Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle

Prepared for

The City of Seattle

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Table of Contents

Table of Tables

Table of Figures

Appendices

1. Executive Summary

In 2004, Seattle's Mayor and Council convened a Task Force to evaluate the City's "technology future." The Task Force concluded that only a fiber-to-the-premises (FTTP) network could deliver the bandwidth and security necessary "to ensure Seattle's broadband future." It further noted that a lack of true broadband competition could relegate the City "to second tier status in terms of its technological sophistication and [the City could] lose its edge to cities that are better positioned to compete in the emerging global economy."

Based on this imperative, Seattle City Light (SCL) hired Columbia Telecommunications Corporation (CTC) to prepare a report evaluating the feasibility of a municipal FTTP network in Seattle under a range of business and technology plans ("Evaluation of Potential Risks and Benefits of Municipal Broadband," November 2008); significant findings included:

- SCL would be well served by constructing additional fiber as necessary to support utility automation efforts and by increasing the count of the fiber SCL is currently deploying. These efforts would benefit FTTP deployment but, on their own, are likely insufficient to attract a private investor to finance full FTTP implementation.

- The City of Seattle, not SCL, may be well served by exploring funding alternatives for at least extending fiber to the neighborhoods. Such infrastructure would likely increase the potential of attracting additional private investment and enable pursuit of non-traditional FTTP business models to bridge the "last mile" to the home and business.

- The business case for building fiber all the way to the premises cannot be made on SCL's internal needs alone. Rather, the primary beneficiaries of FTTP are the City, residents, and businesses of Seattle. SCL would be a secondary beneficiary of the additional fiber, but likely would not have immediate use for the "last mile" fiber to the home and business.

- Despite the cash flow risk, CTC's market research indicates significant interest and need for high-speed networking among Seattle residents and businesses—a need that is not currently met by private carriers. The market research affirms that the City has compelling objectives in encouraging FTTP deployment, and there exists a foundation for investment in fiber. The market research suggests that Seattle residents and businesses recognize benefits of high speed networking ranging from consumer choice to competition to enabling innovation to facilitating emerging applications such as telework, distance learning, and telemedicine.

This Report, which was also prepared by CTC at the request of the city of Seattle, is a follow-up to the earlier report. It presents an *evaluation of the direct and indirect benefits of a municipal FTTP network in Seattle*. Specifically, it considers the benefits in light of the City developing an FTTP network in a private/public partnership, *with the City constructing a fiber-to-the-neighborhood (FTTN) infrastructure, and a private entity completing the "last mile" of the FTTP network* to individual homes and businesses.

As conceived in this report, the benefits of FTTP fall into two distinct categories: Direct benefits and indirect benefits.

Direct Benefits

Direct benefits are, plainly speaking, the revenue that a proposed fiber network would generate. This cash flow is needed to cover the City's capital investment and debt service (principal and interest), as well as ongoing network maintenance and operating expenses.

The per-user subscription fees that third-party service providers would pay to the City (as owner of the network) are the most concrete of these benefits, though even these are projections; if the number of subscribers is lower than expected or the service providers negotiate a lower-than-estimated fee structure, the City will earn less income than the business model illustrates—and may not break even. (See Appendix A and "Evaluation of Potential Risks and Benefits of Municipal Broadband" for more details.)

CTC examined a range of other potential direct benefits that, by having FTTP, the City might be able to generate. Among the most promising are carbon credits and offsets, through which the City could monetize the FTTP-enabled reduction of its greenhouse gas emissions and create a new revenue stream (see Section 3). CTC was not able to quantify any true value in the carbon market, however.

The bottom line is that, aside from the very traditional measures of network cash flow (e.g., subscription fees), an FTTN or FTTP network will not produce direct monetary benefits to the City.

Indirect Benefits

Indirect benefits represent a potentially significant pay-back on the City's investment in FTTN—more than $1 billion *annually* in benefits accruing to all of the stakeholders in the City (as well as, in some cases, King County, the state of Washington, and beyond). The indirect benefits of FTTN also include an annual reduction in CO_2 emissions of as much as 595 million kilograms.

It is important to note, however, that none of these benefits would appear on the City's balance sheet; as described in the Report, the dollar amounts represent not revenue generated, but savings to residents, businesses, institutions, and the City itself.

Indirect benefits fall into three categories:

1. Cost avoidance. These are budget items that the City would otherwise have to fund, but that it avoids with a fiber network. These items include both current and future expenditures. For example, the Department of Information Technology (DoIT) spends approximately $4 million annually on leased communications services, and estimates that approximately $1 million could be avoided by transferring services to an FTTN network.

2. Monetary savings accruing to stakeholders. This category represents the largest quantifiable benefit of an FTTN network in Seattle, primarily related to increased telework ($324 million) and reduced healthcare expenditures ($602 million). As indicated in Table 1 the annual estimated savings approaches $1 billion.

Table 1: Estimated Annual Stakeholder Savings ($000,000)

Benefit Area	Annual Savings Estimate ($000,000)
Environmental Benefits	
Increased Telework	
Vehicle Expenses	$ 52.80
Time Savings	48.40
Traffic Congestion	215.30
Electricity Savings	0.15
Teleconferencing	7.40
Total Environmental Benefits	$ 324.05
Reduced Cost and Enhanced Quality of Healthcare	
Lowered Transportation Costs	
Emergency Department Transfers	$ 1.05
Correctional Department Transfers	0.16
Avoided Benefits- Nursing Homes	0.92
Improve Medical Efficiencies	100.90
Medical Cost Savings	
Asthma	1.12
Diabetes	108.00
Cardiovascular	390.00
Total Health Care Benefits	$ 602.15
Miscellaneous Benefits	
Enhanced Competition	$ 33.07
Total Miscellaneous Benefits	$ 33.07
Total Estimated Benefits	$ 959.27

The calculation of savings that are related to telework—mostly reduced automobile expenses—are based on statistically valid market research CTC

conducted in Seattle, though they do depend to some extent on real-world consumer behavior and other externalities.

The healthcare cost savings may be somewhat more optimistic, given that realizing all of them would require a range of intermediate steps, including the installation of network infrastructure at hospitals and the development of a critical mass of residents who are both fully computer literate and have necessary computer hardware in their homes.

Direct benefits in this category include cost savings related to aging-in-place for senior citizens, enhanced video surveillance and security, more efficient government services, "in-sourcing" of tele-jobs, and enhanced competition in the retail broadband market.

(Many of these savings would be offset to some degree by savings that are or could be realized through currently available cable modem or DSL "broadband" service. However, it is important to put that term in perspective: The Federal Communication Commission's 2008 definition of "basic broadband" is downstream—not symmetrical—speeds between 768 Kbps and 1.5 Mbps. That's higher than the previous definition of 200 Kbps but still laughably low. As one observer has noted, it would take 8.16 hours to download a movie under the old broadband definition; at the new definition, an American with basic broadband would still need 2.12 hours to complete the download.[1] So the high *symmetrical* speed of 100 Mbps or more delivered by a fiber network would enable many applications and services—especially related to telework and healthcare—that simply would not be possible with cable modem or DSL service.)

3. Environmental impact. Though there are no quantifiable direct benefits to be derived from an FTTN network (e.g., selling carbon credits), the potential environmental benefits are significant. Reduced automobile travel related to increased telework, among other sources, could lead to an annual reduction of approximately 535 million kilograms of CO_2 of emissions. The detail of the projected emission reductions are shown in Table 2.

Table 2: Estimated Annual Emission Reductions

Benefit Area	Annual CO_2 Reduction Estimate (million kilograms)
Increased Telework	
Vehicle Emissions	40.30
Traffic Congestion	481.36
Teleconferencing	13.04
Total Environmental Benefits	534.70

[1] "FCC Definition for Broadband Now 786 Kbps," http://elliottback.com/wp/archives/2008/03/22/fcc-definition-for-broadband-now-768kbps/.

Challenges

The core business model that CTC was asked to evaluate is one in which the City deploys an FTTN infrastructure that is designed to support an FTTP network, with the hope that the core fiber is enough to attract a private entity to build the last-mile FTTP fiber and operate an open access network. A summary of this business model is shown in Table 3. (Please note that a private FTTP provider that leverages the proposed Seattle FTTN may follow a range of business models.) Further details are shown in Appendix A and Appendix B.

Table 3: Overview of Fiber-to-the-Neighborhood Network

Description	• The City builds and controls a fiber-to-the-neighborhood (FTTN) network throughout Seattle. The neighborhood fiber serves to attract other investment in which the "last mile" is bridged through a range of potential options financed by the private sector or, potentially, an Equity model in which subscribers pay for and own the fiber extensions to their homes and businesses and the customer premises equipment. • Private sector entities are selected to operate the network and offer services to residences and businesses. These entities pay the City an access fee for use of the City network.
Overall City Risks	• Potential perception of the City "redlining" high-income households if private fiber investment to complete the fiber to the premises is only made in areas of those willing to pay. • Unproven model in the U.S. Value proposition basis not well understood by consumers. • The City is required to develop technical support since approach is no longer a dark fiber offering. • Limitations due to regulatory and legal concerns.
Approach	• Deploy fiber to the neighborhood to help attract FTTP investment
City Risks (specific approach)	• Potential for stranded capital investment. • Potential litigation due to Qwest ownership interests with SCL poles. • Competes with financial resources for city investments. • Financial projections are highly speculative—no municipal examples in U.S. available to test assumptions.
Opportunities	• Supports a range of last-mile business models such as the Equity model. • Success in Europe (Sweden) has increased interest with new business models and approaches in the U.S. (UTOPIA example). • Increasing awareness of shortcomings of existing business models in the U.S.
Minimum Additional Capital Investment	• $150 M ($100 M for fiber,[2] $40 M to cover implementation costs,[3] $10 M loan for initial operating expenses[4]).
O&M (Year 1 $)	• $2.8 M (employees, inventory requirements, location to house equipment).
What Is Needed to Meet Objectives	• Residential market shares of 21 percent cable television, 54 percent Internet, and 15 percent telephone. Business market shares of 21 percent cable television, 36 percent Internet, and 27 percent telephone. • Attract a private investor to complete the FTTP investment. • Attract providers that are willing to pay access fees at required levels while obtaining required penetration rates and manage the network.
Benefits to Consumer and City	• Provides consumers an alternative provider of voice, video, and data services. • Provides a wide-range of ancillary benefits such as emission reductions and cost savings (vehicles, roads, public transportation) due to increased telecommuting. • Provides a foundation for economic development initiatives requiring enhanced connectivity. • Supports data speeds and capacity for beyond the capability of cable modem and DSL options.

[2] 4.5 percent interest, 20 year repayment, principal repayment begins in year 1, 1 percent issuance cost on borrowed amount.
[3] 5.0 percent interest, 20 year repayment, principal repayment begins in year 1, 1 percent issuance cost on borrowed amount
[4] 6.0 percent interest, 20 year repayment, issued in year 1, principal repayment begins in year 3

The primary challenge in considering this model is that it has never been done before. No other city in the United States has successfully attracted a private last-mile provider with the "carrot" of an FTTN infrastructure. In theory, such a plan would work. In practice, it is unproven.

If the City does successfully attract a private partner to complete the FTTP network, it would accrue the benefits of a full FTTP network with an investment limited to the cost of an FTTN infrastructure. However, the City would still faces hurdles: The projections underpinning the FTTN business model are, like any projections, merely estimates. There is no guarantee that a private provider would achieve the penetration rate that the model predicts, or that it would be willing to pay the subscription fees upon which the model is based. (Just as there is no precedent for this type of operation, neither is there precedent for the subscription fees.)

And if no private partner comes forward, the City would have two options to salvage its investment in FTTN:

1. Sell the FTTN infrastructure to an entity willing to operate it.
2. Complete the FTTP buildout itself, and become the open-access provider to the community.

Given that selling the FTTN infrastructure would represent a net loss to the City, and would not guarantee an eventual FTTP network, the second option is the only viable alternative. Thus, if Seattle were to build out an FTTN network, it must be prepared to finance and complete the FTTP network itself if no private entity steps forward to complete the last mile.

Ultimately, then, the City's pursuit of an FTTN network will be a speculative decision based not on its balance sheet, but on its desire to reap—for its citizens and itself—the tremendous ancillary benefits that FTTP could deliver.

2. Background

The City of Seattle has been evaluating the feasibility of a public/private partnership to build and own a fiber-to-the-premises (FTTP) network for the past several years. The City focused on the potential for a private/public partnership as a means of reducing the City's risk. The City has engaged in a feasibility and exploratory process that is among the first in the United States for a city of Seattle's size—with a population in excess of 560,000 and covering nearly 84 square miles.[5]

In 2004, Seattle's Mayor and Council convened a Task Force to evaluate the City's "technology future." In 2005, the Task Force adopted a goal that would bring true broadband to the entire City by the year 2015. The Task Force articulated its vision in this way:

> *Within a decade all of Seattle will have affordable access to an interactive, open, broadband network capable of supporting applications and services using integrated layers of voice, video and data, with sufficient capacity to meet the ongoing information, communications and entertainment needs of the city's citizens, businesses, institutions and municipal government.*[6]

The Task Force Report concluded that Seattle would require symmetrical (both upload and download) speeds of 20 Mbps to 25 Mbps in the short run and 100 Mbps and more in the longer run.[7]

While the Task Force recognized the mobility benefits of wireless technologies and the important complementary role of wireless, the Task Force found that only FTTP could deliver the bandwidth and security necessary "to ensure Seattle's broadband future."[8]

Significantly, the Task Force noted the dramatic impact technology has had on the City's development and nature. It further noted that a lack of true broadband competition could relegate the City "to second tier status in terms of its technological sophistication and [the City could] lose its edge to cities that are better positioned to compete in the emerging global economy."[9]

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[5] U.S. Census Bureau, 2000 Census. http://factfinder.census.gov/home/saff/main.html?_lang=en. Date of Access: July 16, 2009.

[6] "Seattle Task Force on Telecommunications Innovation," May 2005, Seattle's Department of Information Technology. www.seattle.gov/cable.

[7] Existing Seattle providers do offer products that include 20 to 25 Mbps download (one-way only) speeds. However, the existing private communications infrastructure in Seattle is not capable of reliable symmetrical 100Mbps service. FTTP is required to increase upload speeds and to reach reliable speeds of 100 Mbps in both directions.

