these contracts.

Cities that choose private networks get one chance to set rules governing the network, in contract negotiations. After that, they rely on corporate good will.

Opponents of publicly owned information networks argue that the private sector is more responsive to customer demands than the public sector. Customers are not asking for high-capacity connections to the home right now, they argue, but once they do, the private sector will respond more quickly and efficiently than the public sector.

Yet the evidence indicates that the even the most aggressive telecommunications companies do not intend to serve everyone. Lower income areas, whether urban or rural, and sparsely populated areas, regardless of income are not attractive places for new investments.

The claims that access speeds have increased and prices have dropped are true only if phone and cable offerings are considered separately. The average DSL speed of 1.5 Mbps available to most households has been the same for almost a decade. Phone companies have offered promotional prices, but often only to customers who buy home phone

service, and they have created lower price tiers for 768 kbps or slower connections. Meanwhile, cable companies have kept prices high, but increased advertised download speeds.

When these companies do invest, the incentive is to do so in ways that provide a quick return on investment. Consumer rights advocate Bruce Kushnick points out that over the last decade, states gave the Baby Bells tax breaks and deregulated some prices in exchange for their commitment to deploy high capacity, high speed fiber optic networks.³⁹ They did so, but instead of making investments in very high speed, very high capacity networks, they made lesser investments to add DSL to their existing copper networks. DSL offers much slower speeds, but it is almost immediately profitable. Yet even here, while the phone network is universal, DSL is not.

The single most reliable predictor of whether a household has broadband connections is income.⁴⁰ Broadband data signals can travel only a limited distance over existing copper-based phone and cable networks, and companies are unwilling to invest in upgrades where average revenue per household is low. In rural areas, expensive satellite (upwards of \$50 per month, plus hundreds of dollars for the dish⁴¹) is often the only alternative to dial-up. In urban areas, a large percentage of households have access to cable modem service, typically at rates of more than \$40 per month, but not DSL service, which provides slower speeds at a lower price.

Universal broadband access will be a long, long time coming from private companies, if it comes at all.

Consider the two highest profile projects currently underway. AT&T (formerly SBC) plans to run fiber to the streets of some 19 million homes in 13 states by 2009. The company will continue to use existing copper connections from the street to the home.⁴² Verizon is spending \$6 billion to run fiber directly to about 6 million homes by the end of 2006, and another 9 to 14 million homes by the end of 2010.

Combined, these deployments might reach about one-third of U.S. households in 2009, overwhelmingly located in communities of above-average income.⁴³

Neither company plans to extend fiber to all their customers, ever, because "... there will be areas that are just not economic to offer fiber everywhere," says AT&T's Homezone managing director Ken Tysell.⁴⁴

Phone companies are making this investment primarily to be able to offer video, a market dominated by cable television companies (less than one-third of households that subscribe to paid television do so through satellite rather than cable).⁴⁵ No cable companies have announced efforts either to connect fiber to subscribers' homes or to increase the capacity of their networks. Instead, they are packaging cable modem speeds that are slightly faster than current DSL offerings, along with video and voice over Internet protocol. A recent study from an industry supported research center indicates the capacity of these networks is strained as a result of these "triple play" packages.⁴⁶

Most cities included full build-out and anti-redlining provisions in their cable franchise agreements. Cable must be available everywhere in the community. But phone companies are now lobbying at the state and federal level to create new franchising systems that would bypass local authorities and eliminate anti-redlining provisions.⁴⁷ Companies would be allowed to build out infrastructure only in the areas with the highest profit potential, that is, densely populated neighborhoods with higher incomes. Moreover, some of these proposals would allow cable companies to exit existing franchise agreements if a phone company began offering video services in any portion of the local market.

The single most reliable predictor of whether a household has broadband connections is income. The private sector is unwilling to invest in upgrades where average revenue per household is low.

Existing and Planned Baby Bell Fiber Optic Deployments

	Communities Targeted for Fiber Deployment	Percent with Incomes Above State Median
Maryland	52	95
Massachusetts	39	97
New Hampshire	8	88
New Jersey	159	77
New York	97	96
Pennsylvania	145	88
Texas	41	90
Virginia	16	94

Source: Broadband Everywhere, A Picture is Worth a Thousand Words, April 2006.

We are already seeing the results of the move to state-level franchising without build-out requirements.

Communities with above average income have at least two competing providers of very high-speed networks – capable of providing video – while neighborhoods of lesser means are bypassed. Any infrastructure investments by the cable companies are in areas where they face competition from telephone companies. Lower-

income and rural areas, many of which already have lesser networks, are ignored.

For example, of the Pennsylvania communities in which telephone companies have filed plans to upgrade their networks, 85 percent are above the state median income.⁴⁸ Meanwhile, Verizon is replacing its copper networks with fiber in certain Boston suburbs, but is reportedly trying to sell rather than upgrade its copper networks in Maine, New Hampshire and Vermont.⁴⁹

Publicly owned networks can insist on neutrality from any service provider that uses the network, a form of local regulation they could not enforce if they were relying on privately owned networks.

In New York, Syracuse is getting fiber to the home, but DSL customers in Queens, New York City are being told there is no more capacity in their area. "You can't wire everything for unlimited capacity," said a Verizon spokesman. "It's more effective to engineer capacity to be a fixed percentage above the average use in a given day."⁵⁰

5. Public ownership can ensure non-discriminatory networks.

Network neutrality is the term used to describe a network whose customers can use their broadband connections to access the content of their choosing, run the Internet applications of their choosing, and attach to their connection any devices of their choosing. This is possible because with Internet Protocol, bits are bits. Whatever you do with your internet connection – listen to radio programs, post your work on a web site, send pictures to family, or talk to friends in Canada – is broken down into little packets of data that move through the network in the same way.

With network neutrality, there can still be multiple tiers of service (i.e. \$15 per month for 1 Mbps, \$30 per month for 3 Mbps). Neutrality simply means that when customers pay for a connection with a certain level of service, they should be able to use that connection however they choose.

The elimination of common carrier requirements and increased Internet traffic – both as a result of more people online and more bandwidth intensive applications like video – have brought a new urgency to the debate on network neutrality.

Cable and phone companies have begun insisting they need to manage traffic in order to ensure "quality of service."⁵¹ A typically cited example is that X-rays shouldn't get tied up in network traffic created by someone downloading a movie.⁵²

But reasonable traffic management can be incorporated into a network without changing the nature of the Internet. Just as emergency vehicles, like ambulances, can take priority on the roads, so emergency pieces of information, like X-rays, can be given priority over information highways.⁵³

Private network owners argue that they need to charge differential rates in order to manage web traffic and provide quality of service. In reality they desire this ability to allow them to maximize their profits. Instead of offering faster or more affordable connections, they would charge you for what you do with your connection. For example, they can charge one rate to download video created by their own company, but a higher rate to download video from an independent filmmaker, and an even higher rate to post your own video for others to download. A digital book purchased from Amazon.com would download faster than the same book from your local bookstore or an independent author, just because the larger company can afford to pay for priority for its traffic.

Those who own the network could make customer interaction with the Internet more like cable television. For example, AT&T's new service uses Internet technology, but won't allow users to browse just any content using the box on their televisions. According to the Wall Street Journal, "While the Homezone set top-box will be connected to the Internet, users won't be able to surf to any Web Site. They will only be able to download content from providers who have made deals with AT&T."

With publicly owned networks, customers can be sure that any traffic management mechanisms are necessary and not simply to improve profitability. Communities can insist on neutrality from any service provider that uses the network, a form of local regulation they could not enforce if they were relying on privately owned networks. Or, if the market is large enough to support multiple service providers, they can leave neutrality to the market, knowing that unhappy customers can easily change service providers.

Evaluating “Public-Private Partnerships” and Other Private Business Models

The term “public-private partnership” is widely used to describe a bewildering variety of municipal broadband projects, projects as different as Philadelphia, where a private company will own and operate the network, and Saint Louis Park, where the city will own a fiber and wireless network and contract with a private company to manage and provide services over the wireless portion of the network.

It might be best simply to drop the term “public-private partnership” since it obscures more than it enlightens. What follows is an overview of business models in which the private sector owns the infrastructure, and an assessment of their risks and benefits to the public sector.

The Status Quo: The dominant business model for telecommunications networks in the United States is a network owned and operated by a private, for-profit company that is also the only or primary provider of monthly subscription services. This is true of your local phone and cable companies. They own the infrastructure, and you as a customer have no choice in who delivers the service.

Cities have little regulatory authority over these networks. (As explained above, these networks are subject to few regulations at any level of government.) For example, they do not have the authority to require phone companies to expand their DSL coverage, nor can they include provisions related to equitable or affordable Internet access in their cable franchise agreements.

Franchise Model: A privately owned and operated, for-profit network that does not have the city as a major customer. The city grants the private company use of public assets for some period of time, and the company compensates the city for use of those assets.⁵⁴ Cities typically work with a company that asks for a franchise and do not issue a request for proposals (RFP), although some have done so as a way of soliciting competing offers.

One of the first wireless franchise agreements was in Anaheim, California. Earthlink will pay the city a fee for use of the public assets needed to support a Wi-Fi network. The city will not be an anchor tenant on Earthlink’s network, because it is deploying a city-owned Wi-Fi system for municipal use. The

franchise agreement does not include any requirements beyond the network providing a certain level of speed, coverage and reliability.

This model poses few risks, but also few benefits. It requires no public investment and little public involvement of any kind. The benefits are modest amounts of revenue from pole attachment fees, and the possibility of additional competition. The city has little influence over the network coverage quality of service, or the prices charged. Franchise models do nothing to overcome the digital divide between higher and lower income households.