[8] "Seattle Task Force on Telecommunications Innovation," May 2005, Seattle's Department of Information Technology. www.seattle.gov/cable.

[9] "Seattle Task Force on Telecommunications Innovation," May 2005, Seattle's Department of Information Technology. www.seattle.gov/cable.

On the basis of these findings,[10] in the spring of 2006 Seattle issued a Request for Interest to attempt to ascertain the interests and ideas of private sector entities interested in partnering with the City on an FTTP network.[11] The City received more than 30 responses to the Request for Interest, of which at least 10 were sufficiently interesting and responsive that City stakeholders interviewed the respondents during the fall of 2006.[12]

The broad and unexpected range of respondents suggests that, at that time, there existed significant interest in the project among financiers, manufacturers, non-incumbent carriers, and other parties.

Given the preliminary nature of the Request for Interest, the source of financing was neither specified nor determined through that process. According to City Department of Information Technology (DoIT) staff, however, there was significant interest on the part of the capital markets at the time the Request for Interest was released—and it was DoIT's perception that in the credit and economic environment of late 2006, private financing was available for such projects. In today's financial market, however, some of the entities interested in completing the FTTP may seek or require City financing guarantees.

In the wake of the Task Force's work, Seattle City Light (SCL) and DoIT were directed to investigate strategies by which to facilitate deployment of FTTP. SCL commissioned a Report exploring various business models and financial projections as part of that investigation. As a follow-up to that paper, this report—commissioned by DoIT and SCL—explores the wide range of indirect benefits that could be delivered by a FTTP network deployed throughout the City.

[10] On the basis of the conclusions of the Task Force, the City preliminarily concluded that it would "be an infrastructure partner," not a service provider or network operator. Also based on Task Force conclusions, the Request for Interest sets out the following parameters for the potential network: (1)"very high bandwidth with maximum scalability;" (2) non-discrimination in treatment of providers of similar services as well as in its treatment of customers (such an approach is directly contrary to the tiering and pricing options the incumbent providers have explicitly reserved for themselves); (3) respect for privacy rights; (4) serve *all* homes and businesses, even if that is achieved in a phased manner; (5) an "open access" platform for multiple service competitors to "fuel experimentation and innovation, lead to new applications and services, lower prices and create more choices for consumers;" and (6) an open device rule in which customers have the option of attaching any non-impairing device (not only those sold or rented by the operator). "The City of Seattle Fiber to the Premises Broadband Network Request for Interest," May 2006. www.seattle.gov/cable.

[11] "The City of Seattle Fiber to the Premises Broadband Network Request for Interest," May 2006. www.seattle.gov/cable.

[12] The respondents interviewed by the City include ACI Communications; Bechtel Telecommunications; Ericsson; iTown Communications; Lucent Technologies; Nextnet Investments; PacketFront Inc.; Qwest; U.S. MetroNets; Verizon; and Vulcan.

3. Generating Revenue Through Greenhouse Gas Reductions

Many municipalities, including Seattle, have begun to inventory their greenhouse gas ("GHG") emissions. Such quantification allows entities to manage climate risks, identify opportunities for emission reductions in a regulated market, participate in voluntary climate programs (by either generating offsets for sale or purchasing offsets to neutralize emissions), and potentially secure recognition for early action in an emerging regulated carbon market. These considerations are increasingly timely as both Congress and the Administration have indicated that passing mandatory climate legislation is a top priority. Moreover, as a member of the Western Climate Initiative, Seattle would be included in any emissions markets created by that regime.

Along with these considerations, Seattle's efforts to quantify its GHG emissions create another possibility: That the short- or long-term reduction of GHG through various broadband applications could be monetized in the carbon marketplace, creating a revenue stream for the City or SCL. However, as an economic model, generating cash flow through large-scale GHG reduction faces a series of practical and accounting hurdles.

3.1 Difficulty in Creating a Carbon Credit for the City

Federal climate legislation is likely to employ a cap-and-trade system. The "cap" would establish a national limit on greenhouse gas emissions, based on science-based targets designed to avoid the most catastrophic effects of climate change. Cumulative emissions from all regulated entities (power companies, fuel distributors, manufacturers, etc.) would not be allowed to exceed this cap. Allowances, in the form of permits representing a single ton of carbon or its equivalent, would be auctioned or allocated to polluters. Regulated entities like electric utilities, in turn, would be free to "trade" pollution allowances with one another.

Because the emissions permits cost money, cap-and-trade systems give companies an incentive to explore all cost-effective pollution controls. If a company can reduce its emissions, it is free to sell its excess allowances at a profit. Alternatively, if the permit price is cheaper than the cost of reducing emissions, a company may choose to buy additional allowances and continue with the status quo. (While individual companies have the flexibility to either maintain the status quo or innovate to reduce emissions, the overall emissions level is firmly determined by the cap.)

Money generated from a regulated entity's sale of pollution permits can be invested to serve the public interest. For instance, auction revenue can be used to help compensate families for increases in their electricity bills, make communities more resilient to climate change, and finance research and development in renewable energy and efficiency programs.

Over time, the federal carbon cap would be made tighter. As this occurs, permits would become more expensive. This, in turn, will create even greater incentives for regulated

entities to invest in new pollution controls. The cap would be tightened in a predictable manner, so that companies would be able to plan accordingly.

Because carbon emissions have a global effect, it is the amount—not the location—of emission reductions that matter. This not only allows companies to buy and sell allowances with one another, but also allows companies to meet their emissions requirements through the purchase of offsets. Offsets provide credit for pollution reductions from methods and locations that are not regulated by the cap. For instance, companies may help finance reductions in other countries. Alternatively, companies may purchase offsets from sectors, like agriculture, that are not covered by the cap. Of course, such offsets must be verified to ensure that they represent actual and permanent reductions, thus ensuring that net emissions do not exceed the limits of the cap.

If Seattle could accurately quantify the reductions associated with a particular project, it could potentially generate a credit or offset, which could be sold on the carbon market. The allure of such credits is significant. The voluntary offset market was worth an estimated $91 million in 2006,[13] and according to some estimates, is expected to increase to $5 billion by 2013.[14] While carbon prices are currently fairly low (roughly $1 to $7 per ton on the Chicago Climate Exchange),[15] these numbers are likely to increase dramatically under a mandatory national cap-and-trade program, with policy experts assuming future values of $20 to $50 per ton of carbon.[16] In fact, President Obama's budget assumes $646 billion in revenue for the first years (2012–2019) of climate legislation, a conservative estimate according to most analysts.[17]

Under this scenario, the potential value of emissions reductions associated with broadband are significant. For instance, according to Connected Nation, simply extending broadband to an extra 7 percent of U.S. households could avoid 1.5 million tons of emissions annually. Assuming a (conservative) carbon price of about $26.50 per ton, these reductions would translate to a $40 million annual "carbon benefit."[18]

Despite the myriad environmental benefits of FTTP (elaborated in Section 5.2 below), however, it would be extremely difficult for the City to generate tradable emission reductions from an FTTP network. This section briefly explores the reasons for this difficulty.

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[13] Katherine Hamilton *et al.*, "State of the Voluntary Markets 2007: Picking Up Steam," Ecosystem Marketplace and New Carbon Finance, July 18, 2007, 6. http://ecosystemmarketplace.com/documents/acrobat/StateoftheVoluntaryCarbonMarket18July_Final.pdf.

[14] Tom Baumann, Dir. of GHG Institute in Presentation to CANARIE Workshop, "Understanding GHG Programs, Accounting Protocols and Rules for Generating GHG Revenues," March 4, 2009. http://www.slideshare.net/bstarn/climate-check-canarie-workshop-march4.

[15] "CCX Carbon Financial Instrument (CFI) Contracts Daily Report," Dec 2003 to March 2009. http://www.chicagoclimatex.com/market/data/summary.jsf.

[16] Steven S. Ross and Masha Zager, "Fiber to the Home Is Green Technology," Broadband Properties, Jan/ Feb 2009, 29. http://www.bbpmag.com/2009issues/jan09/BBP_JanFeb09_CoverStory.pdf.

[17] Deborah Zabarenko and Ayesha Rascoe, "Obama Budget Realistic on Climate Revenue: Analysts," Reuters, Feb 26, 2009. http://www.reuters.com/article/environmentNews/idUSTRE51P4Q920090226.

[18] Ross and Zager, "Fiber to the Home Is Green Technology."

3.1.1 Methodologies for Quantifying Emission Reductions

To receive compensation for a project's GHG reductions, a city must be able to accurately quantify the effects of the measures, or projects, that it undertakes. In this case, that would mean developing an accounting methodology for anticipated carbon reductions associated with FTTP. Such measurement would be extremely difficult.

The GHG Protocol for Projects and ISO 14064 are the primary methodologies for quantifying emission reductions. These methodologies were designed to enhance the transparency, consistency, and credibility of project accounting.[19] In short, they help ensure that one ton of CO_2 is measured as one ton of CO_2—regardless of where it occurs. Although some uncertainty is inherent in measuring project reductions, the methodologies embrace a suite of principles (relevance, completeness, consistency, transparency, accuracy, and conservativeness), which are intended to limit and expose this uncertainty.[20] The GHG Protocol and ISO are complementary, with "ISO identifying what to do and the GHG Protocol explaining how to do it."[21] While additional methodologies have been developed for various carbon programs, these alternate approaches are generally based on the principles embodied in the GHG Protocol and ISO 14064 and are simply intended to provide additional guidance to stakeholders.

Unfortunately, the benefits of FTTP are not amenable to easy quantification using any of the accepted methodologies. This section highlights some of the chief obstacles.

Unclear Baseline. Under the GHG Protocol, any emissions reductions associated with a project must be measured against a "baseline scenario," which serves as the reference case for the project activity. The baseline is a hypothetical description of what would have most likely occurred in the absence of any considerations about climate change mitigation.[22] Thus, to determine a project's effectiveness, "it is important to count only GHG reductions from project activities that differ from—or are additional to—their baseline scenarios. Distinguishing a project activity from its baseline scenario is often referred to as determining additionality."[23] This is "the most important challenge for GHG project accounting,"[24] and would be particularly difficult in the case of FTTP. As discussed more fully in Section 5.2, FTTP can affect a wide range of behaviors with potential environmental benefits. Unfortunately, these behavioral changes are difficult to

[19] "The GHG Protocol for Project Accounting," WBCD and WRI, 5. http://www.ghgprotocol.org/files/ghg_project_protocol.pdf. (GHG Protocol is intended to: "Provide a credible and transparent approach for quantifying and reporting GHG reductions from GHG projects; Enhance the credibility of GHG project accounting through the application of common accounting concepts, procedures, and principles; and Provide a platform for harmonization among different project-based GHG initiatives and programs "); Paul Reed, "ISO 14064 Environmental Standard," IRCA e-zine, 2006 (available online at http://www.irca.org/inform/issue15/ISO14064.html)(visited Mar. 19, 2009) ("The ISO 14064 and ISO 14065 standards are aimed at injecting credibility and assurance to GHG emissions reports and claims made in regard to reductions or removal of GHGs.")

[20] "The GHG Protocol for Project Accounting," 22-24.

[21] Jay Wintergreen and Tod Delaney, "ISO 14064, International Standard for GHG Emissions Inventories and Verification" http://www.epa.gov/ttn/chief/conference/ei16/session13/wintergreen.pdf.

[22] "The GHG Protocol for Project Accounting," 12.

[23] "The GHG Protocol for Project Accounting," 16.

[24] "The GHG Protocol for Project Accounting," Figure 2.1.

predict and quantify. While FTTP is becoming a precondition for encouraging telework, residents may also be more inclined to telework in the face of rising gas prices or traffic congestion. Conversely, retail behavior may change with a declining economy, regardless of FTTP. Moreover, because broadband's benefits are not limited to these environmental considerations, critics may argue that FTTP itself is part of the baseline scenario. To hold otherwise would mean that the project would not have been constructed *but for* its associated emissions reductions.

Most Effects Are Secondary. Project accounting would also be very difficult because FTTP creates indirect, or secondary, emissions reductions. As discussed more fully in Section 5.2.1, the installation of FTTP by the City would have a downstream effect on consumer demand for electricity and fuel. By contrast, the GHG projects highlighted in the GHG Protocol have an immediate, or primary, effect on emissions.[25] The Protocol cautions, that "it is wise to consider the type and magnitude of secondary effects before proceeding with the rest of the Project Protocol."[26] While market assessments can be used to estimate these changes, "[a]ny method used to estimate secondary effects is prone to uncertainty."[27] As such, the "conservativeness principle" would compel the City to understate many of these benefits, thereby reducing the claimed reductions from the Project. The downstream nature of the benefits not only complicates Project accounting, but also raises questions about ownership of carbon reductions. The GHG Protocol does not resolve these issues.

No Appropriate Protocol. Most project accounting schemes have established protocols for a suite of projects that are amenable to quantification.[28] Notably, there is no protocol for FTTP. While this alone would not preclude quantification of project benefits, developing an appropriate protocol is extremely challenging and resource-intensive.

[25] "The GHG Protocol for Project Accounting,"31, 33, Table 5.1.This also relates to the distinction between what the GHG Protocol Corporate Accounting and Reporting Standard dubs "scope 1" and "scope 2" emissions. The former refers to emissions from generators of electricity, whereas the latter refers to emissions from end users. The different nomenclature is intended to help avoid double counting and to ensure that two different entities do not claim ownership over the same emissions.
[26] "The GHG Protocol for Project Accounting," 30.
[27] "The GHG Protocol for Project Accounting," 34.
[28] "Opportunities and Quantification Requirements for Local Government Participation in Greenhouse Gas Emissions Trading Markets," WRI and State of Washington Department of Ecology, July 8, 2008. Appendix (listing existing Protocols).
http://www.ecy.wa.gov/climatechange/2008CTdocs/10102008_LocalGovernmentsGHGtrading.pdf.

3.1.2 Potential Market for Broadband Emission Reductions

There are two primary ways that a reduction project can generate revenue for a city.[29] Unfortunately, the City is unlikely to benefit from either.