Anchor Tenant Model: A privately owned network, with the city agreeing to become the anchor tenant by agreeing to buy a minimum annual level of services. The city grants the private company use of public assets (or assists in negotiating access from private entities⁵⁵), and also agrees to be a major customer of the network (an anchor tenant). In exchange, the city is compensated for use of public assets. The agreement contains a public benefits section that may include a share of revenue or limited free access to the network.

If the city will rely on the network for its own internal communications and revenue for public projects, it cannot allow the network or the company that owns it to fail, even when its intervention contradicts the public interest.

One of the first anchor tenant models was in Minneapolis. As explained above, under the terms of the contract, the City will pay the private owner of the network a minimum of \$1.25 million annually for services over the 10-year life of the contract. The company will give five percent of net revenues to a digital inclusion fund managed by an outside foundation, and provide free access in selected parks and community technology centers.

The largest benefit of this model, in the eyes of many elected officials, is that the city does not have to finance construction of the network and assumes no responsibility for its ongoing operation. The city gains a new competing network to its incumbent phone and cable companies, and receives funds for public benefit projects.

This model, however, does have substantial risks. Since the city will rely on the network for its own internal communications and revenue for public projects, it cannot allow the network or the company that owns it to fail, even when its intervention

contradicts the public interest. Consider the recent case involving Massport (Boston-Logan Airport). Massport entered into an agreement with a private company that would provide for-fee wireless Internet access throughout the airport and share a portion of its revenues with the airport. After the for-fee service was introduced, Massport tried to prevent airlines from offering their own free wireless Internet access in the airport. The conflict ended up at the FCC, which eventually ruled in favor of the airlines, on the grounds that landlords cannot prevent tenants from using legal technologies of their choosing.

Cities also face the possibility that state or federal legislation will preempt their authority to enforce these agreements at some future date, as has happened with cable franchise agreements.

A number of companies are offering to build networks at no up-front cost to the city. City officials should understand that although seemingly attractive for its convenience, such a model may not offer the city and its households and businesses the best long term benefits.

The Dollars and Sense of Public Ownership

Every city that is seriously exploring a citywide broadband network should do a detailed economic and financial analysis. This will serve it well even if it should end up choosing a privately owned system because it will allow it to negotiate with the private company from an informed perspective.

The analyses can use different assumptions. Some of the issues involved are:

- Who will manage the network? This may be the entity that owns the network, or management may be contracted out.
- Will the network be for profit or not-for-profit?
- Will the owner of the network sell retail services only, wholesale access only, or a combination of the two?
- Will the city be a major customer?
- Will ongoing operations be supported by monthly subscriber fees, advertising revenue, sponsorships, municipal uses, or a combination of these?

A complete analysis requires that the city examine different ownership structures. A number of companies are offering to build networks at no up-front

cost to the city. City officials should understand that although seemingly attractive for its convenience, such a model may not offer the city and its households and businesses the best long term benefits.

A financial analysis includes several key items.

Capital expenditures Capital expenditures include wireless hardware and software, backhaul (the connection from wireless access points to the larger local network, which in turn connects to the global Internet network), network engineering and deployment. It also includes core network equipment (i.e. servers and routers). The city's existing assets – streetlights, electric poles, optical fiber connecting public buildings, etc. – can significantly affect the cost of a network.

Costs depend on the technology. Wi-Fi hot spots, like those found in cafes or homes, are inexpensive. Ongoing costs may be as much as ten times the capital investment, however, since each hot spot must be connected to a wired connection in the existing last-mile infrastructure.

More typical is the use of Wi-Fi mesh that reduces the number of wired connections in the network by allowing information to hop from one access point to another before reaching a wired connection. Wi-Fi mesh networks for municipal use only (public safety, meter reading, mobile municipal workforce) can be deployed for \$100,000 or less per square mile. Residential service networks, typically designed to reach 90 to 95 percent of homes and businesses, can cost upwards of \$200,000 per square mile.

Fiber to the home is the most expensive alternative, but it is also the longest-lived and the only “future proof” option. Estimates range from \$600 to \$3000 per home, depending on existing infrastructure and building density.

Operating expenditures For municipal use only wireless networks, the rule of thumb is that operating expenditures are about 15 percent of capital expenditure annually. This includes 24-hour network operations, pole attachment fees and electricity, monthly equipment maintenance and software upgrades, and Internet bandwidth. For combination wireless networks, operating expenditures are about 30 percent of capital expenditure for a retail network, 15 to 20 percent for a wholesale network. The added retail costs include customer service, billing and marketing as appropriate for retail or wholesale customers.

For fiber to the home, annual operating costs will be around 5 percent of capital expenditure, though this may be slightly higher for smaller cities.

More detailed breakdowns vary by location. For example, average pole attachment fees are in the range of \$36 annually in California, but \$86 annually in Louisiana. Wi-Fi Access points with a single radio may draw \$20 worth of power annually, while multi-radio deployments combined with high-powered wireless backhaul can draw five times more.

Wireless hardware maintenance will be in the range of 7 to 10 percent of equipment costs annually (though this may be higher for some backhaul components). Internet bandwidth consumption will depend on the number of subscribers and the average bandwidth use per subscriber, generally assumed to be 250 kbps to 500 kbps per user on average, and 1 Mbps per business on average.

Revenue. Monthly subscriptions are one of two major sources of revenue. Monthly rates depend on whether the network is wholesale only or retail. In a wholesale network, the city would be responsible for maintaining the network (or contracting for management) and relationships with companies that sell retail services. In a retail network, the city would be responsible for retail service and support, as well as all marketing and advertising. Gross wholesale revenue will typically be about one-quarter to one-third of gross retail revenue.

The wholesale rate that can sustain the network will depend not only capital expenditures and projected subscription rates, but also the division of responsibilities between the wholesaler and retailer(s).

Fiber to the premises can generate much higher revenues than wireless, because the networks can easily support television.

The other major revenue category is municipal use. Many cities currently budget for mobile computing, most often subscribing to cellular data services that are both slow (half the speed of a typical DSL or T-1 connection) and expensive (\$60 per month). Within the city, the Wi-Fi network replaces these subscriptions, directly saving the city hundreds if not thousands of dollars each month. Other direct savings may come through replacing leased lines to public buildings with fiber or high-speed wireless connections that provide faster speeds at a lower price, or replacing local-use cellular phones with Wi-Fi phones. Cit-

ies that have invested in fiber connecting public buildings typically have a five to eight year pay-back relative to the expense of leased lines.

Advertising may be a source of revenue for wireless networks, but it would be unwise at this point for a municipality to count on that as anything other than an added benefit of perhaps one or two dollars per user, per month.

The most challenging aspect of the evaluation will be to estimate second order effects. Some can be evaluated directly. For example, if the city has a choice between hiring a new building inspector or using wireless to improve the efficiency with the same number of inspectors, the salary of the inspector not hired can be credited as an avoided cost. But there is also a wide array of machine-to-machine communications (automated meter reading, wireless parking meters, traffic monitoring, etc.) that may improve provision of municipal services but do not directly reduce the city's expenditures.

If the city is planning to purchase these as communications services from a private network owner on a per unit basis, the value of the cost savings must be directly determined. Many of these are zero marginal cost applications, which is to say there is no additional cost beyond that of the hardware, that are essentially free to the city if it owns the network.

There are other, less tangible but very important benefits the city should take into account, including economic development, reducing the digital divide, and increasing municipal efficiency and service levels.

The city should also take into account the citywide impact of reduced rates due to competition. Sometimes cities see this as a disadvantage. They worry that incumbents will reduce their rates below those of the city owned network. In no case of which we are aware, did this result in a city network losing substantial amounts of money. Moreover, the city, by the nature of its mission and charter, should have a broader balance sheet. A drop in prices by incumbents by \$10 per month translates into millions, perhaps tens of millions of dollars in collective savings to city households and businesses. That not only enriches their individual balance sheets, but keeping at least part of these savings will enrich municipal coffers as well.

Wireless networks facilitate many zero-marginal-cost applications, which is to say there is no additional cost beyond that of the hardware, that are essentially free to the city if it owns the network.

Risk

Any financial analysis must analyze risk as well as return. There are two primary risks involved. One involves technology, the other subscription revenue.

Technology – The biggest decision cities must make is whether to deploy an inexpensive wireless network or invest in fiber to the premises. An all-wireless network has lower up front costs. The capital cost of a wireless network with fiber backhaul is as much as one-third higher, but leaves the city with a tangible asset with a lifespan of thirty years or more. A fiber to the premises network can cost ten to twenty times as much as wireless, but can carry all of a city's information and communication traffic for decades to come.

Deploying WiMAX will not be an option for anyone, municipalities or otherwise, who does not hold licenses for spectrum in the bands that will be used for WiMAX in the U.S.

When it comes to the question of ownership, the most important part of the system for a city to own is the fiber infrastructure. However, many cities have chosen to own the Wi-Fi hardware because of its low investment and the fact that the investment can be paid off quickly. Standard depreciation for wireless components of a network is 5 years. On the other hand, it may be attractive for the City to contract with one or more private companies to install a wireless system and lease access to the City owned fiber network.

Households and businesses in cities that are touting low cost city-wide wireless are learning there are often additional hardware costs. Although Wi-Fi is installed in most laptops, and Wi-Fi cards are widely available for desktop computers, many users will require additional equipment to connect to outdoor wireless from the interior of their homes or businesses. Often this has less to do with the strength of the signal from the wireless node than it does with the strength of the signal from the wireless connection in the user's computer. This is not a barrier to deploying a Wi-Fi network, but the cost of so-called customer premises equipment (currently around \$100 but falling) and who will pay it must be factored into network planning.