1. **Sale of Emissions Credits.** First, to the extent that a given project reduces emissions at a city-owned facility, a city would be able to claim the reduction benefits and sell the resulting emissions credits on a regulated carbon market. Quantification would be fairly simple: The city could simply assess emissions before and after project implementation and sell any surplus credits. In the case of broadband, however, any projected reductions are indirect, in the form of reduced fuel use or lowered electricity demand. This may benefit the regulated entities and any other producers or distributors of fossil fuels that are involved in the project, but the city itself cannot claim credit for these indirect reductions. To do so would lead to double counting, since the electric utility serving the community would likewise seek to purchase fewer emission allowances to account for lower electricity demand. In the case of Seattle, if the benefits were direct, sale of emission credits could be realized through SCL.

2. **Generation of Offsets.** Seattle could seek to certify any potential reductions as carbon offsets, which could be sold to sources (like Puget Sound Energy) under either a voluntary or regulated market. It is very unlikely, however, that reductions associated with FTTP would be eligible as offsets.

   Offset programs are intended to lower compliance costs by giving regulated sources access to low-cost reduction opportunities at unregulated sources.[30] In other words, covered entities can "offset" an increase in their own emissions by paying to reduce another entity's emissions elsewhere. Thus, by definition, to be creditable, *offsets must occur outside the cap.* In this case, most anticipated reductions associated with FTTP installation relate to reduced electricity and fuel use. To the extent both utilities and fuel sources are subject to climate legislation, reductions from these sources would not be eligible as offsets. In the event that future climate legislation were limited to electricity generation (as is the case with the Regional Greenhouse Gas Initiative in the Northeast), quantifiable reductions in fuel use could conceivably be eligible as offsets. Even under this unlikely scenario,[31] however, it would be difficult to credit such reductions. To be

[29] In its report "Opportunities and Quantification Requirements for Local Government Participation in Greenhouse Gas Emissions Trading Markets," WRI identifies a third potential funding stream, whereby the FTTP project could be financed from auction revenue from federal climate legislation. Although this is possible, it is not discussed here, as this analysis is limited to revenue that would be generated from emissions reductions associated with the project. 10-12, 14, 25.

[30] "Opportunities and Quantification Requirements for Local Government Participation in Greenhouse Gas Emissions Trading Markets," 6.

[31] "Design Recommendations for the WCI Regional Cap-and-Trade Program," Western Climate Initiative, Sept 23, 2008, 1-2. http://www.westernclimateinitiative.org/ewebeditpro/items/O104F21252.pdf. This scenario is unlikely as both the electricity and transportation sectors are likely to be covered by any regulated carbon market. The climate legislation considered by the Senate last spring regulated both utilities and petroleum producers. S. 3036, "Lieberman-Warner Climate Security Act of 2008," 110th

creditable, an offset must be "real, surplus (or additional), verifiable, permanent, and enforceable."[32] The proposed project raises questions with respect to many of these factors.

Real. An offset must represent actual net emission reductions. An offset cannot be claimed, for instance, if a tree-planting project in one city decreases emissions while logging increases elsewhere. Critics will argue that FTTP suffers from similar problems. For instance, although telework may reduce work-related auto use, teleworkers may make more frequent, unbundled trips for groceries or other errands. High-speed Internet access may prompt some residents to purchase items online that they would not have purchased in a store, thereby potentially increasing emissions over the status quo due to potential decreased efficiencies in the delivery of goods (i.e., requiring a delivery truck to drive to a person's home). Moreover, teleworkers may be based in a home office outside Seattle, leading to a net *increase* in carbon emissions statewide. That's because, while over 98 percent of SCL's energy mix is derived from low- and no-carbon sources, electricity in neighboring cities is more coal-intensive.[33] Thus, even if telework results in less office construction (and related electricity use) within City limits (see Section 5.2.1 below for a discussion about the potential effect of telework on electricity use), it could nonetheless lead to increased emissions in the state.

Additional. Offsets can only be claimed for reductions that would not have occurred absent investment in the project. This is perhaps the City's biggest hurdle in claiming offset credit for investment in FTTP. As an initial matter, any reductions from covered sources are not additional and, by definition, would not be eligible as offsets. Moreover, it will be difficult to prove that many of the benefits associated with broadband would not have occurred *but for* this investment. While CTC's market research indicates Seattle residents are more likely to telework with FTTP (see Section 5.2.1), other factors may also influence residents' behavior. For instance, it is possible that individuals may choose to telework because of rising gas prices or frustration with a long commute, rather than installation of FTTP. Similarly, changes in e-commerce may be dependent on economic conditions as much as on Internet speed.

Cong., § 4(7) (2008). The preliminary design recommendations for the Western Climate Initiative likewise propose regulating both electricity generation and transportation fuel combustion.

[32] "Opportunities and Quantification Requirements for Local Government Participation in Greenhouse Gas Emissions Trading Markets," 15. Note that several of these factors are problematic for reasons already discussed in the previous section.

[33] *Compare* Seattle City Light, "Fuel Mix: How Seattle City Light Electricity is Generated" http://www.cityofseattle.net/light/FuelMix/ (Date of Access April 15, 2009) (SCL fuel mix comprised of 90.61% hydroelectric, 4.83% nuclear, 3.25% wind, .85% coal 0.85%, .37% natural gas, and .09% other) *with* Puget Sound Energy, "Energy Supply – Electricity – Power Supply Profile" (http://www.pse.com/energyEnvironment/energysupply/Pages/EnergySupply-Electricity-PowerSupplyProfile.aspx (Date of Access April 15, 2009) (Puget Sound Energy fuel mix comprised of 42% hydroelectric, 37% coal, 19% natural gas, nuclear 1%, and other 1%).

Verifiable. Emission reductions must be accurately monitored to claim credit as an offset. Such monitoring would be very difficult for broadband installation. For instance, while market research reveals an increased preference for telework, actual reductions depend on the particular vehicles that are taken off the road and the commutes that are eliminated. Although analysts can develop a metric with detailed assumptions, this would complicate the analysis, making it difficult to claim a salable credit.

Permanent. Claimed offsets must represent permanent reductions. The question of permanence often arises with forestry projects, which may absorb carbon in the short term but eventually may be subject to fire or infestation, returning the stored carbon into the atmosphere. This would not be an issue for FTTP. While it is possible that residents will revert to their previous commuting and shopping habits, even short-term behavioral changes result in net emissions reductions.

Enforceable. To be enforceable, carbon reductions must be transparent and subject to monitoring. Because human behavior cannot be perfectly predicted, it would be difficult to enforce reductions associated with the FTTP project. For instance, individuals may claim to prefer telemedicine in market analysis (Section 5.3), but be unwilling to forego medical visits in reality. By contrast, a more direct offset project (e.g., methane capture) has more predictable (and thus quantifiable) results.[34]

3.2 Large Carbon Generators May Be Able to Benefit from FTTP

Although installation of FTTP is unlikely to generate a salable emissions credit or offset for a given community, electric utilities may potentially receive economic benefits.

Under a mandatory climate program, permits must be purchased by sources that are regulated under the emissions cap. A city by itself is unlikely to be considered a regulated source (unless it owned or controlled covered GHG emissions sources) under either a federal climate program or the Western Climate Initiative (which includes Washington State). As discussed above, a mandatory emissions market, however, is virtually certain to include electric utilities (like SCL) and will likely include the transportation sector, by regulating producers or distributors of fossil fuels.[35]

[34] "Opportunities and Quantification Requirements for Local Government Participation in Greenhouse Gas Emissions Trading Markets," at 19 ("Measures that target behavioral changes, rather than technology use, can have effects that are especially difficult to quantify.").

[35] "Design Recommendations for the WCI Regional Cap-and-Trade Program," 1-2. The Regional Greenhouse Gas Initiative ("RGGI") in the Northeast is limited to CO_2 emissions from the power sector. It is conceivable that future climate legislation would likewise be limited to power generators, although most proposals have also included the transportation sector in the form of producers or distributors of fossil fuels. Notably, the climate legislation considered by the Senate last spring regulated both utilities and petroleum producers. S. 3036, "Lieberman-Warner Climate Security Act of 2008," 110th Cong., § 4(7) (2008). Similarly, the preliminary design recommendations for the Western Climate Initiative propose regulating both electricity generation and transportation fuel combustion. Western Climate Initiative,

Because the availability of enhanced broadband over FTTP may reduce electricity demand and fossil fuel use by enabling less energy-intensive alternatives like telework and remote medical care,[36] FTTP may affect regulated electric utilities by easing compliance with the cap. Specifically, by reducing the demand for electricity, FTTP might reduce costs for the electric utility under either a mandatory climate program or the status quo. And the electric utility might not necessarily need any special quantification protocols to determine the cause of these reductions, depending on the program requirements and the protocols the electric utility may already have developed.

SCL has already conducted a baseline emissions inventory. If SCL's emissions are lowered below the number of allowable permits under a mandatory cap and trade bill, it might be able to sell surplus permits on the market. By reducing demand, this may also have the effect of lowering the market permit price, with additional benefits for all regulated entities.

Moreover, because SCL is already purchasing carbon offsets on the voluntary market,[37] SCL could benefit from an FTTP-driven reduction in electricity consumption even absent a mandatory carbon cap. Historically, SCL has spent up to $756,000 per year to offset its annual GHG emissions (roughly 200,000 metric tons).[38] To the extent FTTP lowers demand for electricity, it would allow the utility to purchase fewer offsets. Under either a mandatory cap or a voluntary market, this may, in turn, reduce electricity prices for Seattle residents.

3.3 Ultimately, Carbon Offsets May Not Provide Financial Benefits

In addition to the difficulty of accurately quantifying FTTP-based carbon offsets for sale, electric utilities must also be aware of the strength of the carbon offset market itself. While the voluntary offset market doubled from 2007 to 2008,[39] it fell by more than one-

[36] Joseph Fuhr and Stephen Pociask, "Broadband Services: Economic and Environmental Benefits," The American Consumer Institute. Oct. 31, 2007. http://www.theamericanconsumer.org/2007/10/31/broadband-services-economic-and-environmental-benefits/. 26. The size of such benefits depends on several factors. It is possible that some SCL customers will telework rather than commuting to jobs located outside of the city center. In this case, SCL electricity use would actually increase over the status quo. Moreover, the effect of telework on electricity use is somewhat conjectural and case-specific. Although studies assume a 3,500 kWh reduction per telecommuter, such reductions are limited to full-time teleworkers with the assumption that they adopt a home office in lieu of commercial office space. Electricity savings are dependent on individual behaviors and the electricity use of actual teleworkers.

[37] "The Climate Trust Shares CO_2 Offsets with Seattle City Light," Jan 21, 2003. http://www.ewire.com/display.cfm/Wire_ID/1475.

[38] Lisa Stiffler, "No Global Warming at City Light: Electrical Utility Halts 'Net Emissions' of Greenhouse Gases," Seattle Post-Intelligencer. Nov 10, 2005. http://www.seattlepi.com/local/247816_warming10.html. Seattle City Light has inventoried and fully offset its emissions since 2005, the only large utility in the nation to do so.

[39] "New report shows that carbon offsets can deliver business benefits—but you have to know how to use them," New Energy Finance, June 25, 2009. http://carbon.newenergyfinance.com/download.php?n=PressRelease_2009_25June_TheBusinessCaseforCarbonOffsetting.pdf&f=fileName&t=NCF_downloads.

third in early 2009.[40] And there are questions, too, about the efficacy and long-term sustainability of the offset market. Indeed, a recent report concluded that "the main business benefits of carbon offsetting are reputational"[41]—a finding that does little to support the expectation of long-term cash flow from the sale of offsets.

[40] Melissa Checker, "The Ins and Outs of Carbon Offsets," IEEE Spectrum. http://www.spectrum.ieee.org/energy/environment/the-ins-and-outs-of-carbon-offsets/0.

[41] "New report shows that carbon offsets can deliver business benefits—but you have to know how to use them," New Energy Finance, June 25, 2009. http://carbon.newenergyfinance.com/download.php?n=PressRelease_2009_25June_TheBusinessCaseforCarbonOffsetting.pdf&f=fileName&t=NCF_downloads.

4. Reduction, Replacement, or Avoidance of Existing City Costs

Developing a business case for the adoption of new Information Technology (IT) usually involves a relatively short-term lifecycle cost analysis of a few years, although certain underlying communications infrastructure components, such as outdoor fiber optic construction, offer much longer useful life spans over which to recover investments and extract value. Consequently, it can be misleading to quantify the potential cost savings presented by fiber optic infrastructure beyond those costs associated with existing services or budgeted plans that can be replaced or reduced as a direct result, because future potential cost avoidance opportunities are often linked to 1) unknown future application needs; 2) the availability and cost of future commercial service alternatives; and 3) opportunity costs associated with hindering the adoption of efficiency-enhancing new technologies due to lack of capacity or reach of connectivity.

The City is a major user of IT and telecommunications, and has invested extensively in dedicated, City-owned fiber optic infrastructure for many years to support the various facets of its public service. This strategy has proven successful in minimizing leased service costs while enabling higher-capacity connectivity than would otherwise be possible. There is every indication that this long-standing trend toward greater adoption of IT systems to increase the efficiency and effectiveness of City operations will continue. Thus, there exists a business imperative to continue to invest in infrastructure with the highest likelihood of decreasing the recurring costs for supporting electronic communications applications, both existing and future, and to indentify sustainable strategies to increase the capacity of this infrastructure to meet growing future demand.

An FTTN network is one long-term strategy with the potential to offer greater sustainability in response to the changing IT environment. This section seeks to identify the key opportunities to offset existing and future costs that might contribute to the overall sustainability and business case of an FTTN network, and to demonstrate the level at which City communications connectivity needs exist.

4.1 Methodology

CTC performed interviews with representatives from a wide swath of City departments and agencies to identify potential opportunities for reducing external costs for telecommunications and connectivity-related services, including planned or likely future costs for known requirements. Interviews were structured according to the Departmental Interview Guide attached in Appendix C. The following sections summarize the findings of these interviews and, in particular, highlight any specific costs or areas of connectivity need outside of existing services provided by or through the Department of Information Technology (DoIT).

4.2 Summary of Cost-Saving Opportunities

The City has a mostly centralized approach to the delivery of telecommunications and information technology (IT) services to support internal operations. The Department of Information Technology (DoIT) supports a wide range of internal systems and services

with enterprise-wide applicability, such as e-mail, Internet connectivity, remote virtual private network (VPN) access, data storage, and telephone service.

In addition to providing the technical support for many internal IT systems and services, DoIT provides central administration for the procurement of most IT and telecommunications services on behalf of other departments. DoIT estimates that it spends approximately $4 million annually on leased communications services. Of these existing costs, DoIT estimates approximately $1 million could be avoided by transferring services to an FTTN network, which would vary depending on services and terms offered by any commercial provider involved in the operations of the network. Included within this are nearly 200 dedicated data T1 (1.5 Mbps) data circuits at a monthly cost of approximately $175 each.

Among those noteworthy services outside DoIT's central administration are the data and telephone circuits for many of the Supervisory Control and Data Acquisition (SCADA) systems operated by Seattle Public Utilities (SPU) and Seattle City Light (SCL). While many are connected by fiber, approximately 150 locations are connected by leased circuits of varying types. An FTTP network could offer more reliable and higher-speed connectivity for these locations, while enabling new applications, including video surveillance for security and system monitoring at these critical infrastructure locations. In total, there are likely more than 400 SPU locations that are not currently served by City fiber and that will at some point require connectivity. These SCADA locations alone represent potential leased service costs ranging from $100,000[42] to as much as $3 million per year,[43] depending on the capacity and functionality required at each site.

Other near-term future City connectivity needs include nearly 400 of the total 1,000 traffic signal locations currently not connected as part of the City's Intelligent Transportation System (ITS), which could incur costs similar to the SCADA sites if not connected by fiber. CTC notes that these locations, aside from the ITS connectivity needs for the Seattle Department of Transportation (SDOT), are likely candidates for connectivity as part of a Citywide wireless deployment due to their geographic dispersion, proximity to roadways, and availability of existing support infrastructure (electrical power, mounting structures, etc.).

Less direct cost savings identified as potential benefits from an FTTN network include:

- A potential 50% reduction, or approximately $250,000 saved annually, in the payouts from damage claims related to storm water flooding, assuming an FTTN network could enable connectivity to provide more effective system control and monitoring of storm water systems.
- The elimination or reduction of software licensing costs for Citrix-based remote access solutions for employee home access by enabling high-speed, secure

[42] Based on a monthly cost of approximately $30 for low-capacity data or telephone service.
[43] Based on a monthly cost of approximately $1,000 for typical private-line Ethernet services of 10 Mbps to 100 Mbps capacity.

connectivity to City employees' residences at a cost of approximately $150 per user annually.
- The elimination or reduction of broadband wireless service costs and related Citrix-based remote access software license costs, totaling approximately $1.2 million per year, in conjunction with a Citywide wireless network deployment (discussed more in Section 4.3).

Other identified future needs and opportunities that could be realized by an FTTN deployment, not directly attributable to particular existing expenses, include:

- More robust connectivity to disseminate emergency information to the public.
- High-speed connectivity with outside entities and contractors for all facets of City business.
- Enhanced connectivity for telecommuting to reduce costs and waste associated with physical office space and travel.
- Enhanced remote connectivity for essential technical support personnel and customer service personnel, including during disasters or dangerous weather conditions.
- More effective recruiting and staff retention by offering free or low-cost broadband connectivity and enabling telecommuting opportunities for employees.

In addition to enabling the City to access its own facilities, staff, and even residents more effectively, an FTTN or FTTP network would provide the means by which to allow City departments to seek out and connect to a wider range of competitive providers of IT and telecommunications services within the City. For services currently outsourced, and possibly even those provided by DoIT currently, there might be more cost-effective options available to City entities once the capacity and reach of connectivity are no longer factors. Just as residential broadband connectivity has created a market for highly competitive, Internet-based telephone service providers over the past five years, greater capacity and depth of connectivity within the City could enable a range of providers of services from telephone and videoconferencing to application server hosting and data recovery. Of course, depending on the extent of the fiber deployment, the same benefits could extend to all residents in the form of competitive pricing and a wider range of innovative services.

4.3 FTTN and Wireless Backhaul Connectivity Synergies

Nearly all City departments have some requirement for wireless connectivity, whether fixed or mobile. In the case of public safety, SPU, and SCL in particular, these needs are extensive and highly prevalent among a large percentage of the workforce. These specific needs, summarized in Table 4 below, are highlighted in more detail in the City's "Strategic Plan for Wireless Data Networking," completed by CTC in February 2009 (hereafter referred to as the "wireless strategic plan").

As identified in the wireless strategic plan, a City-operated wireless deployment capable of significantly reducing or eliminating current expenditures on wireless services will

require a robust fiber optic backhaul network. In this sense, an FTTN network can provide the enabling backbone capacity necessary to meet a wide range of wireless connectivity needs, reduce long-term operational costs for wireless services, and avoid the inevitable expansion of leased wireless service expenses in the future. Depending on the technological approach ultimately adopted for wireless access, whether using available 4.9 GHz public safety broadband frequencies or future 700 MHz frequencies, annual backhaul costs of many hundreds of thousands to millions of dollars per year could be avoided with access to widespread fiber connectivity.

Table 4: Summary of Wireless Connectivity Requirements

Requirements Category	Low-bandwidth / low-cost fixed and mobile access (9.6 to 500 kbps)	High-bandwidth mobile and fixed access (500 kbps to 10 Mbps)	High-bandwidth LAN access (> 10 Mbps)
Candidate Technologies / Spectrum	• Unlicensed 900 MHz devices • Licensed VHF/UHF narrowband channels • Commercial low-utilization polling service plans	• WiFi / 4.9 GHz • Unlicensed Ethernet • Commercial 3G and 4G technologies • 700 MHz Public Safety spectrum(future, uncertain)	• WiFi / 4.9 GHz Public Safety devices
Application Requirements	• Vehicle and personnel location tracking (AVL) • Utility meter reading and control for SPU and SCL • Update of fire apparatus "Knox box" access codes • Fleet maintenance access vehicle performance data • Traffic signal control • Traffic data collection • Portable variable message signs for traffic information • Building automation, security alarms, and facility management	• Security and traffic cameras • Mobile video for situational awareness (public safety) • Basic public safety mobile computers • Field personnel access to central databases and files, • Fixed facility connectivity to reduce leased service charges (i.e. Parks) • Backup connectivity to City facilities for COOP • Temporary connectivity for mobile command, incident response, and project oversight	• More widespread access for flexible use of conference rooms and public space • Support for growing adoption of laptops and PDAs replacing desktops

Currently, the City relies primarily on Sprint for wireless mobile broadband connectivity. This service provides connectivity between laptops and other mobile devices for access to the City's internal network via the Internet. Police and Fire are the predominant users of this technology, supporting their computer-aided dispatching, automated vehicle location (AVL), and access to databases and outside agencies, including queries to law enforcement databases. These capabilities are not luxuries, but rather essential tools upon which first responders depend to provide an effective response to emergency calls and to provide better situational awareness and communications with their colleagues for their own safety.

Other departments use this service to provide field personnel with capabilities similar to what they have while in the office, increasing the efficiency and effectiveness of

inspectors, engineers, technicians, etc. This connectivity enables access to e-mail, work-order generation and processing systems, and specialty applications such as the City's Geographic Information System (GIS) and computer-aided drafting (CAD) software.

With approximately 1,900 City users of Sprint's mobile broadband service, not including handheld devices (BlackBerrys) providing mobile telephone service, the City spends approximately $1.2 million annually. The City has experienced relatively reliable coverage and performance. Unfortunately, the per-user price of approximately $50 per month prevents the technology from being deployed as widely among City personnel as would be functionally beneficial. Moreover, the limited capacity of the connections provided compared to wired connections or WiFi technology necessitates the use of costly systems and software, such as Citrix application virtualization solutions, to minimize the speeds needed to effectively use applications designed for a wired Local Area Network (LAN) environment.

Additionally, the City has a wide range of applications that depend upon telemetry data collection and control between fixed and mobile devices, representing low-speed data needs. While these applications may not warrant the cost of higher-speed network services or represent a capacity growth area, there are significant functional benefits that can be offered by lower-speed wireless technologies enabled by a widespread and densely deployed fiber backbone. The applications are numerous and the benefits substantial, from more effective traffic control to more efficient use of power in City facilities; SDOT, for example, already uses 900 MHz wireless as a means to provide connectivity to traffic control systems in some cases. City facilities require connectivity for control of heating and air conditioning systems, monitoring of alarms systems, and control of other automation systems. In many cases, recurring costs for dial-up telephone lines can be reduced if wireless technologies are leveraged instead. Moreover, the City can implement low-speed network technologies as a nominal incremental addition to any high-speed network deployment it may have in the future, both from a cost and a data capacity engineering perspective.

Due to the extensive need for more widespread mobile wireless connectivity, identified during surveys for the previous wireless strategic plan and reiterated during interviews for this study, the current expenditures in wireless services represents a minimum figure that is likely to grow substantially in the coming years. It is for this reason that DoIT and the Fire Department collaborated on the development of the wireless strategic plan, recognizing that this growing need requires careful planning to control these necessary costs. Regardless of the technical wireless approach, a dense fiber network provides the enabling infrastructure to allow City and/or commercial operators to provide more robust and cost-effective wireless connectivity.

4.4 Departmental Interviews

The following sections provide summaries of the information provided by City staff during the departmental interviews CTC conducted for this Report.

4.4.1 Seattle Public Utilities

CTC interviewed Nick Pealy of Seattle Public Utilities (SPU) on July 27, 2009. SPU operates the City's water, wastewater, storm water, and solid waste systems, and therefore has an extensive amount of distributed infrastructure and field operations. SPU network connectivity for administrative functions and backbone Supervisory Control and Data Acquisition (SCADA) systems are provided almost exclusively through DoIT. In particular, SPU utilizes fiber connectivity to its pump stations and has leased (telephone line) connections to certain SCADA devices. Additionally, SPU uses Sprint mobile broadband wireless services for connectivity in nearly all field maintenance vehicles.

Although there are no significant existing direct telecommunications expenses beyond those captured through DoIT that could be eliminated or reduced by fiber deployment, there are potential opportunities for the reduction or elimination of certain existing expenses in conjunction with other potential complementary initiatives enabled by more expansive fiber connectivity. These include:

- Reduction or elimination of personnel costs for up to 12 meter readers, provided fiber connectivity could enable an automatic meter reading (AMR)/advanced metering infrastructure (AMI) deployment eliminating the need for manual meter reading activities.

- Reduction or elimination of Sprint mobile broadband cards (approximately $275,000 annually) and Citrix VPN maintenance costs (approximately $180,000 annually through DoIT), provided fiber connectivity could enable deployment of a robust wireless broadband network, as discussed in Section 4.3.

More widespread connectivity for SCADA systems is a significant need that is currently unmet, in part due to the cost of either constructing fiber or leased telecommunications services, representing a potential cost avoidance opportunity as SPU expands its SCADA systems. SPU plans to continue SCADA connectivity deployments, which could ultimately extend to more than 400 locations throughout the City (including pumps, lifts, flow monitors, etc.). This represents a future, avoidable cost of at least $100,000 per year for low-speed data or basic telephone line connectivity. More costly, higher-capacity services will be needed in some locations as SPU employs video cameras for security monitoring of critical assets and visual monitoring of system status, such as retention pond water levels.

Mr. Pealy estimates that a significant cost savings could be realized through the reduction in claims due to damage caused by flooding from storm water. Payouts from claims are typically on the order of $500,000 per year, or significantly more in some years, of which half could potentially be avoided through more effective system control and monitoring enabled by SCADA system connectivity of storm water systems.

Other future needs, not directly attributable to particular existing expenses, include:

- More robust connectivity to disseminate information to the public regarding system problems, emergencies, and repair status.
- High-speed connectivity with outside entities and contractors, ranging from planners to the scientific research community.
- Enhanced connectivity for telecommuting to reduce costs and waste associated with physical office space and travel.
- Enhanced remote connectivity for essential technical support personnel and customer service personnel, including during disaster or dangerous weather conditions.

Current and future SCADA connectivity must be provided via a reliable and survivable medium, particularly for any components for which the system provides real-time control functionality (as opposed to only status monitoring). Communications alternatives not offering significant redundancy and targeting 99.99 percent availability or better are likely unsuitable.

4.4.2 Fleets and Facilities Department

CTC spoke with Bryant Bradbury of the Fleets and Facilities Department (FFD) on July 30, 2009. FFD plays a key support role within the City government, maintaining the vehicles and buildings required by nearly every City department. FFD provides services according to a chargeback model, similar to DoIT, meaning that cost savings for FFD operations can be passed on to all City departments.

Naturally, connectivity needs for FFD are as geographically distributed as the facilities it supports. FFD monitors and controls facility systems, such as air conditioning and electronic door access systems, with connectivity supported almost exclusively through DoIT. A range of more isolated facilities, such as fueling stations for the Harbor Patrol boats, Police precinct buildings, and the Training Center, are not connected—which negatively impacts maintenance. FFD is in the process of a widespread implementation of building monitoring and automation control systems, likely to occur in phases starting in the second quarter of 2010. The systems will provide connectivity to status monitoring and control for electrical generators, air conditioning systems, security systems, key card accesses systems, and fire alarms. These systems will provide real-time information for more effective timing and planning of maintenance.

Critical real-time alerting from security and fire alarm systems must be supported over highly reliable connectivity. In an emergency situation, connectivity to less time-sensitive telemetry-such as fuel pumping stations providing fuel to first responder vehicles, snow plows, and utility repair crew vehicles becomes more critical, too. Low-cost, unreliable connections may not be suitable for many of these connections, though phone lines are currently utilized for many of FFD's connected systems.

FFD has significant need for expanded remote access connectivity, both for internal and external users. FFD interacts extensively with outside contractors and architects when managing City building construction projects, which necessitates ongoing sharing of construction standards and technical design documentation. Sharing large files requires the use of costly VPN services or, more often, simply complicates and delays information sharing. In an emergency situation, such as when transportation is hindered by weather or sheltering in place is necessary due to a health or biological emergency, there would be significant benefit to enabling remote access to building monitoring and automation systems. These unmet needs represent soft costs in the form of lost productivity or lessened effectiveness.