A second decision is whether, if a city chooses wireless, it should commit to Wi-Fi with WiMAX on the horizon. The important difference between Wi-Fi and WiMAX is that the former uses unlicensed spectrum with power restrictions and smaller coverage areas,

while the latter uses licensed spectrum that allows for higher power and therefore covers larger areas. Deploying WiMAX will not be an option for anyone, municipalities or otherwise, who does not hold licenses for spectrum in the bands that will most likely be used for WiMAX equipment in the U.S.

What is the risk of technological obsolescence? Fiber is, for all intents and purposes, a future-proof technology. The greatest expense is in installing the fiber. The electronic equipment used to "light-up" the fiber can be upgraded over time. Wi-Fi hardware is assumed to have a life-span of five years, with software upgrades in the third year. Given that the useful life exceeds the payback period, and the investment itself is modest, the risk of obsolescence in Wi-Fi is minor.

A risk does arise if a city system depends on proprietary technologies. Wi-Fi is an open standard, meaning it is available free of charge to any one who uses a Wi-Fi device. Users interface with wireless mesh networks via Wi-Fi, but most hardware vendors rely on proprietary software for the network backhaul (the connection from the access point to the larger local network and the national and international Internet). There is no similar standard for mesh networking. Vendor bankruptcy, or even failure to invest in ongoing software development, could shorten the useful life of proprietary wireless hardware.

Project pricing – Vendors in this field deem pricing to be proprietary information. They are often unwilling to provide pricing information outside of a closed request for proposals process, and when they do so, are unwilling to itemize the bid components. This can make it very difficult for cities to estimate the actual costs for their specific circumstances. Under these circumstances, cities should insert contract provisions that shift the risk of cost overruns to the vendor.

Subscription rates – Subscription rates may not meet targets for any number of reasons, but increased competition is the most likely cause. Existing service providers may add services they previously did not offer or lower their prices in response to the new network. While this is problematic for private companies, it is no less a win for the policy makers that chose to build the new network. After all, regardless of whose customers they are, they are all constituents.

The city's options for dealing with this risk are substantially different between publicly owned and privately owned networks. If the city owns the network, the question is how much the city owned

project can afford to lose while still generating a net benefit for the community.

The private sector benchmark is a return on investment of 30 percent or more within 5 years. Municipal projects also must recoup their original investment, but they have greater flexibility than privately owned networks both in the payback period, and in the willingness to accept indirect and community-wide benefits as part of the return.

For example, Saint Louis Park projects its network could lose between \$240,000 and \$1.4 million over five years if projected subscription rates are not obtained. On a per household basis, that is \$2.31 to \$13.48 per year. If competition drives prices down to \$20 from the current \$35 for DSL-equivalent service, and \$30 from the current rates of \$45 for cable equivalent service (both are rates that the new network will charge), households will save \$180 per year. If the percentage of households with Internet access remains the same (an unlikely prospect, given the substantial reduction in price) the community as a whole will gain more than \$12 million over five years, or more than eight times what it stands to lose in the worst case scenario.

A Note About Municipal “Failures”

City leaders considering municipal broadband networks may well come across reports, largely from industry-funded think tanks, of municipal “failures.”

Some municipal telecommunications ventures do lose money, often because the competitive landscape changed with their introduction. Marietta Fiber Net is one such example. It connected businesses only in the suburbs of Atlanta, and as such is not comparable to many other municipal projects. Ashland, Oregon is another example. Built in the late-1990s, before the telecom crash, it has had difficulty covering its debt service in part because the local cable company has lowered prices to half of what it charges in neighboring communities.

As the following examples illustrate, these “failures” should not be taken at face value.⁵⁶

Bristol Virginia Utilities (BVU): The Heartland Institute insists that BVU is a failure because “its operating budget is growing at an unexpected rate.”

Facts: The Bristol City Council approved “OptiNet,” a municipal fiber-to-the-home network operated by BVU, in 2001. In July 2003, OptiNet launched services after being delayed more than a year by legal challenges from the incumbent phone and cable

companies. Throughout this time, it had to bear legal costs without revenue. Nevertheless, financial performance was 20 percent better than projected for the first, traditionally difficult start up years. Currently, the network is taking in more revenues than the sum of all its cash outlays, including debt service and interest.

Bristol is a town of 17,400 in Appalachia, a region hit hard by the decline of mining, farming and manufacturing. Median household income was \$27,389 in 2000, one-third lower than the national median of \$42,151. The City Council and BVU view OptiNet as an economic development tool. The network is credited with helping attract 700 new jobs in 2005. Cross Stone Products moved a 30-employee operation across the state line to take advantage of high-speed connection. Two technology companies, Northrup Grumman and CGI-AMS, are building data centers that will create 1500 high paying jobs.⁵⁷ The success of the network led neighboring Bristol, Tennessee to build its own fiber to the user network.

Cedar Falls Utility (CFU): The Heartland Institute cites CFU as a failure, principally for not generating enough free cash flow to finance its expansion.⁵⁸

Facts: CFU started offering cable television in 1996 and high-speed Internet in 1997. Subscriber revenue has exceeded operating costs and debt service every year since 1997. No tax dollars have been used. Voters approved issuance of general obligation bonds to finance construction of the network, and CFU is on track to pay off all long-term debt by the end of 2011, five years ahead of schedule. In response to customer demand, additional bonds were issued to finance network expansion. Those bonds are also being repaid with subscription revenues.

CFU returned \$4 million to the city and school district in 2006, and expects the amount will increase to \$10 million in 2009. In addition, Cedar Falls residents pay \$2 million less each year on cable and Internet access than the statewide average. The community has also received services they would not otherwise have had. For example, CFU first offered high-speed Internet to businesses and residents in January 1997. The local

CFU returned \$4 million to the city and school district in 2006, and expects the amount will increase to \$10 million in 2009. In addition, Cedar Falls residents pay \$2 million less each year on cable and Internet access than the statewide average.

cable company did not launch high-speed residential service until 2001, and high-speed business service in 2003. DSL was not widely available in 2004. CFU built its fiber plant to the city's industrial park to attract businesses. The private cable company has yet to extend its infrastructure there. Since the fiber was installed, the industrial park has grown from 30 to 146 businesses, and employment from 1,400 to 4,300 people. And since 2005, CFU Internet subscribers also have access to a wireless network in the downtown area.

Muscatine (Iowa) Water and Power (MWP) –Heartland Institute views MWP as a failure because it has raised cable rates to cover its costs.

Facts: In 1996, after learning that incumbents TCI and U.S. West (now Qwest) had no plans to bring broadband into the community, Muscatine's business leaders recommended a municipal communications utility. Voters in Muscatine overwhelmingly approved the utility in 1997, with 94 percent voting in favor. Muscatine launched cable television service in March 1999, and Internet service later that year.

Fiber-to-the-premises requires a very large up front investment. This is equally true for the private sector. Verizon began offering its much publicized FiOS service in 2005, and expects to lose money on the investment until 2009.

Despite predatory pricing and other anticompetitive behavior by the incumbent cable operator, Mark Muscatine Power and Water successfully maintained its customer base by providing higher quality services, including video on demand and wireless Internet access. In January 2003, the public utility bought the incumbent's (then Mediacom) assets in Muscatine and neighboring Fruitland.

The network is not just for residential service. It also provides 100 Mbps connections to Provo's city buildings, fire stations, and schools, and improved reliability of the power grid. In the coming years, iProvo's fiber to the premises network can offer services the cable and phone networks are not capable of, such as distance learning courses with full-screen interactive video.

much publicized FiOS service in 2005, and expects to lose money on the investment until 2009.

Provo also had unexpected expenses. Like most networks built by public power utilities, the backbone of Provo's network was built to connect electrical substations, allowing for improved monitoring of the electrical grid. In 2001, the Utah legislature passed a bill making it possible for cities to build their own networks and sell wholesale access to private service providers. But the bill also imposed restrictions on the use of general or enterprise funds. Provo had used \$2.3 million in power reserves to fund its network. The law was applied retroactively, and the city was given 10 months to repay the fund.

Finally, Provo made a single company, HomeNet, exclusive provider when the network was launched. After failing to meet subscription targets for a year, the company asked to be released from its contract and then filed for bankruptcy. In July 2005, the city added two new service providers and began meeting subscription targets, and is now on track to achieve its original goal of 10,000 subscribers in early-2007, and to begin breaking even sometime in 2008.

The municipal utility has indeed raised its rates, but they remain below those of private providers elsewhere in the state.⁵⁹

iProvo, Provo, Utah - The Reason Foundation calls this citywide fiber-to-the-premises network a failure because it has posted negative income in its first 18 months of operation.

Fiber-to-the-premises requires a very large up front investment, and takes time to build, but the network will last for at least 20 years. It is normal to project losses for the first several years, during construction and while the customer base is built. This is equally true for the private sector. Verizon began offering its

Broadband: A Brief Technical Overview

What is Broadband?

Broadband refers to transmission media that can simultaneously carry multiple channels. When most people speak of broadband, they are using the term to refer to high-speed Internet connections. Broadband is not a specific data transmission speed, and in fact definitions vary widely. The International Telecommunications Union Standardization Sector defines broadband as greater than 1.5 million bits per second (or megabits per second, written as Mbps or Mbit/s).

Instead of “broadband,” the Federal Communications Commission (FCC) uses the term “advanced telecommunications capabilities.” “High-speed,” according to the FCC, is more than 200 kbps (kilobits per second, or 200,000 bits per second) in at least one direction. It’s a definition they haven’t updated since 1998.