4.4.3 Department of Executive Administration

CTC interviewed Mr. Bryon Tokunaga, IT Director for the Department of Executive Administration (DEA), on August 3, 2009. DEA's staff of 250 is responsible for financial, human resources (HR), and a range of other functions, including homeless shelters, taxi cab licensing, and administration of business taxes. Mr. Tokunaga's staff comprises approximately 50 information technology (IT) workers.

DEA's IT department is a consumer of services provided through DoIT, such as network communications, telephones, desktop support, mid-range and large server support, VPN and Citrix services, and cellular telephones. These services represent a monthly chargeback from DoIT of about $300,000. Mr. Tokunaga believes that he would not likely supplant DoIT's offerings by seeking to transfer his telecommunications services to the proposed fiber network. His budget, he indicated, is thin for such capital expenditures; he would not be willing to redirect his existing budget away from his core service offerings to fund development of new fiber-based applications.

Mr. Tokunaga stated that he might consider adopting future video teleconferencing services to connect at least five existing locations and 250 potential users. He stressed, however, that widespread adoption of telecommuting by City workers would require a significant change in management culture to accept working-in-absence.[44]

4.4.4 Office of Emergency Management

CTC interviewed Mark Sheppard of the Office of Emergency Management (OEM) on August 5, 2009. With the exception of contracted satellite-based telephone services for emergency communications, OEM is exclusively a consumer of DoIT services for telecommunications and network services.

Beyond the well-known opportunities for backhaul of wireless connectivity (discussed in Section 4.1.1), Mr. Sheppard identified the following potential future needs and cost-avoidance opportunities that might be met by an FTTP network:

[44] In addition, a majority of City employees live outside of the City. So for DEA and all other City agencies, the potential benefits of FTTP for telecommuting would be limited.

- Immense social and economic benefits associated with effective telecommuting for City staff and residents could be realized during a pandemic flu situation or other "shelter-in-place" emergencies. Mr. Sheppard noted that the City's own continuity of operations (COOP) plan calls for telecommuting, for which their own analysis has identified there would not be sufficient bandwidth and remote access-related system capacity to effectively implement.

- Widespread fiber access would enable OEM to acquire access to a broader range of real-time information feeds—in particular, video sources such as security and traffic cameras—within the Emergency Operations Center (EOC).

- Residential connectivity would enable OEM to more effectively distribute video information sources to staff and residents. For example, an IP-based video multicast system is used to distribute situational status reports to City desktops during an emergency, but this capability cannot be extended to the home because of the limitations of traditional, lower-capacity Internet-based delivery.

4.4.5 Seattle Fire Department

CTC interviewed Mr. Leonard Roberts, IT Director for the Seattle Fire Department, on August 10, 2009. This group comprises 12 IT professionals who are responsible for the city's 911 service as well as 30 to 40 other applications. The Fire Department is a consumer of both wired and wireless service for alerting and tactical, on-scene communications.

All of the Fire Department's telecommunications services needs are met through third-party contracts administered by DoIT. These services include 50 BlackBerry devices, plus cell phones, 160 Wide Area Network wireless devices, leased T1 and frame relay service from Qwest, and fiber optic cable service to all fire stations. In total, DoIT back-charges the Fire Department more than $17,000 per month (approximately $200,000 annually) for these services. According to Mr. Roberts, his future connectivity plans could include WiFi access at all fire stations, plus fiber optic backhaul service as an alternative to the department's one existing 450 MHz low-data-rate channel for fire scene text, GPS, and status monitoring.

Most of Mr. Roberts' future plans are based on having ubiquitous, broadband wireless access to existing and future applications. He envisions having available real-time, on-scene, two-way tactical video, real-time mapping of apparatus, enhanced medical reports, and the ability to file inspection reports from client sites. He also hopes to have access to multiple, overlapping networks from one hand-held device. The significant amount of voice and data traffic generated by these potential new wireless services could be brought back into core network elements via a City-owned fiber-optic backhaul network.

Of particular note, the Seattle Fire Department is prepared, as part of OEM's disaster plan, to permit its IT employees with commercial broadband service to telecommute during natural disasters such as flu outbreaks. Having ubiquitous broadband service available to all City employees, as well as to all Seattle residents, would reduce pressure

on the Fire Department to have a City-owned and -operated bricks-and-mortar backup facility available for such circumstances. Mr. Roberts expects to use grant funds, rather than cannibalizing his existing budget, to pay for such future communications enhancements.

4.4.6 Office of Economic Development

CTC interviewed Tim Rash, Finance and Operations Director for the Office of Economic Development (OED), on August 11, 2009. OED is comprised of 19 staff. The office is supported almost exclusively by DoIT for its IT and communications services at an approximate annual chargeback cost of $71,000. Of that total, approximately $26,000 is for telephone services. OED directly outsources hosting services for an Internet-based application (Executive Pulse) that it uses to track data associated with its outreach visits and survey efforts among local businesses; the annual cost for this service is approximately $3,000.

Because DoIT provides virtually all of OED's IT and communications services, there are no substantial existing costs to OED that could be directly offset by more expansive fiber connectivity, although OED would be interested in examining opportunities presented by an FTTP network to reach competitive commercial providers of the IT and telecommunications services it currently uses.

OED has a need for more expansive telecommuting capabilities, for which current VPN-related costs through DoIT are prohibitive. A substantial amount of OED staff have job functions that keep them out of the office on a routine basis; more than half carry BlackBerrys for mobile e-mail communications. As a "family-friendly" work environment, OED has telecommuting agreements with several of its staff, and would like to expand this capability both as a personal benefit to its staff, and as a means to improve efficiency and reduce office costs. A current barrier to this expansion is the inability to cost-effectively share and collaborate on files stored internal to the network; an FTTP network arrangement providing high-speed, secure connectivity to staff members' homes could resolve this issue.

Outside of OED's internal needs, the office's involvement in the community provides its staff with a unique perspective on business needs within the community. Although they do not see connectivity as being a barrier to attracting businesses to the City, they note that approximately 60% of the City's businesses are comprised of 10 people or less. Many of these companies, particularly the high-tech companies, have high-bandwidth needs—but high-bandwidth connectivity (beyond cable modem speeds) is often cost-prohibitive for businesses of this type. Clearly, FTTP would offer a direct benefit to these businesses in the form of new alternative and/or competitive service offerings for high-speed connectivity.

4.4.7 Human Services Department

Ms. Sara Levin, Deputy Director of Seattle's Human Services Department, is responsible for an annual budget of $140 million and a staff of 330. Human Services provides

funding and administrative oversight to the Seattle community through case management and community contracts for food banks and similar services.

Ms. Levin told CTC interviewers that a ubiquitous fiber optic network would enable her field forces to better access department records and file reports from the field via their wireless devices and laptop computers. She also said that the various community agencies served by her department could reap the benefits of a fiber-based broadband network by utilizing this bandwidth for educational and vocational training purposes for their constituents. For example, Ms. Levin cited the Rainier Valley facility for refugee and immigrant women as a facility that could utilize broadband service to provide employment skills training for the citizens of Seattle.

She also told CTC that her department would utilize video teleconferencing as a way to save time and reduce the need for her staff and their community clients to travel and park throughout the City to attend meetings.

4.4.8 Office of Film and Music

The arts in Seattle would also benefit from the availability of a broadband fiber optic network. Mr. James Keblas, the office's Director, told CTC that his three full-time staff and two interns operate outside the purview of DoIT due to their unconventional telecommunications requirements. The F&M staff carry iPhones, use Google for their office calendars, and are in constant contact with each other from field locations throughout the business day. They do utilize DoIT's software applications for such things as issuing movie permits.

Mr. Keblas sees a future replete with wireless media connections for delivery of streaming video, movies, music, and game content in high-fidelity formats. He expressed a desire to be able to access "all files and media from anywhere at any time," such as while on movie sets, without compromise in speed or content accessibility. As with many other Seattle officials, Mr. Keblas' need for ubiquitous and high-speed wireless services points to the benefit of having a City-owned fiber optic network to connect wireless terminal devices with core services. Mr. Keblas told CTC that he would reallocate a portion of his existing budget to new, enhanced telecommunication services if it would increase his capability to offer innovative services such as virtual performances (remote viewing of performance pieces) or remote editing of video, film, or audio products.

The Office of Film and Music would also encourage greater use of telecommuting. In addition, according to Mr. Keblas, being able to access all manner of City databases would permit his staff to actively engage with their clients and customers while in the field or on the movie set.

4.4.9 Seattle Police Department

CTC interviewed Assistant Chief of Police Dick Reed to get his perspective on the potential for a City-owned fiber optic network. The Seattle Police Department has 1,850

employees, of which 1,330 are sworn members. Assistant Chief Reed's department is responsible for human resources, the 911 centers, IT, and training.

Most of the Police Department's telecommunications services are provided through DoIT. The exceptions, according to Deputy Chief Reed, are a few investigative telephone lines and cellular telephone accounts that are discontinued after the investigations are completed.

Assistant Chief Reed told CTC interviewers that, "IT is the lynchpin for future COG [continuity of government]." He said that having a ubiquitous, secure fiber-based broadband network available for City use would allow City police employees to work from home or other facilities if an earthquake were to severely damage their existing headquarters building in downtown. He also told CTC that teleworking would permit desk-bound employees to work from their homes in case of a flu epidemic in the Seattle area. Teleworking would also permit the physically challenged to work for the Police Department from their homes.

As with many other departments, Seattle's Police Department expects reliable service and coverage from its wireless networks. Long-term enhancements to wireless services envisioned by Assistant Chief Reed are texting, video, and image transmission from citizens to 911 centers. A secure broadband backhaul network, as provided by a fiber optic infrastructure, will be an essential element of these services. Likewise, the City's e-ticket program would benefit by enabling officers to upload their citations nightly without having to return to a single central deployment point.

Although video arraignment is not yet available in Seattle, Assistant Chief Reed believes that it will be needed when two new jails are finished in the near future. He said that using a fiber optic network to minimize the exposure of the general public to violent criminals as they are transported between court appointments would be a significant benefit to Seattle. He also said that he'd like to be able to have alarm feeds and live on-scene security camera video distributed to stakeholders such as the Fire Department, EMTs, or business owners through a City-owned broadband network.

4.4.10 Seattle Public Library

Lois Fenker, Director of Library Services for the Seattle Public Library (SPL), provided written responses to the Departmental Interview Guide (See Appendix C). Her responses are summarized as follows:

SPL is a relatively large City entity with a unique role, consisting of more than 700 staff members supporting nearly 430,000 registered users across 28 locations. SPL is provided telephony services through DoIT, but with the exception of its website hosting (www.spl.org) and leveraging City dark fiber, is largely autonomous for its internal IT services. SPL requires relatively high availability of its network services, and targets no more than nine hours of annual outage (99.9% availability).

The SPL network directly serves the public and internal staff, with both SPL-owned and patron-owned computers directly connected and accessing its resources. This represents a significantly dissimilar operational and administrative model compared to internal City networks—which, according to SPL, necessitates an approach to IT outside of DoIT and other City operations. Moreover, as a relatively large organization with substantial internal economies of scale on its own, SPL believes it is better able to align its resources with its needs by keeping its IT support and operations internal. Other unique attributes of SPL driving its approach to IT include:

- SPL uses numerous specialized software applications, including a circulation system, an online catalog, and a public computer reservation system; SPL has the internal resources and expertise to maintain each.
- The hours of operation for library facilities are unique and vary significantly from most City departments.
- SPL uniquely qualifies for certain grants and discounts, including E-Rate, which other City entities are not able to receive.

SPL incurs recurring charges for leased data and telecommunications services of approximately $280,000 per year. Of this amount, approximately $72,000 is for point-to-point data connection to the following branch library locations: Capitol Hill, Wallingford, International District/Chinatown, Madrona-Sally Goldmark, and Mobile Services. Telephony costs represent the main DoIT chargeback expense, with the vast majority of SPL's ongoing connectivity costs incurred for 492 telephone lines, including dedicated lines at various locations for life safety systems.

SPL intends to continue its existing strategy of shifting leased data connectivity services to City dark fiber wherever possible, with most of the existing T1 circuit costs to be replaced with fiber connectivity in 2009. SPL contributes $15,000 annually for fiber maintenance, and has a total of approximately $107,400 of fiber construction planned ($77,000 funded and $30,400 unfunded).

Future applications driving the need for enhanced connectivity include the use of more streaming media, distance learning, connectivity of portable devices (laptops, PDAs, etc.), and voice-over-IP (VoIP). An increase in the availability of digital resources and downloadable media, as opposed to traditional print media, has begun to shift the role of SPL from a repository of physical print media to a connectivity provider and facilitator of online access to these resources.

The Library is required to maintain a separate technology budget in order to qualify for E-Rate discounts and software grants. SPL is interested in working with DoIT on innovations that could achieve savings or enhance functionality, but must entertain such proposals on a case-by-case basis in the context of the SPL's Technology Plan. SPL is already working with DoIT on potential ARRA Broadband stimulus applications, but does not have the resources to undertake the improvements contemplated in these proposals without substantial financial assistance.

For both enhanced connectivity for telecommuting and reaching the public, SPL sees the potential for a fiber network to facilitate peering relationships with local ISPs as a means to reduce costs for its growing Internet capacity needs.

4.4.11 Department of Transportation

Ms. Amy Hughes is the IT Manager for the Seattle Department of Transportation (SDOT). CTC staff interviewed her on August 5, 2009. Her department is responsible for IT systems, projects for desktop computers, and business-specific applications.

SDOT's recurring costs for telecommunications services pay for circuits to signal controllers, traffic lights, and other devices and for the City's Park-and-Pay wireless parking meters. In the fall of 2009, the department will also be deploying a Zonar's wireless fleet vehicle tracking and monitoring system. All of these services are centrally procured through DoIT.

SDOT staff operates several drawbridges at canals in the City. Ms. Hughes told CTC that she could envision constructing DSL-like circuits, established through DoIT, to each of these drawbridges. Eventually, the five to seven operator positions could be eliminated through this remote-control capability.

Having a broadband fiber-optic network available throughout the City, according to Ms. Hughes, would allow her department to expand its planned Intelligent Transportation initiative, for which the department has received grant funding, and install more traffic cameras to monitor vehicular speed. She also said that video teleconferencing could be constructed to four remote sites within her department. However, teleworking would not be of much benefit to her department, as most SDOT staff works in the field away from either home or office.