This definition suffers from at least two major shortcomings. One is that its minimum speed level is ridiculously low. Anyone who uses the Internet knows that 200 kbps is no longer high-speed. Yes, it is faster than a 56 kbps dial-up connection. But try navigating any site with images, including the local newspaper, at 200 kbps. At 200 kbps a two-hour movie would take over three days to download (85 hours). That compares to only one minute using a one-gigabit fiber connection.⁶⁰

The second is that its position on directionality – 200 kbps in either direction – ignores the great potential of the Internet to democratize economics, politics and the media. The FCC considers it acceptable to have hare-like downloads and tortoise-like uploads. Receive your e-mail or surf the web quickly but send your e-mail, post information to an Internet site or engage in peer-to-peer networking at much slower speeds.

Most current home Internet connections are asymmetric, that is, they are faster in one direction than the other.⁶¹ The user is viewed as a consumer of information, not a producer, as a buyer not a seller. Yet the most inspiring aspect of the Internet is its decentralizing ability. Unlike TV or radio, which allows one person to transmit to many people, the Internet allows anyone to connect to anyone else.

Speed and Capacity

The National Academy of Sciences offers the broadband definition that might be most appropriate. It defines broadband not as a speed but as a service that provides sufficient capacity and access to enable today’s applications and encourage the development of new ones.⁶²

Speed and capacity overlap, but they are not identical. Speed is the rate at which bits of information move through your connection, e.g. one million bits per second. Capacity is, to use a highway analogy, the number of lanes. If there are more bits of data moving through any portion of the network than there is capacity, congestion will occur.

Most current home Internet connections are asymmetric, that is, they are faster in one direction than the other. The user is viewed as a consumer of information, not a producer, as a buyer not a seller. Yet the most inspiring aspect of the Internet is its decentralizing ability.

Text transmission requires very little capacity; web browsing little more. And the nature of such traffic is “bursty,” which is to say your computer sends out a request for a Web page, then the page loads, and then nothing happens for a while. Unlike power companies, which build sufficient power plants to handle projected peak loads even though most of the time the excess capacity is not used, telecommunications companies oversubscribe their networks based on a calculation of how much capacity is needed on average. That means at times of peak demand, the network may be quite congested.

More people are using their Internet connections to do things like upload or download video and music, or to make telephone calls. These activities are less bursty and generate a steadier stream of bits. Few local networks have been upgraded to support this increased demand. This is a key reason why subscribers only rarely will attain the connection speeds they believe they were promised. This is the reason that in their ads, communications companies almost invariably use the words “up to”.

Consider a household with a cable Internet connection. The connection may be achieve a speed of 3 Mbps at three in the afternoon on a weekday. But come six o’clock, when people begin arriving home and firing up their computers, the portion of the network that carries traffic from all the houses soars, and the speed may drop to 1 Mbps or even lower.

Unlike power companies, which build sufficient power plants to handle projected peak loads even though most of the time the excess capacity is not used, telecommunications companies oversubscribe their networks based on a calculation of how much capacity is needed on average. That means at times of peak demand, the network may be quite congested.

The cable company may then announce a speed increase to a 5 or 6 Mbps connection, without making any changes to the local infrastructure. Using the highway analogy, it has raised the speed limit but hasn't added any lanes. At three in the afternoon on a weekday, the connection may achieve the announced speed. But unless they also upgrade the capacity of the local network infrastructure, come six o'clock, the connection speed will be back down to 1 Mbps. The Internet, as you experience it, is only as fast as its weakest link.

Imagine the Internet as the world's most amazing highways – ten thousand lanes across, connecting every city in the world. Think of the data as vehicles and the highway made up of fiber optic cables – threads of glass that carry data at the speed of light.

Right now these highways extend to virtually every U.S. community, but not to every house or even neighborhood. Most Americans access the ten thousand-lane highway via an unpaved country lane. Only a single car can travel at any given time. Traffic is painfully slow. Those who can afford it pave their access road, but the road is still narrow and prone to congestion.

The ten thousand-lane, cross-country highways, made up of fiber optic cables, were installed years ago. Today the debate focuses on the speed and capacity of the on-ramps, the local access roads inside our urban and rural communities.

Broadband Technologies

One way to connect homes and businesses to the information highway is to bring the ten thousand-lane highways to the building itself. This is known in the industry as fiber to the premise (FTTP) or fiber to the home (FTTH). This highway can deliver digital information at speeds of 100 Mbps or more to individual buildings (100 times faster than a typical DSL connection, and 20 to 30 times faster than a typical cable modem connection), enough capacity to provide very high-speed Internet access (15 Mbps or more), telephone, and high-definition

television over the same line. Fiber has, for all intents and purposes, unlimited capacity and a multi-decade life-span.⁶³

Another way to improve access speeds is to increase the speed at which data can be delivered over copper lines that already deliver telephone and cable television. A combination of fiber to the street and existing copper lines to the home can achieve transmission capacities of 21 to 26 Mbps. Since a single high-definition television channel takes up about 20 Mbps, little is left for voice or Internet access. This is fine for high-density areas. But copper can only carry that much capacity over very short distances, perhaps 1000 feet. So it won't work in rural communities, or even some suburbs.

A third transmission method is to send information over the air. Wireless broadband, Wi-Fi, WiMAX, and 3G (or 4G)⁶⁴ are all terms used to describe technologies that allow users to connect to the Internet via radio waves and microwaves.

Wi-Fi is the common name for IEEE standard 802.11. It is the kind of wireless found in most laptops, and used for home networks or in coffee shops. It can deliver high-speed data connections over short distances (a few hundred to 1000 feet). The actual speed depends on a number of factors.

First, there are different versions of 802.11. The most common is 802.11b, which has theoretical speeds of 11 Mbps and practical speeds of 5 Mbps or less, and 802.11g, which has theoretical speeds of 56 Mbps and practical speeds of 26 Mbps or less. Devices using the two standards can use the same access points, but the throughput of an 802.11g network will be slower if 802.11b devices are using it.

Second, since wireless' range is limited, the speed of the wireless connection is always limited by the speed of the connection from the wireless access point to the larger network (known as backhaul). If the access point is connected to the Internet via DSL or a cable modem, the connection is limited to the capacity of that line. If it is connected via other wireless devices, as in a mesh network (described below), it is limited by the configuration of that network.

Third, bandwidth is shared among users, so the speed experienced by an individual user is limited by the number of other people using the access point.

Finally, there are the limitations of unlicensed spectrum. Users of unlicensed spectrum do not have exclusive use of the frequency and must accept

interference from other devices. Thus there is the possibility of interference from other devices (e.g. microwaves, baby monitors, or other wireless access points).

WiMAX is the common name for the IEEE 802.16 standard. It is primarily used in licensed spectrum. WiMAX is not currently available in average consumer devices, such as laptops or PDAs.⁶⁵ Certified WiMAX consumer products are not yet available, because the standard was only recently certified. As a comparison, the Wi-Fi standard was initially certified in 1996. The current iteration was issued in 1999, but consumer products were not widely available until 2004. So it is unlikely that WiMAX will play anything other than a supporting role in citywide wireless networks for the near future. Whether or not WiMAX is incorporated into the network, cities may want to own long-range wireless towers as emergency links should an extreme event disrupt fiber connections.

Licensed spectrum can reduce the unwanted interference problem that may occur with Wi-Fi because license holders have exclusive use of that frequency. This means signals can be broadcast at higher wattages, allowing them to cover longer distances. Indeed, many of the differences between Wi-Fi and WiMAX are related to power limitations related to the use of unlicensed spectrum. While Wi-Fi can cover areas with diameters of 150 to 1000 feet, WiMAX can carry signals for miles. Thus far fewer WiMAX transmission points, or nodes, are needed.

But these advantages come at a cost. Licensed spectrum is sold in auctions to the highest bidder and its currently quite restricted nature makes it both prohibitively expensive for all but the largest corporations and hard to come by.

Currently, Sprint-Nextel owns the most spectrum in the frequencies likely to be used for WiMAX in the U.S., Clearwire is second, and AT&T has substantial holdings that will grow with its acquisition of Bell South.⁶⁶

The FCC has set aside a portion of spectrum within the licensed spectrum range for free use by community networks. Computer companies and Internet service providers have asked the FCC to set aside more spectrum for community use, but so far this has been rejected. The more spectrum that becomes available for free use, the less valuable is the licensed spectrum. The Wall Street Journal has noted, “[T]he economics of Wi-Fi were unattractive

to large carriers because the service relies on unlicensed radio spectrum, allowing even tiny Internet service providers that own no radio spectrum to compete. A service using spectrum owned by the providers would be more exclusive.”

Indeed, companies that have invested heavily in buying licensed spectrum have asked the FCC to reconsider allowing even a small part of that same part of the spectrum to be used by the public.⁶⁷

Deploying Fiber

Many people, on hearing that fiber can provide 35, 100 or 1000 Mbps to the home dismiss such speeds as unnecessary given their current 1 or 3 Mbps Internet access. Or they hear that wireless or copper connections will soon be able to provide much higher speeds, making investments in fiber possibly unnecessary. Or they believe fiber will become much less expensive and therefore it is prudent to wait until it is absolutely necessary.

Installing fiber is indeed expensive. But fiber in the near future will become a conduit for all information-based systems. It will carry music, like the radio, voice like the phone, TV like the cable and movies like the theatres. And in planning for what the industry calls this “convergence” the city would want to ensure that it can meet the peak demand, not only the average demand. This would lead it to choose the widest roadway possible.

Public ownership allows for low cost, long term financing from municipal bonds. A city, which is trying to maximize the benefits to the entire community, can accept a longer payback or a lower rate of return for the investment, than can a private company that is trying to maximize the benefits to its investors.

The single most expensive part of building a new network is in the labor required to install the infrastructure. Corning estimates that about 44 percent of the capital expenditure is for installing dark fiber, and 80 percent of that, or more than one-third of the total capital expenditure, is for labor.⁶⁸ The cost of

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the fiber and hardware may decline, but it is unlikely that the cost of labor will go down.

With proper planning, the installation can be done just once. New fiber, when needed, can be pulled through the existing conduits.

As for wireless, remember again that the capacity of the system is only as great as its weakest link. Wireless is largely a convenience. It allows for mobile communications, and allows connections in areas that would be cost-prohibitive to reach with wires. But wireless access points must connect to wired infrastructure. Speeds of all kinds of wireless connections are going up, but unless they are connected to high-capacity fiber they will suffer from the limitations of copper wires.

When we talk about citywide wireless we must consider both wireless devices and the fiber optic wires that connect them to the global information highway.

Deploying Wireless

Wireless broadband is not the same as satellite communications. When you send an email from a wireless Internet connection, it does not travel via airwaves to its final destination. Instead, the signal must travel from your computer to the fiber optic cables that make up the information highway.

Thus, when we talk about citywide wireless we must consider both wireless devices and the fiber optic wires that connect them to the global information highway. Similarly,

we can have a hybrid wireless system. WiMAX (or similar long range wireless) towers can aggregate signals from wireless mesh networks, given the much lower cost of installing Wi-Fi nodes. Users send and receive data through Wi-Fi access points, but in this case, the access points themselves have the ability to relay signals from point to point. Eventually, the signal reaches a WiMAX tower, which is connected to the fiber loop.

Wireless offers a short-term cost advantage over wires. But we shouldn't think that wireless is a substitute for wires. As Jim Snider of the New America Foundation writes, "For a point to point link, the capacity of a single fiber optic cable is greater than the entire capacity of the radio spectrum... any cost advantage wireless might have in the backbone is, except in fairly unusual cases, dwarfed by fiber optic cable's quality advantage."⁶⁹

Community Intranet

A citywide network can be used not only to connect users to the rest of the country and world via the Internet, but also to create an "intranet" – a wide area network that connects people in the city or neighborhood to one another even without a connection to the Internet.⁷⁰ A wide area network can carry data to and from users throughout the city even without a connection to an Internet service provider. This means some network services, such as community bulletin boards, can be completely free (after the cost of the networking hardware). It also means people using computers on the same network can communicate and share files directly, if they choose.

A community intranet may be useful for two reasons. First, it can keep local traffic local. That reduces the distance bits of information travel, which reduces lags and delays. Second, and more importantly, it reduces the need to purchase Internet bandwidth. Intranet applications have no cost beyond the cost of the network itself. For example, my neighbors and I may want to set up a security camera in the alley. Today, we might do that by paying a fee to maintain a Web site. The video stream from the camera would go to the server of the company that hosts the web site, then through the Internet to the servers of the ISPs used by each household. Tomorrow we might do that by installing wireless routers on the block connected directly to the camera, allowing the video packets to travel a very short distance from the alley to the houses on the block.

Case Studies

Saint Louis Park, Minnesota

Population: 45,000

Area: 16 square miles

Municipal Utilities: Water and sewer

Network Type: Citywide wireless mesh with fiber backhaul

Model: Municipally owned, privately operated by retail service provider, monthly subscription fees

Financing: Information technology enterprise fund (fiber), general obligation bonds (wireless)

Services Provided: Internet access

Saint Louis Park will begin building a citywide wireless network in early 2007. The wireless network builds on a fiber optic network the city and school district installed to replace leased T-1 lines for public buildings.

In April 2005, the city conducted informal citizen surveys to gauge interest in wireless Internet. Generally positive responses in the survey led the City Council to approve \$58,750 for comprehensive study of the technical and financial feasibility of a new network, and examine options to ensure reasonably priced access. In July, the city held a town hall meeting at which residents discussed the results of the informal survey and the study plans.

In November 2005, the council approved the pilot project, with the plan to move ahead with citywide wireless unless the pilot demonstrates that it is not technically or financially possible.

The business model selected is a public-private partnership in which the City owns the network infrastructure, and a private company operates the network and provides retail services under contract with the city. The City looked at many business models. Their analysis indicated that it made sense to own the infrastructure. "We tried to define our goals first, based on survey work and so forth," says Clint Pires, the city's CIO. "We were very open to all the models that were out there, and the pros and cons of each. The council was looking for a partner that would share the risk."

In December, the City issued two documents: a request for proposals for network operation and management, and a request for bids from hardware providers. They received 11 responses to the RFP (one was the City of Chaska, which was among the first cities in the country to go wireless), and two bids for hardware. Two local companies were chosen.

Beginning in April 2006, residents could subscribe to a pilot project covering about one square mile of the city. The City invested \$280,000 in the pilot, approximately half for hardware and the rest for operations. The city-owned fiber optic network, approximately 15 miles installed in 2004, provides backhaul. The main thing dictating the pilot locations was the location of fiber, but they tried to get diversity in terms of topography, residential and commercial, single-family homes and apartments, and access to DSL (two-thirds of the city cannot get DSL).

The pilot met its two most important goals: expanding access to broadband, and evaluating the technology. On the former, it was very successful. Fully half of the subscribers previously used dial up or had no Internet connection at all.

In terms of evaluating the technology, it was also successful in that it showed that the chosen hardware (Tropos) did not meet the City's expectations.

Despite the shortcomings of the pilot hardware, resident enthusiasm for the service convinced the council that it was worthwhile to pursue the project with another hardware vendor. In August 2006, armed with more specific guidelines for performance standards, the City Council voted to issue a new request for bids for hardware. In October, the city selected a new winning bidder. The company will begin installing a solar-powered wireless mesh network, and additional fiber, in early 2007.

Part of the analysis in the pilot was to determine if the network can be affordable and attractive to subscribers, while generating enough to pay off the capital investment and be an attractive business venture for the chosen service partner, Unplugged Cities. Unplugged Cities will pay the City \$14 per subscriber, and will offer a variety of residential packages ranging from \$15 to \$35 per month. All data rates are symmetrical, and the monthly fee includes a \$5 per month fee to lease a CPE, which is required.

The city is not planning to allocate any funds from departmental budgets toward network financing at this point. It is expected that if the network goes citywide, some existing costs can be offset and some efficiencies will be gained. But at this point the city is making no attempt to justify it based on municipal applications.

Throughout the process, Saint Louis Park has set a very high standard for transparency. All documents related to the project, from the results of initial surveys to the evaluation of the pilot project, are available on the City's web site, www.stlouispark.org.

Corpus Christi

Population: 287,290

Area: 147 square miles

Municipal Utilities: water, gas

Network Type: Citywide wireless mesh with fiber and wireless backhaul

Model: Municipally owned, privately operated, open access for retail service providers

Financing: Revenue bonds

Services Provided: Internet access, public safety, automated meter reading

Corpus Christi's citywide wireless network arose as a logical extension of the upgrade to wireless automated meter reading for the city's gas and water utilities.

In 2002, the City faced a large investment in updating its meter reading capabilities, and was considering privatizing its municipal utilities. It was still utilizing meter readers who walked door to door, a risky job with high turnover. If they couldn't get into a yard for any reason, they would skip the house, which was the source of inaccuracies. Also, the once-monthly monitoring meant system leaks were not quickly recognized and repaired.

The City compared the cost-per-read of its current walking system, a drive-by system, and a fully wireless automated meter reading (AMR) system. Despite the relatively high upfront cost of the wireless system (\$17.8 million for 146,000 meters), it found the cost savings of \$32 million over the 20-year life of the wireless system, an average \$1.6 million annually.

During the AMR pilot phase, it became apparent that Wi-Fi was a logical add-on. The AMR system uses only a small amount of the system's capacity, and only twice daily.

The core of the network is 70 miles of fiber optics that also connect traffic signals. Pre-WiMAX is used in areas not served by the municipal fiber network. The network is separated into multiple virtual local area networks (VLANs) – one for public safety, one for municipal services, and one for residents and visitors.

The total cost of the public access network was \$7.1 million. Annual operating costs include \$100,000 in light pole attachment fees (around \$62 per pole, per year). The city expects to get a full return on investment in four years.

The city formed a non-profit corporation, called Corpus Christi Digital Community, which will sell wholesale capacity to private service providers to provide a range of for-fee services to residents and

businesses. The city itself will pay the non-profit \$2 million annually for network services – including phone, Internet access, and maintenance of the wireless and A five-member board will assist the City Council in governing the non-profit.

The completed public access network was officially launched in December 2006. In January 2007, the City Council also voted to sell the wireless portion of the network to a private company, EarthLink, for \$9 million. The City will pay EarthLink \$450,000 annually for use of the wireless network, and will have free use of the AMR network. EarthLink will pay the City \$239,000 annually to start for access to public infrastructure. The City retains ownership of the fiber optic portion of the network, and may sell access to other service providers wishing to use the network as backhaul for a wireless network, or to extend fiber optic access to buildings.