5. Off-the-Balance-Sheet Benefits

In a recent article on the *Government Technology* website, Bill Schrier, chief technology officer of the City of Seattle, summarized the broad range of social and economic benefits that a fiber network can deliver:[45]

> The core of a national broadband strategy is fiber-optic cable—fiber running to almost every home and business in the United States.
>
> Such a network would significantly change America's economy—it would affect our way of working and playing as profoundly as did the telegraph, telephone, railroad and original Internet.
>
> A fiber network is an investment that would last 50 years or more. The network would carry two-way high-definition video streams and convert every high-definition TV set into a video conferencing station. This addresses a fundamental human need—to actually see our co-workers and friends.
>
> For the first time, working at home—true telework—would be possible because workers would connect with and see each other in real time. Whole technology businesses would collaborate on developing 21st-century products. Students would be able to attend classes and interact with their classmates from home. Quality of life would improve as families scattered across a region would talk together, while seeing one another.
>
> This fiber network would also support high-speed wireless, because wireless access points can be added at any place the fiber terminates—at every home and business.
>
> The network would also significantly reduce commute trips and travel. This, in turn, would reduce our dependence on imported oil and the production of greenhouse gases.
>
> Fiber broadband with two-way video and similar applications are a fundamentally new economic network and engine for America.
>
> FTTP provides a platform for innovation and development of next generation applications and software.

These social and economic benefits were a key to Lafayette Utilities System's decision to pursue an FTTP implementation. Lafayette Utilities System reported:[46]

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[45] Bill Schrier, "The Future Is Fiber," *Government Technology*. June 3, 2009. http://www.govtech.com/gt/articles/692922.

[46] Lafayette Utilities System's Fiber for the Future, http://www.lus.org/uploads/FFTFDirectMail1104.pdf.

Videoconferencing, document sharing, telecommuting—today's businesses move at the speed of light and their connection to the outside world needs to be able to keep up. The fiber optic network in Lafayette, Louisiana promises to deliver just that. "It takes geography out of the picture and allows you to communicate with your clients and coworkers as if they're in the next room," says Bill Fenstermaker, president and CEO of C.H. Fenstermaker & Associates, Inc., of Lafayette. "That allows you to run your business more effectively and more efficiently."

Fenstermaker says without fiber optic infrastructure in Lafayette, he's been forced to move employees to the company's Houston office. He argues that if Lafayette Utilities System's dream of fiber optics for the future becomes a reality, those jobs and tax revenues would stay in the Lafayette area.

Dan Henderson, director of Information Technology Business Development, says the creation of high-speed fiber networks for research will create new jobs, attract more skilled talent, add much-needed infrastructure, and it will also create additional wealth in the state as a result. Plus, with these economic benefits in place through this fiber connection, there is not only more of a chance for businesses to locate in Louisiana, but also for the state's existing companies to expand and flourish beyond its borders. All of these economic benefits come as a result of this driver of high technology fiber activity, he says.

"The use of high-speed fiber connectivity is clearly an economic development infrastructure tool," Henderson says. "This is an infrastructure that attracts information technology talent and companies to Louisiana. Information technology and its related research activities are part of what we need to do to diversify our economy and improve our way of life."

5.1 High-Bandwidth Technology and Application Development

It is no exaggeration to say that the Internet has changed the way many Americans work, communicate, and live their lives. E-mail alone would bear the same distinction, and "Google" has become a verb because of its ubiquitous place in the lives of many Internet users. Well-known examples of other game-changing Internet offerings run the gamut of experience:

- Amazon.com and other successful online retailers changed the way Americans buy everything from books to groceries. Consumers often get better deals than in the past, too; easy comparison shopping means online and bricks-and-mortar stores face real price competition every day.
- eBay and other auction sites didn't just give people an alternative to setting up a yard sale in July—they gave entrepreneurs a platform for creating viable businesses out of their homes.

- Monster.com and similar sites gave job seekers instant access to employment listings, worldwide and at every level. Looking for work no longer means waiting for the Sunday newspaper to hit the doorstep.
- Craigslist has further eroded the importance of that local newspaper, too, by offering free "classified ads" for any item or service you wish to sell—or give away.
- YouTube has given everyone with a video-enabled cell phone the ability to post and play videos, instantly, from anywhere.
- Skype made a traditional landline phone superfluous for anyone with a computer and high-speed Internet access.

In fact, look at any consumer or business relationship—banking, trading stocks, watching video of the latest news, interacting with your local government—and the Internet has changed it. During a time when most users had dial-up or relatively slow cable or DSL broadband connection, the Internet enabled the creation of applications and services that, as recently as 10 years ago, were impossible for most people to imagine.

Now imagine the innovation and possibilities presented by truly high-speed, fiber connectivity. FTTP networks hold the promise of expanding on those previous innovations, and acting as a springboard for innovations that most people can't yet imagine. In education and healthcare, especially, the potential advances enabled by fiber's huge bandwidth are of the type that could lift the entire population. A fiber network offers enough bandwidth, for example, to support an interactive, high-definition video link between a teacher and a sick child in a hospital—enabling the child to stay connected to the classroom.

Is it possible to envision what educational opportunities, businesses, or social connections might be possible? Perhaps some of them—but certainly not all.

5.2 Wide Array of Environmental Benefits

The United States represents 5 percent of the world's population yet is responsible for more than 20 percent of global GHG emissions.[47] There is a growing scientific consensus that developing countries must reduce their carbon emissions by 25 percent to 40 percent from 1990 levels by 2025 and upwards of 80 percent by 2050 to avoid the most catastrophic effects of climate change.[48] Recognizing the urgency of climate change, the City of Seattle has committed to reducing its emissions by 7 percent by 2012 and 80 percent by mid-century.[49]

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[47] "Emissions of Greenhouse Gases Report," Energy Information Administration, Report No. DOE/EIA-0573 (2007), Dec 3, 2008. http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html.

[48] Sujata Gupta, *et al.*, "Policies, Instruments and Co-operative Arrangements," in Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, at 776 (Box 13.7).http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf.

[49] Seattle Climate Protection Initiative Homepage. Date of Access: Mar 19, 2009. http://www.seattle.gov/climate/.

The widespread adoption of Information and Communication Technologies ("ICT") can facilitate these ambitious reductions. Like most industries, ICT is directly responsible for GHG emissions: The industry consumes 6 percent to 10 percent of global energy and is responsible for 2 percent to 3 percent of the world's carbon emissions, roughly the same contribution as aviation.[50] Conversely, however, ICT also functions as an "enabler" to support significant carbon *reductions* from other sources.[51] In fact, one analysis holds that ICT alone could reduce global GHG emissions by 15 percent by 2020 (an amount at least five times larger than the sector's carbon footprint), representing about $946.5 billion in savings to the economy.[52] Another study finds that widespread adoption of ICT could support a net reduction of 1 billion tons of GHG emissions over 10 years.[53] Indeed, FTTP—which is, broadly speaking, based on ICT—conveys a broad range of environmental benefits, including increased opportunities for and access to telework, teleconferencing, telemedicine, and e-commerce, as well as increased efficiencies in home energy use and transportation. Connectivity is "the backbone" of each of these solutions.[54]

Section 3 of this Report investigated the potential to monetize the GHG reductions enabled by FTTP. This section considers the potential benefits of FTTP for all stakeholders.

5.2.1 Increased Telework

Dependable, high-speed Internet access greatly improves the ability to work from home, or telework. This is often touted as the "most transformative"[55] and "biggest environmental benefit"[56] of FTTP. Indeed, telework confers a wide array of primary and secondary emissions benefits, which will provide significant cost savings to the City and

[50] "An Inefficient Truth," Global Action Plan, Dec 2007, 3. http://www.globalactionplan.org.uk/upload/resource/Full-report.pdf.
[51] "Working Paper: The Contribution of ICT to Climate Change Mitigation," World Economic Forum, 2008, 2. http://www.unapcict.org/ecohub/resources/the-contribution-of-ict-to-climate-change-mitigation.
[52] SMART 2020: Enabling the low carbon economy in the information age," Global e-Sustainability Initiative & BCG, June 2008. Chapter 3, Figure 8. http://www.gesi.org/files/smart2020report_lo_res.pdf.
[53] Joseph Fuhr and Stephen Pociask, "Broadband Services: Economic and Environmental Benefits," The American Consumer Institute, Oct 31, 2007. 2. *See also* Michael Render, "U.S. Fiber to the Home Market Update," Render Vanderslice and Assoc., June 2008. 35-36. (Finding that universal FTTH could lead to a 5 percent reduction in gas use, a 4 percent reduction in carbon emissions, a $5 billion reduction in road expenditures and 1.5 billion fewer hours spent commuting). These analyses consider the net environmental benefits associated with ICT, as the direct impacts associated with installation and operation can be recovered in four to six years. *See* Steven S. Ross and Masha Zager, "Fiber to the Home Is Green Technology," Broadband Properties, Jan/ Feb 2009. 28-35. http://www.bbpmag.com/2009issues/jan09/BBP_JanFeb09_CoverStory.pdf. (Modeling the projected environmental benefits of FTTP against the direct environmental costs associated with installation).
[54] "Report Addendum: SMART 2020: Enabling the low carbon economy in the information age." 1.
[55] Stephen Ezell *et al.*, "The Need for Speed: The Importance of Next Generation Broadband Networks," Information Technology and Innovation Foundation, March 2009. 15. http://www.itif.org/files/2009-needforspeed.pdf.
[56] Steven S. Ross and Masha Zager, "Fiber to the Home Is Green Technology," Broadband Properties, Jan/ Feb 2009, at 30 http://www.bbpmag.com/2009issues/jan09/BBP_JanFeb09_CoverStory.pdf.

its residents by reducing vehicle-operating expenses, the amount of time spent traveling, road repairs, and traffic congestion. In addition, by decreasing miles driven and gasoline burned, telecommuting benefits the environment and reduces GHG by lowering auto emissions. Where telework occurs full time, it can reduce demand for constructing office space and related electricity use.[57] Indeed, the American Consumer Institute estimates that doubling the number of full-time teleworkers (to 20 percent) could reduce national GHG emissions by almost 600 million tons over the next 10 years due to reduced auto use, business energy conservation, and reduced office construction.[58]

"Universal, affordable, and robust broadband" is a "necessary prerequisite" for telework.[59] In market research conducted by CTC in San Francisco, for example, 67 percent of respondents reported that they needed higher speeds than cable modem to telework and 70 percent of respondents indicated that they would telework more if they had sufficient broadband speed. Other studies support this finding. Indeed, fiber networks have quadrupled the amount of time employees spend working from their homes.[60]

CTC's market research team conducted similar market research in Seattle in August 2008 to determine, among other things, the potential effect of a Citywide broadband system on telework and the amount of associated savings.[61] In total, CTC completed and analyzed telephone surveys of 301 randomly selected businesses and 381 randomly selected homes in the City. The surveys provided market information about Internet, telephone, and cable television services and gauged interest in a Citywide broadband network.

The market research team asked a number of questions to establish the current working environment of Seattle's residents. These questions included working status, primary mode of transportation, distance traveled to work, and ability or willingness to telecommute on a daily or weekly basis.

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[57] "Broadband Services: Economic and Environmental Benefits." 20. (Reporting a $25 million reduction in national real estate costs.)

[58] "Broadband Services: Economic and Environmental Benefits," 25-26. *See also* Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008. 24. http://www.benton.org/initiatives/broadband_benefits/action_plan; Consumer Electronics Association, "The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Commerce," July 2007. 8, 29. http://www.ce.org/Energy_and_Greenhouse_Gas_Emissions_Impact_CEA_July_2007.pdf. (Reporting average daily energy savings from telework of 16-23 kWh/ teleworker, assuming a "typical" vehicle with 21 miles per gallon and a 24 mile round-trip commute.)

[59] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov 2008. 24. http://www.benton.org/initiatives/broadband_benefits/action_plan.

[60] "The Need for Speed: The Importance of Next Generation Broadband Networks." *See also* Irene Berlinsky, "Working at Play, Playing at Work: The Rise of the Prosumer," IDCLink, January 15, 2009.

[61] CTC's market research team includes CTC itself (designing the survey and analyzing results); WS Live of Cedar Rapids, IA (conducting phone surveys); and Clearspring Energy Advisors of Madison, WI (conducting survey statistical analysis).

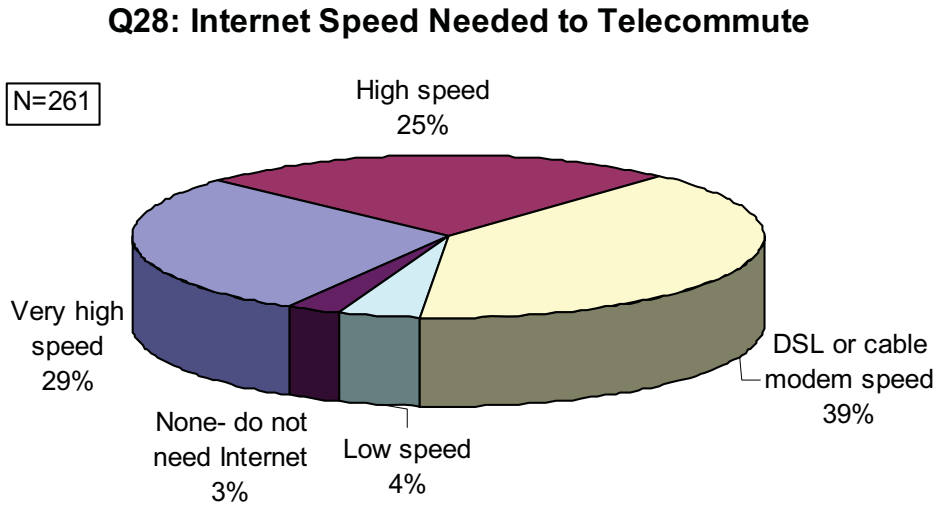
Out of the households surveyed in Seattle:

- 73 percent of respondents work on a full- or part-time basis.
- 57 percent of respondents who work travel to work alone by car when they commute; of those, over 70 percent drive alone at least five days per week.
- The average one-way commute to work for respondents who drive alone is 10.2 miles and takes, on average, 21.3 minutes.