Benton Public Utility District, - Kennewick, Washington

Population: 150,000

Area: 40 square miles

Municipal Utilities: water, gas

Network Type: Fiber loops with wireless

Model: Municipally owned, privately operated, open access for retail service providers

Services Provided: Internet access, municipal use

Since 1998, public utility districts throughout the Pacific Northwest have had access to dark fiber installed by the Bonneville Power Administration (a federal agency that markets wholesale electricity and transmission), which built a 2400 mile fiber network to monitor substations. Northwest Open Access Network (NoaNet), a non-profit cooperative, has a 20-year lease on the excess capacity, and manages the network as a cooperative. NoaNet allows rural communities in Washington and Oregon to connect to the Internet at lower costs than would be possible through commercial providers. A typical example is Oregon State University, which obtained a gigabit connection by installing a 20-mile fiber link to NoaNet at a one-time cost of \$315,000 rather than paying \$6 million annually to a traditional telecommunications carrier.⁷¹

Benton PUD connected to the fiber optic network, but it faced problems extending the network to homes in the sparsely populated county. In 2003, Benton PUD, in cooperation with Maverick Wireless, began installing an 802.11b wireless network. Each access point connects directly to the fiber network.

Benton PUD and Maverick share operating revenues, and a portion of the network is set aside for the City's use.

Under Washington State law, the network must be open access. Five companies currently offer a variety of access packages and services via both fiber and wireless, including a security company.

OneCommunity - Cleveland, Ohio and surrounding counties

Network Type: Multiple fiber loops, wireless hot spots

Business Model: Aggregated purchasing for consortium of government and not-for-profit entities, donor-supported free wireless

Financing: Tax-deductible donations of dark fiber, foundation and corporate support, organizational operating expenditures

OneCommunity offers a completely different model for network infrastructure. It is neither privately owned by a service provider, nor municipally owned.

In October 2003, OneCleveland was incorporated as a nonprofit of equal partners: Case; Cuyahoga Community College; Cleveland State University; the City of Cleveland; the Greater Cleveland Regional Transit Authority; the Municipal School District; ideastream (the local PBS and NPR affiliate); Cuyahoga County Public Library; and NorTech, Northeast Ohio's Technology Coalition, a group of technology and business leaders. In February 2006, the network formally adopted a new name, OneCommunity, to reflect its expansion into Akron and Canton.

OneCommunity provides broadband to educational institutions, government offices, hospitals, and community organizations. At this point, wireless connectivity through OneCommunity is a decentralized undertaking, deployed and supported by entities connected to the network. For example, Case Western has deployed a large number of wireless access points throughout its campus. Long-term, OneCommunity has as a goal creating a high-speed wireless network along the same model as the fiber network.

Both the technical and financial dimensions of the OneCleveland initiative allow for significant efficiencies and savings. According to Lev Gonick, President of Case Western: "In the pre-OneCleveland architecture, it was not uncommon for traffic to be routed from a community college via a fractional T-1 line in suburban Cleveland via a local central office (CO) to the point of presence (PoP) in downtown Cleveland, over dedicated cir-

cuits to Columbus, back over additional dedicated circuits to the Cleveland PoP, and then back over T-1 lines to a distance-learning origination site at the Cleveland Museum of Art or another content provider in University Circle. While this architecture imposed a relatively trivial inconvenience for simple e-mail traffic on the Web, this architecture led customers to believe that the technology was a significant rate-limiting feature of their desired educational experience. The incumbent technical infrastructure also proved to be fairly costly."

"The central value proposition is the acquisition and ownership of fiber assets and the electronics that light those services rather than managed services and dedicated circuit leasing. The OneCleveland model shows an overall savings of 50 percent or more, and for many agencies and institutions the savings are even more pronounced. As we develop optical wired services, many OneCleveland subscribers are providing free public wireless access around their institutions through implementations of VLAN services that isolate guest public access from trusted services associated with institutional goods and services."

OneCommunity, the non-profit corporation, runs the network. It contracts most operations to private firms, many with unionized workers. Incumbent SBC was invited to be part of the initiative, but declined. It lost the bid to light up the network to IBM, and has subsequently fought the effort.

OneCommunity shows that a non-profit infrastructure model, with government involvement, can take root nearly anywhere in the country. The circumstances in Northeastern Ohio were not ideal for this kind of visionary project. On one hand, Cleveland has long history of public and political support for municipally owned utilities, starting with the first politicians to campaign on municipalization of services in the 1890s, to a 1980s successful campaign against selling the municipal power utility to its long-term competitor. The city's municipal water system is one of the oldest and most successful in the country, with rates among the lowest of any major city.

On the other, Cleveland and other cities in Cuyahoga County are facing the need for massive infrastructure investments (e.g. bridge replacement, storm water sewer upgrades). A 2004 report by the Greater Cleveland Partnership estimated \$8.5 billion in infrastructure investments will be needed over the next decade, and that user fees and state and federal transportation funds will fall \$3.5 billion short of this target. At the same time, the City of Cleveland faced a \$61 million deficit, and the Cleveland School Dis-

trict had a \$100 million deficit, caused by state budget cuts and declining value of commercial property. The City laid-off 250 police officers and 70 firefighters to help close the deficit, and the schools laid-off 1400 employees. In 2004, the U.S. Census Bureau declared Cleveland (pop. 460,000) the country's poorest big city.

Government entities have invested in the project, but capital costs are shared among the partners. For example, the Cleveland City Council approved a \$200,000 grant in July 2005, and Case Western invested more than \$2 million in unlit fiber for the project. Private sector companies have provided financial support and donated dark fiber, and state and received tax benefits for the donations.

Thus, new sites are connected through a combination of public and private sector contributions. A typical example is the connection of three locations in Summit County (Akron Art Museum, University of Akron, and Summa Health System) in late 2005. OneCommunity negotiated with the owners of dark fiber optic rings to have the ownership transferred, as it did for the original portions of the network. The sites were connected to the network and the dark fiber lit up with a \$100,000 grant from the GAR Foundation in Akron.

The annual operating budget – \$2.8 million for 2006 – is fully supported by fees from the 25 current subscribers.

Today, the network can be accessed at over 250 sites. Over 100 of those were added in May 2006, when all schools in the Cleveland Municipal School District were connected to the network. Cleveland Clinic helped fund the schools' connections with a \$10 million gift.

"We're just a platform that fosters and enables innovative applications," said Scot Rourke, OneCommunity's president. "It's the applications that actually transform the community."

Saint Cloud, Florida

Population: 28,000

Area: 14 square miles

Municipal Utilities: sewer and water

Network Type: Citywide wireless mesh network with wireless backhaul

Business Model: Municipally owned, privately operated, municipally funded free access

Financing: General obligation bonds

Services Offered: Internet access

Saint Cloud, Florida's free, publicly owned network has been up and running since March 2006. The City undertook the Cyber Spot initiative both to improve the efficiency of municipal operations, and as an economic development tool.

By a strict internal balance sheet calculation, the \$2.3 million investment in the network pays for itself in 9 years. The City estimates it will save \$650,000 annually through reduced cost of telecommunication services and greater efficiency in government. Network operations are projected to cost \$400,000 annually, so the city will save \$250,000 annually, but will take on the cost principal and debt on the capital expenditure.

There are benefits not taken into consideration by financial calculations, however. The city sees benefits from keeping more dollars in the local economy. Before CyberSpot, Saint Cloud residents sent their monthly subscription fees for Internet connections to out-of-state companies. More than 4300 users have registered for the City's free Internet service, and approximately 86 percent say it will be their only Internet access. Those households each save \$450 per year, more than the city collects in property taxes on the average home. This keeps over \$1.6 million in the local economy each year. Businesses save even more, about \$750 annually.

Additional benefits include improved public safety through increased patrol time on the streets, because officers are able to quickly file reports from their vehicles rather than spending time doing paperwork at the precinct. They can pull up thumbnails of cameras around the city instead of driving down the street. The force is using live feeds from patrol cars. For the officer, it means someone is watching out for them at every traffic stop. For the force as a whole, it means an officer at patrol headquarters can monitor officer's activity and, for example, tell them to discontinue a high-speed chase.

City officials expect to generate revenue from the network in the future. For example, the police chief in St. Cloud wants to use the network to start monitoring alarm systems. Right now, system alerts go to a security company call center, which calls the local police. St. Cloud's system allows it to cut out the middle-man. The police know where every patrol car is through the GIS system, and the alarm would go to the nearest one.

Utah Telecommunications Open Infrastructure Agency (UTOPIA)

Population: 265,000

Area: 325 miles between cities

Network Type: Fiber to the home

Business Model: Open access, wholesale only

Financing: Revenue bonds, backed with a commitment to levy a sales tax if necessary

Services Offered: Internet access, VoIP, video, security monitoring, and any other service a provider can dream up

UTOPIA is a multi-community endeavor that will bring 100 Mbps fiber connections (upgradeable to 1 Gbps) to 250,000 homes and businesses spanning 325 miles in western Utah.

In the late 1990s, the cities of Murray and Provo began exploring fiber optics for meter reading and control systems. They recognized the potential to piggyback other municipal services on the network. Murray started planning a fiber optic network in 1998, initially connecting only key public buildings.

At the same time, US West (later Qwest) was building a fiber optic network in preparation for the 2002 Winter Olympics. The company had signed a \$60 million contract to be the event's telecommunications sponsor in 1997. The network was to connect Olympic venues only, however, and not residents or even businesses.

Murray had been installing fiber piecemeal for several years by that time and wanted to expand to include municipal services, Provo wanted to add residential video since private companies had built out only the wealthy parts of the city. Provo bought Provo Cable, one of two cable franchisees in the city, during its bankruptcy and started plans for a fiber optic network in 2000.

AT&T fought Provo's move by going to the legislature and asking for a ban on municipal telecom utilities. At the last minute, representatives of a company called Pinnacle (the predecessor of Dynamic City) proposed an airport model, in which the public sector can be a wholesaler but not a retailer. In 2001, the Utah legislature passed a bill making it possible for cities to build their own networks and sell wholesale telecom services. But the bill also imposed barriers. It limits use of general or enterprise funds (Provo, which used \$2.3 million in power reserves to buy Provo Cable, was given 10 months to repay the fund), and requires a feasibility study to show a municipal network would be profitable.