Given that approximately 267,254 households[62] are located in the Seattle area, 129,401 commuters drive alone in their vehicles sometime during the workweek.[63]

CTC's market research confirms that Seattle residents require high-speed Internet access to support telework. As seen in Figure 1, more than 54 percent of respondents indicated that speeds beyond cable modem/DSL are required for telecommuting (25 percent indicated speeds of 10 Mbps to 100 Mbps are required, 29 percent indicated speeds of 100 Mbps or greater are required).

Figure 1: Connection Required for Telecommuting



Fifty-seven percent of respondents would be willing to telecommute at least one day per week if connection speed were not an issue. This is an increase of 20 percentage points over the number of workers who telecommute today (37 percent of workers telecommute at least occasionally today). CTC's market research thus clearly demonstrates a strong interest in telework, assuming adequate Internet access.

[62] U.S. Census projection for 2007.

[63] Adjusted to account for multiple residents working per household. The adjustment is based on U.S. Census Bureau and Bureau of Labor and Statistics Data indicating that 31 percent of households are married couple families, and that both spouses work in 51.78 percent of married couple families. This adjustment is conservative since it does not include non-family households with multiple working residents.

Table 5 shows the projected increase of telecommuting with improved access. This data is limited to respondents who would otherwise drive alone to work. A similar analysis can be done to assess increased interest in telework among carpoolers or residents who rely on public transportation.

Table 5: Increase in Telecommuting

Frequency (Days per week)	Telecommute Today	Interest if Home Connection Speed Was Not an Issue	Increase in Telecommuting with High Speed Internet
1	3.00%	16.39%	13.39%
2	5.00%	12.13%	7.13%
3	4.00%	5.69%	1.69%
4	2.00%	5.35%	3.35%
5	12.00%	17.94%	5.94%

5.2.1.1 Miles and Time Saved by Telecommuting

Independent of the environmental benefits, telework accords significant benefits to participants. As indicated above, CTC's market research found that the average commute for the estimated 129,401 Seattle-area individuals who drive alone is 10.2 miles and takes 21.3 minutes. Telecommuting could lead to a reduction of almost 84 million miles driven per year, with an annual savings of more than 3.3 million hours. Table 6 shows the projected reduction in miles driven through increased telecommuting.

Table 6: Miles Saved by Increased Telecommuting

Frequency (Days per Week)	Increase in Telecommuting	Miles per Week	Miles per Year (48 Weeks)
1	13.39%	353,467	16,966,416
2	7.13%	376,433	18,068,784
3	1.69%	133,837	6,424,176
4	3.35%	353,731	16,979,088
5	5.94%	784,015	37,632,720

Table 7 shows the time savings associated with increased telecommuting.

Table 7: Hours Saved by Increased Telecommuting

Frequency (Days per Week)	Increase in Telecommuting	Hours per Week	Hours per Year (48 Weeks)
1	13.39%	12,187	584,953
2	7.13%	12,978	622,959
3	1.69%	4,614	221,487
4	3.35%	12,196	585,389
5	5.94%	27,031	1,297,468

5.2.1.2 Cost Savings to Residents

Based on the projected increase in telecommuting, CTC calculated the potential cost savings in gasoline and vehicle expenses to residents telecommuting at least one day per week.

Assuming an average fuel efficiency of 21 miles per gallon and an average fuel cost of $2.32 per gallon,[64] Seattle residents could save 4.6 million gallons and $10.6 million per year through increased telecommuting.[65]

Gas savings, however, do not represent the total cost of driving. The Internal Revenue Service (IRS) mileage rate was created to assign an annual value to the permanent and changeable costs for operating a vehicle, of which gasoline is one part. The 2009 standard mileage rate for businesses is 55 cents per mile.[66] Based on the average miles saved per week, residents would save more than $52.8 million on their vehicle expenses per year. At a 6 percent discount rate over 15 years, this represents a net present value of $513.2 million of potential vehicle savings.

Table 8: Annual Cost Savings to Seattle Residents

Average Miles Saved per Week by Telecommuting	IRS Mileage Rate	Vehicle Operating Cost Savings per Year (48 Weeks)
2,001,483	$0.550	$52,839,151

Most time spent commuting is of limited or no productivity. It reduces the amount of time Seattle residents can spend with family, work on household projects, or learn new

[64] "Congestion Data for Your City, Sept, 2007," Texas Transportation Institute. The report assumed an average fuel cost of $2.32/ gallon in its 2007 Urban Mobility Report.
[65] Based on the average gasoline price in Seattle in September 2009 of $2.90 per gallon, residents would save $13.3 million annually.
[66] "IRS Announces 2009 Standard Mileage Rates," Internal Revenue Service Press Release, IR-2008-131, Nov 24, 2008. http://www.panache-yes.com/mileagerate.html.

skills. Assuming these "alternate" activities are valued at $14.60 per hour,[67] telecommuting would save an additional $48.4 million per year. At a 6 percent discount rate over 15 years, this represents a net present value of $469.7 million in personal growth and family time. Considering both the value of time and vehicle expenses, telecommuting thus yields a potential discounted 15-year savings to commuters of $982.9 million.

5.2.1.3 Auto Emission Reduction

According to the Bureau of Labor Statistics, there are 146 million employed people in the United States.[68] Nationally, the average one-way commute is 15 miles and 26.4 minutes, with 91 percent of workers commuting by private car.[69] This accounts for 918 billion miles and 1.7 billion minutes spent driving annually. Assuming fuel efficiency of 21 miles per gallon, Americans consume 44 billion gallons of gasoline and produce 424 million tons of carbon dioxide and 26.3 million tons of other GHG annually during their workday commutes.[70]

Telecommuting can dramatically reduce these emissions.[71] (Emissions are all of the substances and gases released into the air as byproducts of driving, including exhaust and evaporation of fuel.[72]) Cars and trucks constitute one of the largest sources of air pollution. Although emissions from an individual car are typically low, emissions rise as the number of cars on the roadways increases.[73] The types of pollutants emitted from gasoline-powered vehicles are:

- ROG (reactive organic gases)
- NO_x (Nitrogen Oxide)
- PM-10 (fine particulates)
- CO (carbon monoxide)
- CO_2 (carbon dioxide)

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[67] "Congestion Data for Your City, Sept, 2007." The Texas Transportation Institute calculates the value of travel delay at $14.60 per hour in its 2007 Urban Mobility Report.
[68] "Broadband Services: Economic and Environmental Benefits." 23.
[69] "Broadband Services: Economic and Environmental Benefits." 23.
[70] "Broadband Services: Economic and Environmental Benefits." 23.
[71] The U.S. Department of Transportation and Highway Administration aggregated three studies on emissions savings by telecommuting in Philadelphia, Houston, and the Washington Metropolitan Region. (http://www.fhwa.dot.gov/environment/cmaqpgs/telework/index.htm). The purpose of the projects was to provide employers with incentives to enable telecommuting. The Philadelphia-area project began in March 2000 and included 79 employees from five companies by early 2002. The estimated emissions reduction was 52kg/day VOC, and 6kg/day NO_x. The Houston-Galveston area project was designed to provide tax credits to employers who successfully reduce emissions through telecommuting. The project cost $9.6 million and received $7.68 in CMAQ funds. The estimated emissions reduction was 32 kg/day VOC, 112 kg/day CO, and 45 kg/day NO_x. The Washington Metropolitan area project was designed to help employers evaluate telecommuting based on travel behavior, cost savings, and employee performance. The total cost of the project was $397,600 funded with CMAQ funds. The estimated emissions reduction was 9 kg/day VOC and 18 kg/day NO_x.
[72] Data obtained from, http://www.merriam-webster.com/dictionary/Emissions.
[73] Data obtained from, http://www.epa.gov/OMS/consumer/05-autos.pdf (visited Sept. 15, 2008) and http://www.dot.ca.gov/hq/transprog/reports/CMAQCAL.pdf (visited Sept. 23, 2008).

Table 9 shows the projected potential emission reduction in Seattle based on the increase in telework as a result of the implementation of high-speed networking. The total potential reduction for each type of emission was calculated by multiplying the amount of annual mileage saved (96.1 million) through increased telecommuting by a reduction factor.

Table 9: Emission Reduction

Types of Emissions	Reduction Factor (gram/mile)[74]	Total Reduction (kilogram/year)
ROG	0.34	32,665
NO_x	0.47	45,154
PM-10	0.52	49,958
CO	2.91	279,568

Carbon dioxide emissions are dependent upon the gallons of gasoline burned, not miles driven. Based upon the EPA's factors, a reduction of almost 40.3 million kilograms of CO_2 is possible in Seattle through the increased telecommuting enabled by improving the performance of available Internet connections.

Seattle has committed to reducing annual carbon emissions by at least 680,000 metric tons (or 680 million kilograms).[75] CTC's market research thus finds that the projected increase in telework associated with improved broadband could satisfy 6 percent of the City's reduction goals, considering reduced vehicle use alone.

5.2.1.4 Traffic Congestion

Traffic congestion carries significant costs. The Texas Transportation Institute's most recent annual Urban Mobility Report found that congestion had caused Americans to waste 4.2 billion hours and 2.9 billion gallons of fuel at a cost of $78.2 billion. This translates to 38 hours, 26 gallons of fuel, and $710 annually per commuter.[76] Seattle residents fared even worse. According to the same analysis, Seattle commuters wasted 74.1 million hours and 54.7 million gallons of fuel, or 45 hours and 34 gallons per commuter in 2005.[77] These conditions make Seattle the ninth-most congested city in the

[74] Data obtained from, http://www.epa.gov/OMS/consumer/05-autos.pdf (visited Sept. 15, 2008) and http://www.dot.ca.gov/hq/transprog/reports/CMAQCAL.pdf (visited Sept. 23, 2008).
[75] "Seattle creating 'Climate of Change' to battle global warming," News Release, Mar 24, 2006. http://www.seattle.gov/mayor/newsdetail.asp?ID=5982&dept=40.
[76] David Schrank and Tim Lomax, "The 2007 Urban Mobility Report," Texas Transportation Institute, Sept 2007. 1, Exh. 1. http://tti.tamu.edu/documents/ums/mobility_report_2007_wappx.pdf. (Data assumes $14.60 per hour of person travel, $77.10 per hour of truck time, and $2.32 per gallon of fuel).
[77] "Congestion Data for Your City" (Seattle data available online at http://mobility.tamu.edu/ums/congestion_data/tables/seattle.pdf.

United States, with a "Travel Time Index" of 1.20.[78] Thus, it takes 20 percent longer to reach destinations during peak travel time (i.e., a 30-minute free-flow trip takes 36 minutes during the peak).

Broadband has the potential to reduce vehicle use by enabling telework, teleconferencing, and e-commerce. The potential impact of these changes on congestion has long been recognized. In fact, researchers assert that telecommunications solutions could "solve the transportation problem" by replacing 10 percent to 20 percent of transportation needs, including:

- 6 million fewer commuters, due to telecommuting.
- 3 billion fewer shopping trips, substituted by e-commerce.
- 13 million fewer business trips, replaced by teleconferencing.
- 6 million fewer truck and airplane delivery miles, because of a reduced need to transport paper documents.[79]

The American Consumer Institute reports that there are currently 127.5 million commuting vehicles, with more than half (66.9 million) leaving for work during peak travel times (6:30 a.m. to 8:29 a.m.). Simply taking a fraction of these cars off the road would have enormous benefit.

Broadband could allow this to happen. Ten percent of U.S. workers currently telework full time (either as an employee or running a home-based business), with more than one-fourth (28.7 percent) working regularly (one day per month or more) from home.[80] Because broadband is a critical element for telework, according to Fuhr and Pociask, ubiquitous Internet access could conceivably double the percentage of full-time telecommuters. Accepting this premise, doubling the number of full-time teleworkers (i.e., a 10-percentage-point increase) would thus result in 6.7 million fewer cars driving during the morning rush hour (10 percent x 66.9 million). The American Consumer Institute estimates that, without any additional telecommuting, there would be 100 million cars driving during rush hour (assuming that commuters share the road with additional drivers). Thus, a doubling of teleworkers would lead to 6.7 percent fewer cars during peak travel.[81]

Removing these cars from the road will relieve congestion. John Edwards, chairman and founder of the Telework Coalition, maintains that there is a 3 percent decline in

[78] INTRIX National Traffic Scorecard, 2008 Annual Report Additional data. http://scorecard.inrix.com/scorecard/MetropolitanDetails.asp?ID=9.

[79] Fuhr and Pociask. 6. (Citing Ashok B. Boghani, Eric W. Kimble and Ethan E. Spencer, "Can Telecommunications Help Solve America's Transportation Problem," Arthur D. Little, Inc. Cambridge, MA, Feb. 1991).

[80] Fuhr and Pociask.

[81] Fuhr and Pociask. E-mail from Joseph Fuhr, Professor of Economics, Widener University, to Jennifer Kefer, March 26, 2009. These estimates are based on the American Consumer Institute analysis, which assumes that teleworkers are among the 91 percent of workers who would otherwise drive alone in a private vehicle.

congestion for every 1 percent reduction in the number of cars on the road.[82] Even more dramatically, the Inrix National Traffic Scorecard reported a modest (3 percent) decline in highway travel and a "startling" 30 percent reduction in congestion from 2007 to 2008, with congestion falling in 99 of the nation's 100 largest cities.[83] As described above, a 10-percentage-point increase in teleworkers will remove 6.7 percent (6.7 million) cars from the road. Using the Telework Coalition's multiplier, this will relieve congestion by 20.1 percent (6.7 percent x 3). Applying that percentage to the Urban Mobility Report data cited above, this reduction in congestion would eliminate 844 million hours of travel delay, 582.9 million gallons of wasted fuel, and $15.7 billion in overall congestion cost. Clearly, an increase in telework can have significant effects.