Both Qwest and Comcast were still unwilling to upgrade their networks for residents and businesses. (In summer 2002, Qwest announced it was considering restating its 2001 financials, a criminal investigation was announced related to fiber optic capacity swaps with Enron and Global Crossing and also insider trading, and the General Services Administration announced it was reviewing Qwest contracts.) So several cities that had been considering networks began concentrating on publicly owned, open access infrastructure as an alternative.

In March 2002, West Valley City became the first city to pass a resolution recognizing UTOPIA as a separate legal entity that will study the feasibility of linking several cities to a fiber optic network. By April of 2002, eight cities had joined. Dynamic City was awarded the contract for a feasibility study in September 2002.

The cities commissioned a market study in which residents and businesses were polled not only on whether or not they would subscribe to the new network, but also how they felt about public ownership. Over 70 percent said they would probably or definitely support publicly owned telecommunications infrastructure. Over 80 percent supported the idea if surplus revenues would be used to improve other government services.

The UTOPIA business case sets out specific costs of building and operating the network, as well as projected subscription rates and revenues. It explains how costs are calculated, and refers to market research to justify subscription rates.

UTOPIA's feasibility study was independently verified using a variety of scenarios. Even the worst-case scenario – take-rates lower than the conservative view, an extended price war with incumbents, and cost overruns – shows the network generating positive cash flows from year six on.

The cities want to earn the investment back, but they're happy to earn it back over 20 years. Moreover, the return on public investment comes from increased business activity and improved quality of life, and the network must need only generate enough revenue to cover operations, upgrades, and debt. This means the wholesale rate is lower than what would be available from a for-profit network, which must realize a full return on investment, plus profits, over just a few years.

The UTOPIA model takes advantage of regional aggregation. The cost of entry for video providers is too high to have real competition in small markets.

Counties have high density, but they also have areas that are low density, which increases the cost of providing ubiquitous service. They concluded that cities are a better center for aggregation.

As elsewhere, but particularly in Utah, there is concern about the issue of government involvement in and influence over programming decisions on public infrastructure. UTOPIA director Roger Black acknowledges that some private service offerings will likely include content that some community members will object to. "We are not concerned with what specific programming they want to offer. Our job is to provide a fiber-optic network."

The earliest footprints are now showing about 30% take rate. Most are buying two or more services (voice, video, and data). There are 4 service providers under contract on the network, one offers voice, video and data; one offers voice and data only, one internet only, one business only (AT&T), and one focused on education. There are 12 or so additional companies going through the process to offer services, ranging from video on demand to telemedicine, multinationals to niche providers. These are open, high capacity connections, completely different asset than anything that exists today, and built that way from the ground up.

More cities may join the UTOPIA consortium over time. In particular, cities that have existing fiber networks are looking to gain access to more service provider by joining UTOPIA's larger customer pool.

Windom, Minnesota

Population: 4500

Area: 3.6 square miles

System Type: fiber-to-the-premises

Model: Municipal utility, retail service provider

Financing: Revenue bonds

Services Offered: phone, Internet, video

Windom is a small town of 4500 people, but it has a history of taking the lead in telecommunications. It started its own municipal cable television service 20 years ago because cable companies had similarly bypassed the town. In 1993, it was host to the country's first teleconference town meeting, with Rep. David Minge connecting from Capitol Hill to a fiber optic connected studio in Windom. The studio was already in use for an interactive class with Hamline University.

In April 2005, the city began offering services through its fiber optic network, can deliver 100 Mbps to every home and business. City officials

saw fiber optics as a way to "future-proof" their telecommunications infrastructure. The system will be able to meet telephone, internet, and video demands for the foreseeable future.

The city tried to pass a referendum to establish its own telephone company in 1999. Under Minnesota law, municipalities may own and operate their own telephone systems, but such an enterprise must be approved by a two-thirds majority in a referendum if there is an existing telephone service provider. In Windom's case, the existing company was Qwest, which offered only dial-up internet service in town. In 2000, Qwest promised to extend DSL services to 13 rural Minnesota communities other than Windom. The same year, a referendum passed with 70 percent of the vote. Qwest announced its intention to provide DSL to Windom in 2003, but by that time the municipal system was underway.

In May 2004 the city issued \$9.4 million in revenue bonds to fund the network. The city plans to retire the bonds with revenues from the system and general funds, because the network is also used for municipal purposes.

Windomnet's first customer was Toro Co.'s manufacturing plant, which moved there from Indiana in 2002. The city also has other industrial development and a hospital, all of which needed access to high speed telecommunications.

Prices are \$30 for 750 k up/512 k down, \$36 for 1.5 Mbps/512 kbps, and \$66 for 1.5 Mbps bi-directional. Faster speeds are available for higher prices. "Triple play" (phone, internet, and cable) packages are also available.

Qwest now offers DSL in Windom. Prices are \$40 per month (\$45 if you don't have phone service with them), plus \$60 for modem, for 1.5 Mbps/896 kbps, \$32 for 256 kbps. Southwest Wireless Net, part of New Vision Coop, offers fixed wireless service. It began in 2001, and is available only to those with a clear line of sight to a tower. They offer 256 kbps for \$30 and 512 kbps for \$40.

¹ Community Broadband Fact Sheet, American Public Power Association, July 2006.

² The first data packet was sent in 1969 using the Department of Defense's ARPANET (Advanced Research Projects Agency Network).

³ Federal Communications Commission, *First Computer Inquiry*, Final Decision, 28 FCC 2d at ¶ 11.

⁴ Robert Cannon, *The Legacy of the Federal Communication Commission's Computer Inquiries*, May 3, 2003. Harold Fedlman, *Debunking Some Telco Disinformation*, May 15, 2006.

⁵ For a full timeline of the FCC's computer communications-related rulings and contemporary Internet developments, see Cybertelecom's *Computer Inquiries Timeline*.

⁶ The FCC divided traffic over phone network into two categories. Basic telecommunications services were defined as transmission of an ordinary-language message from point-to-point, and were regulated as common carriers. Enhanced telecommunications services use common carrier transmission facilities, but use computer processing on the form or content of the transmitted information. For more definitions, see Cybertelecom's *Notes: Computer Inquiries*.

⁷ Earlier networks facilitated the research that led to the development of NSFNET. But NSFNET, established in 1986, was the basis for the national Internet backbone we use today.

⁸ Rijiv C. Shah and Jay P. Kesan, "The Privatization of the Internet's Backbone Network", Presented to the Association of Internet Researchers, Maastricht, Netherlands, October 16, 2002.

⁹ *National Cable and Telecommunications Association v. Brand X Internet Services* (04-277), 345 F.3d

¹⁰ Federal Communications Commission, *FCC Adopts New Rules for Network Unbundling Obligations of Incumbent Local Phone Carriers*, February 20, 2003. For an overview of the federal court rulings leading to the FCC's decision, see *Written Statement of Michael K. Powell, Chairman, Federal Communications Commission*, before the Senate Committee on Commerce, Science and Transportation, January 14, 2003.

¹¹ "Specifically, the Commission determined that wireline broadband Internet access services are defined as information services functionally integrated with a telecommunications component. In the past, the Commission required facilities-based providers to offer that wireline broadband transmission component separately from their Internet service as a stand-alone service on a common-carrier basis, and thus classified that component as a telecommunications service. Today, the Commission eliminated this transmission component sharing requirement, created over the past three decades under very different technological and market conditions, finding it caused vendors to delay development and deployment of innovations to consumers." Federal Communications Commission, *FCC Eliminates Mandated Sharing Requirements on Incumbents' Wireline Broadband Internet Access Services*, August 5, 2005.

¹² S. Derek Turner, *Broadband Reality Check II*, Free Press, August 2006.

¹³ SBC purchased AT&T and then took the older company's name, and is in the process of acquiring Bell South (though media reports in late 2006

¹⁴ Free Press, *Who Owns the Media?*

¹⁵ International Telecommunications Union, "World Information Society Report," July 2006.

¹⁶ Robert X. Cringely, "The \$200 Billion Lunch", I, Cringely, Public Broadcasting Service, November 2, 2006.

¹⁷ *Washington Post*, November 10, 2006.

¹⁸ Government Accountability Office, "Broadband Deployment is Extensive throughout the United States, but It Is Difficult to Assess the Extent of Deployment Gaps in Rural America," GAO-06-426, May 2006.

¹⁹ Satellite broadband is very, very expensive to provide. A satellite costs upwards of \$250 million to launch. Unlike television, which can be beamed to an unlimited number of customers, Internet access requires a two-way connection and more satellite capacity must be added for additional customers. "With a Dish, Broadband Goes Rural," *New York Times*, November 14, 2006.

²⁰ BPL faces strong opposition from the amateur radio community because of the potential for interference.

²¹ WiMAX is a brand name for the IEEE 802.16 standard, and also the commonly used name for long-range, high speed wireless.

²² "Comcast, Cablevision target businesses for growth", Reuters, September 20, 2006.

²³ For a fuller discussion, see Kimo Crossman, *What's really going on with Muni WiFi?*, January 4, 2006.

²⁴ Ken DiPietro, National Summit for Community Wireless, Saint Charles, MO, April 2006.

²⁵ Phone networks and computer networks are both telecommunications networks, but they function quite differently. Traditional telephone networks are circuit-switched. They work by creating a temporary direct connection, a completed electronic circuit, between the users. Your voice is converted to electronic pulses that are sent through the connection. All the intelligence that allows services like call-waiting and caller ID are contained in the network itself, and can theoretically be used regardless of the type of phone plugged into the network. Computer networks (high-speed data networks), on the other hand, are packet switched. They work by converting your voice (or email, or image) into digital format (1s and 0s), then breaking the digital communication into individual packets. Each packet is sent independently through the network. The packets are reassembled at the final destination. The intelligence is contained in devices that plug into the ends of the network. A phone network is designed for phone service. A cable network is designed for video service. High-speed information networks, however, aren't designed for any particular service. Telephone calls, movies, photographs, and emails are all broken down into packets that look the same to the network. This flexibility means that modern high-speed networks are an unprecedented platform for innovation.

²⁶ Works of Franklin D. Roosevelt, "The Portland Speech", *A Campaign Address on Public Utilities and Development of Hydro-Electric Power, Portland, Oregon*, September 21, 1932.

²⁷ The owner of the network charges independent service providers a higher access rate than they charge their in-house service provider.

²⁸ An entity that builds out a full, competing network.

²⁹ For more on open networks, see the *International Network of e-Communities Declaration on Open Networks*, signed October 2006.

³⁰ National League of Cities, *Advisory Council Trends and Changes Topics* and *About Cities: Trends in Our Nation's Cities*.

³¹ Balhoff and Rowe, *Municipal Broadband: Digging Beneath the Surface*, September 2005. Blandin Foundation "Increasing Economic Vitality: A Community Guide to Broadband Development."

³² Experian Business Reports, October 2, 2006.

³³ Bill Beck, Minneapolis Deputy Chief Information Officer, Minneapolis City Council Ways and Means Committee Meeting, September 1, 2006.

³⁴ The Digital Inclusion Fund will be managed by a private foundation. The fund will distribute money to organizations that promote technology literacy.

³⁵ *Is a Publicly Owned Network a Wise Public Investment for Minneapolis?* ILSR, May 2006.

³⁶ Saint Cloud, Florida, *Annual Budget FY 2005/06*.

³⁷ The average Saint Cloud household pays \$300 annually in local property taxes. Jonathon Baltuch, MuniWireless Santa Clara, June 2006.

³⁸ "The Leaf Chronicle", October 4, 2006.

³⁹ Bruce Kushnick, *The \$200 Billion Broadband Scandal*, Tele-Truth, 2006.

- ⁴⁰ S. Derek Turner, *Broadband Reality Check II*, Free Press, August 2006.
- ⁴¹ *New York Times*, November 14, 2006.
- ⁴² *New York Times*, July 2, 2006. About 1 million homes are in new developments and will get fiber to the premises.
- ⁴³ Broadband Everywhere, *A Picture is Worth a Thousand Words: How the Bell Business Model Leaves Much of America Behind*, April 4, 2006.
- ⁴⁴ *New York Times*, July 2, 2006.
- ⁴⁵ U.S. PIRG, *The Failure of Cable Deregulation: A Blueprint for Creating a Competitive, Pro-Consumer Cable Television Marketplace*, August 2003. Cable networks were essentially deregulated with the 1996 Telecommunications Act, which prohibited local franchising authorities in most places from regulating rates. Cable rates increased by over 50 percent from 1996 to 2003. While cable companies blamed increased programming costs for their rate hikes, 40 percent of the top cable channels are owned in whole or in part by cable companies or the conglomerates that own them.
- ⁴⁶ *Wall Street Journal*, "Cable Industry May Need to Spend Heavily on Broadband Upgrades", August 17, 2006.
- ⁴⁷ The Communications Opportunity Promotion and Enhancement (COPE) Act of 2006, which provides for national video franchising, passed the House in June 2006. The Senate version is being held in committee as of July 2006.
- ⁴⁸ State Representative W. Curtis Thomas, "Redlining in the Digital World", *Philadelphia Daily News*, July 26, 2006.
- ⁴⁹ *Wall Street Journal*, May 10, 2006. *Boston Herald*, May 11, 2006.
- ⁵⁰ "Verizon says 'Come get DSL', then turns some away", *New York Post*, October 8, 2006.
- ⁵¹ Quality of service is about guaranteeing a specific level of performance within a short time window. For most applications, quality of service doesn't matter. When browsing the web, a half-second delay is unlikely to cause you problems. With pre-recorded audio or video, a ten second buffer ensures smooth viewing. The exceptions are voice over Internet Protocol, live video (e.g. teleconferencing), and online gaming. Edward W. Felten, "Nuts and Bolts of Network Neutrality", June 2006.
- ⁵² Not coincidentally, this also allows those who own the network to maximize revenue from their networks. Instead of offering faster or more affordable connections, they can charge you for what you do with your connection. For example, they can charge one rate to download video created by their own company, but a higher rate to download video from an independent filmmaker, and an even higher rate to post your own video for others to download. A digital book purchased from Amazon.com would download faster than the same book from your local bookstore or an independent author, just because the larger company can afford to pay for priority for its traffic.
- Tom Rutledge, the Cablevision COO famously told a Wall Street conference in June about the contrast between his VoIP (Voice Over Internet Protocol) service with that of Vonage. "We actually prioritize the bits so that the voice product is a better product."
- ⁵³ Some have argued that allowing any prioritization of bits will lead to technologies that disguise low-priority bits as high-priority. See Sascha Meinrath and Viktor Pickard, "A New Net Neutrality."
- ⁵⁴ If the new network will provide television (i.e. if it is a fiber optic network rather than wireless), the company may be obligated to meet the same terms as the existing cable franchisee, providing public access channels and meeting build-out requirements.
- ⁵⁵ In some cities, investor-owned electric utilities own the light poles. Some wireless networks must also gain access to the roofs of buildings or other private assets.
- ⁵⁶ Information for this section is from Jim Baller, "Response to Progress and Freedom Foundation Paper of February 2004," June 16, 2004; and Ben Scott and Frannie Wellings, "Telco Lies and the Truth about Municipal Broadband Networks," Free Press, April 2005.
- ⁵⁷ Paul Miller, "Bristol's broadband push," *Virginia Business Magazine*, November 2006.
- ⁵⁸ Ronald J. Rizzuto, *lowa Municipal Communications Systems: The Financial Track Record*, Heartland Institute, September 10, 2005.
- ⁵⁹ City of Iowa City Cable TV Division, *Frequently Asked Questions*.
- ⁶⁰ *Speed and Bandwidth of the UTOPIA Network*, from M&I Partners, *FiberSpeed* program.
- ⁶¹ In recent years, U.S. cable and telephone companies have substantially increased the down-stream speeds of their broadband services. For example, cable modem service went from up-to 3 Mbps in 2004 to up-to 5 or 6 Mbps today. But up-stream speeds have stayed at 384 Kbps.
- ⁶² The National Academies Committee on Broadband Last Mile Technology offers two definitions for broadband: 1. Local access link performance should not be the limiting factor in a user's capability for running today's applications. 2. Broadband services should provide sufficient performance--and wide enough penetration of services reaching that performance level--to encourage the development of new applications.
- ⁶³ The capacity of the fiber is limited not by the fiber itself, but by the electronics used to light the fiber.
- ⁶⁴ Cellular data services are referred to as 3G or 4G. Right now there are two competing 3G services on the market in the U.S.: EV-DO (Evolution Data Only, to distinguish it from Evolution Data Voice, or Evolution Data Optimized), and CDMA (code division multiple access). Current services are comparatively slow (around 400 kbps or less) and expensive (\$60 per month), but are available in most major cities.
- ⁶⁵ Wi-Fi devices work with any Wi-Fi network because they all use the same standard. As of late 2006, there are no certified WiMAX products on the market. Products billed as WiMAX, pre-WiMAX, or WiMAX-compliant are in fact proprietary technologies. For example, Motorola Canopy is a proprietary technology that uses unlicensed spectrum, and the company is also working on technologies that will meet the 802.16e standard and operate in licensed spectrum. A device designed to work with Motorola Canopy would not work with Motorola's WiMAX-standards compliant product (unless it is designed to support both, which adds expense).
- The most common band for WiMAX products is likely to be one that is not available for consumer devices in the U.S. In most of the world, the 3.5 GHz band is unlicensed spectrum. In the U.S., it is reserved for military use. It is therefore likely that U.S. consumers will not benefit from much of the research and innovation in WiMAX devices.
- ⁶⁶ Some spectrum holdings of these companies are leased from educational institutions. See *Comments of the New America Foundation et al, to the FCC in the Matter of the Commission's Rules to Facilitate the Provision of Fixed and Mobile Broadband Access, Educational and Other Advanced Services*.
- ⁶⁷ Another possible area for unlicensed spectrum is the "white space" between digital television frequencies. Michael Marcus, Paul Kolodzy, and Andrew Lippman, "Reclaiming the Vast Wasteland: The Engineering Case", New America Foundation, October 18, 2005; Jim Snider, Paul Kolodzy, *Comments on DTV Converter Box Coupon Program*, September 26, 2006.
- ⁶⁸ Merriion Edwards, "To Overbuild or Underbuild?", *OSP Magazine*, June 2006.
- ⁶⁹ J.H. Snider, *Spectrum Policy Wonderland*, Prepared for delivery at the Telecommunications Policy Research Conference, September 30, 2006.
- ⁷⁰ Sascha Meinrath, *The Rise of the Intranet Era: Applications and Emergent Technologies, Open Source Innovations, and On-the-Ground Implementation*, Presented at CityWLAN2006, Lahti, Finland.
- ⁷¹ Jon Dolan and Curt Pederson, "Building a Champagne Network on a Beer Budget," *Educause Quarterly*, Vol. 27, No. 2, 2004.