5.2.1.4.1 Seattle Application

CTC's market research indicates that 5.94 percent of Seattle's daily commuters might telecommute five days per week, given the availability of adequate broadband service. (See Table 6 and Table 7.) Using the Telework Coalition's multiplier, this potential increase in telecommuting would reduce Seattle's congestion and its concomitant costs by 17.82 percent. Therefore, 13.2 million of the commuters' 74.1 million wasted hours and 9.75 million of the commuters' 54.7 million wasted gallons of gasoline would be saved by reductions in congestion. The potential economic benefit accrued due to reduced congestion would amount to approximately $192.7 million in saved time and $22.6 million in saved gasoline costs for a total benefit to commuters of $215.3 million annually. Additional savings in time and fuel could be realized if other Seattle commuters adopted telecommuting one or more days per week. As fuel prices increase over time, so will the economic benefit of telecommuting to Seattle residents.

The benefit is not only the value of gasoline and time savings, but emissions reductions as well. Reducing annual fuel consumption by 54.7 million gallons will reduce annual CO_2 emissions by 481.36 million kilograms.[84]

5.2.1.5 Electricity Savings

Telework can also reduce electricity demand under certain scenarios, particularly where telecommuters replace a traditional office space with a home office. The American Consumer Institute (ACI) reports that a home office uses 3,000 to 4,400 fewer kWh per year than a commercial office.[85] Using the number of workers who currently commute to

[82] Fuhr and Pociask.
[83] INRIX, National Traffic Scorecard.
[84] Based on the EPA's rate of 8.8 kilograms of CO_2 emitted for each gallon of gasoline burned.
[85] Fuhr and Pociask. Note that actual reductions in electricity use depend on individual behavior. Some critics claim teleworkers may use more electricity by heating and cooling an entire house, rather than a limited office space. These reductions will also not occur if a home office does not replace commercial office space. At 9.6 percent, Seattle's commercial occupancy rate is the third lowest in the nation, suggesting that such substitution is relatively more likely than it would be in other cities. *See also* Commercial Real Estate Outlook," National Association of Realtors, Dec 2008. (Reporting a national vacancy rate of 13.9 percent.) http://www.realtor.org/wps/wcm/connect/cc9073804c53bc70b3bab778e322d571/CREO1208.pdf?MOD=AJPERES&CACHEID=cc9073804c53bc70b3bab778e322d571).

work in personal cars (132.9 million, or 90 percent of workers) as an estimate of workers who work in offices, ACI estimates that shifting 10 percent of office workers to fulltime telework would translate to a reduction of 46.6 billion kWh (3,500 x 13.3) of electricity.[86] (Please note that CTC believes the ACI calculation may overstate the potential benefit. The reported difference in electricity use between home and traditional offices is only realized if there is a one-to-one reduction in traditional offices for each home office. A more accurate calculation would adjust the reduction by the actual percentage of office space reduction.)

5.2.1.5.1 Seattle Application

Telework would lead to reduced electricity consumption in commercial offices only to the extent that vacated office spaces were to remain empty. Seattle's commercial office space vacancy rate has increased from 9.6 percent in 2008—when it was the third-lowest in the nation[87]—to a much higher rate now,[88] so the likelihood that an office space vacated by a new teleworker would remain unoccupied in the short term is now much greater.

Using a figure of 3,500 kWh saved annually by home teleworkers over commercial office workers,[89] CTC calculated the total approximate reduction in electrical energy demand for Seattle. Using the above assumed five-day Seattle teleworkers (which number 7,687), the reduction in electrical energy consumed by these workers when compared with office workers would amount to 26.9 million kWh annually. At 5.51 cents per kWh,[90] this represents an annual savings of $150,000.

This energy savings would be distributed over all teleworkers, irrespective of where their offices were located, but CO_2 production would be reduced only to the extent that fossil fuels were used to generate the electricity for the office space they vacated. Because Seattle generates over 98 percent of its electricity from low- or no-carbon sources such as hydroelectric, nuclear, and wind power,[91] increased telecommuting would not lead to significant reductions in CO_2 for Seattle City Light and its customers.

See also "Seattle's office vacancy rate third lowest in U.S." Puget Sound Business Journal (Seattle), Dec 19, 2008. http://www.bizjournals.com/seattle/stories/2008/12/15/daily31.html.

[86] Fuhr and Pociask. 26. This calculation relies on statistics from the Oak Ridge National Laboratory, which find that 2.3 pounds of CO_2 are produced from using one kWh of coal-generated electricity. Fuhr calls this estimate conservative because it does not include potential teleworkers who currently commute on transit (E-mail from Joseph Fuhr, Professor of Economics, Widener University, to Jennifer Kefer, April 22, 2009.) Including workers commuting by transit in this calculation would add 14.6 million additional teleworkers, reducing electricity use by 51.1 billion kWh (3,500*14.7), or 58.8 million tons of carbon dioxide. *See* Fuhr at 23 (there are 146 million persons employed in the U.S.).

[87] Puget Sound Business Journal (Seattle), Dec 19, 2008. http://www.bizjournals.com/seattle/stories/2008/12/15/daily31.html.

[88] "Office rents drop, vacancy rate rises in Seattle, Bellevue," The Seattle Times, June 30, 2009. http://seattletimes.nwsource.com/html/businesstechnology/2009399977_office300.html.

[89] Fuhr and Pociask. 26.

[90] Based on SCL's Small General Service energy charge.

[91] "Fuel Mix: How Seattle City Light Electricity Is Generated."

The Seattle region, on the other hand, might experience a reduction in CO_2 emissions. This reduction would depend on the number of Seattle teleworkers who would ordinarily commute to offices outside of Seattle city limits where the fuel mix for producing electrical energy contains a greater proportion of fossil fuels. (For example, Puget Sound Energy reports that its fuel mix for energy delivered in 2007 was 37 percent coal and 19 percent natural gas, with hydroelectric sources providing 42 percent.[92]) By avoiding working in those office spaces, Seattle's teleworking population would cause non-trivial reductions in CO_2 gas throughout the region.

It is worth noting that SCL could see an *increase* in demand for electricity if telecommuting were to increase. Seattle residents who had previously commuted to jobs outside of SCL's service area, for example, would create a net increase in SCL electricity consumption if they were to start teleworking from their homes in the City. So while telecommuting could, in the long term, lower electricity consumption overall in the Seattle region, SCL or other communities may actually see increased consumption, depending on commuting patterns. Understanding this potential shift would require a detailed analysis of where potential telecommuters live and where their current offices are located.

5.2.1.6 Additional Benefits

There are a number of other, indirect benefits afforded by telework that are not analyzed here. Beyond the direct benefits that can be determined from the market research, a more detailed model of the impact of increased telework would also take into account the reduction in such indirect factors as:

- Cost of roadway repair and maintenance.
- Maintenance and expansion of public transportation.
- Overhead costs.
- Office space congestion.
- Parking congestion.
- Other soft benefits, including quality of life and employee morale.
- Reduced medical expenses (e.g., for respiratory ailments) due to clean air.

5.2.2 Improvement in Traffic Management

Broadband can also relieve congestion by allowing cities to coordinate traffic lights to improve flow. According to the U.S. Department of Transportation, poor traffic signal timing is responsible for 10 percent of all traffic delay—roughly 300 million vehicle hours annually.[93] By using a broadband network to coordinate traffic signals, a municipality can:

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[92] Puget Sound Energy, "Energy Supply – Electricity – Power Supply Profile" (http://www.pse.com/energyEnvironment/energysupply/Pages/EnergySupply-Electricity-PowerSupplyProfile.aspx (Date of Access April 15, 2009).

[93] U.S. DOT, Intelligent Transportation Systems for Traffic Signal Control, April 2005. http://www.its.dot.gov/jpodocs/repts_te/14321_files/a1019-tsc_digital_n3.pdf.

- Reduce congestion by allowing for the smooth flow of traffic at a constant speed.
- Improve mobility by increasing the traffic-handling capacity of intersections.
- Improve air quality and increase fuel efficiency by reducing vehicle stops and idling.[94]

These benefits can be accomplished through the installation of a high-speed fiber network to support intelligent transportation systems (ITS).[95]

The benefits of traffic management were dramatically realized in a 2005 to 2006 signal synchronization program in Austin, Texas. That city reported more than $40 million in savings, including:

- Delay reduction, valued at $35 million annually (9.8 percent overall reduction in travel time for all arterials; total delay reduced by 2.342 million hours).
- Fewer stops, valued at more than $3 million annually (28 percent reduction in the number of stops per intersection for a total of 195.1 million fewer stops per year).
- Fuel savings, valued at $2.6 million (3.5 percent reduction—nearly 1.3 million gallons—in total fuel consumption).[96]

Kansas and Missouri likewise celebrate the "complete success" of "Operation Green Light," a 400-square-mile, 19-city traffic management project. The project coordinates traffic lights and cameras to reduce congestion and pollution while simultaneously providing broadband services to government buildings and municipal vehicles.[97] Similar traffic management improvements have been reported in Bellevue, Washington;[98] Lakewood, Colorado;[99] Syracuse, New York;[100] and Sacramento, California.[101] Despite

[94] "The National Traffic Signal Report Card: Technical Report," National Transportation Operations Coalition, Washington, D.C., 2007. 7. http://www.ite.org/REPORTCARD/technical_report%20final.pdf.
[95] John Windhausen, Jr., "A Plan to Extend Super-Fast Broadband Connections to all Americans," The Century Foundation, Jan. 27, 2009. 20. (Note that broadband networks enable municipalities to monitor traffic patterns and adjust signals to minimize traffic congestion and reduce pollution). *See also* Raj Ghaman, U.S. Department of Transportation, e-mail to Jennifer Kefer, Mar. 26, 2009. (Note that traffic management requires four to 16 fibers for operation).
[96] "The National Traffic Signal Report Card: Technical Report." 13-14.
[97] Electronic Technology Institution, Case Study: Operation Green Light. http://www.etikc.net/customer/case_study_ogl.html.
[98] "Virtual Remote Visits" Data-Linc Group, Article: Traffic Management and Control, Save City Time and Money. http://www.data-linc.com/traffic/bellevuecst.htm.
[99] "News Release: Moscow Traffic Signal Project Will Reduce Congestion, Improve Traffic Flow," Idaho Transportation Dep't, May 17, 2007. http://apps.itd.idaho.gov/apps/MediaManagerViewer/NewsRelease/NewsRelease.aspx?Id=887. (Linking the city's traffic signals with a 2.5-mile underground electrical conduit and fiber optic communication cable).
[100] "Intelligent Transportation Systems for Traffic Signal Control," USDOT. 1. http://www.its.dot.gov/jpodocs/repts_te/14321_files/a1019-tsc_digital_n3.pdf. (Using a communications network to reduce travel time up to 34 percent).
[101] "Sacramento Sees Significant Improvement in Communications, Traffic Congestion and the Environment With Ethernet Solutions From Actelis Networks," Business Networks. Mar. 2, 2009. (Installing an Ethernet over copper solution to manage traffic). For additional case studies, *see* USDOT,

these potential benefits, the majority of U.S. cities have failed to modify traffic lights as traffic patterns evolve.[102]

5.2.2.1 Seattle Application

Seattle already has signal synchronization and other traffic management technologies in place, so additional fiber connectivity would provide minimal, if any, benefit in this area. To the extent that fiber construction reached newly built neighborhoods and roads, it could conceivably help the City extend its existing traffic management efforts.

For example, CTC's report on Wireless Network Development for the City of Seattle[103] reported that 400 of the City's nearly 1,000 traffic signals were not included in the City's current synchronization system. The proposed fiber-optic network could connect these signals wherever it passes an unsynchronized intersection.

5.2.3 Teleconferencing

FTTP facilitates teleconferencing, enhancing telework performance and allowing companies to grow without having to build new offices or shuttle between them. Video arraignment could also allow face-to-face interaction between a judge and prisoners in jail, without expending time and money to transport a prisoner to the courthouse.

The potential environmental benefits of teleconferencing are dramatic. In fact, videoconferencing uses 500 times less energy than a 1,000 km (621 mile) business flight. Nationally, emissions could be reduced by nearly 200 million tons if only 10 percent of airline travel were replaced by teleconferencing over the next 10 years.[104] These reductions also confer significant economic benefits. GlaxoSmithKline reports that its corporate travel costs declined by 20 percent after it installed a telepresence system.[105] As with telework, teleconference potential could not be realized without a reliable, high-speed broadband connection.

5.2.3.1 Seattle Application

At Seattle-Tacoma International Airport (Sea-Tac), 14,313,379 passengers enplaned for domestic flights in 2007.[106] According to the U.S. Department of Transportation approximately 15.9 percent of all long-distance travel in 2001 was for business

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"Intelligent Transportation Systems for Traffic Signal Control." 2. http://www.its.dot.gov/jpodocs/repts_te/14321_files/a1019-tsc_digital_n3.pdf.

[102] Charlene Sarmiento, "America's Traffic Lights Not Timed Properly," April 22, 2005. http://www.voanews.com/english/archive/2005-04/2005-04-22-voa14.cfm?moddate=2005-04-22. (Reporting on a study of 387 U.S. cities in 49 states).

[103] "Strategic Plan for Wireless Data Networking," prepared for the City of Seattle by Columbia Telecommunications Corp., February 2009.

[104] Fuhr and Pociask. 40.

[105] Ross and Zager. 31.

[106] 2007 Seattle-Tacoma International Airport Activity Report. http://www.portseattle.org/downloads/seatac/2007activity.pdf.

purposes.[107] Assuming the same level in 2007, business travel departing Sea-Tac amounted to 2,275,827 individual departures.

If the availability of FTTP were to induce Seattle's travelers to avoid 10 percent of their planned trips by air, irrespective of the round-trip distance involved, the environmental impact would be significant. Assuming that Seattle residents travel from Sea-Tac in proportion to their population within the Seattle metropolitan statistical area (SMA), then 17.6 percent[108] of all Sea-Tac departures are made by Seattle residents. Table 10 lists the top 40 destination cities from Sea-Tac for 2007[109] and straight-line mileage from Seattle to each.[110] It shows the miles saved and the kilograms of CO_2 potentially eliminated if the 17.6 percent of Sea-Tac business travelers who are Seattle residents were to eliminate 10 percent of their airline trips in favor of teleconferencing. As that table shows, if having a robust FTTP service available in Seattle were to reduce airline travel by 10 percent, Seattle travelers could avoid more than 68 million airline miles and reduce the amount of CO_2 released into the atmosphere by more than 13 million kilograms.

Assuming a savings[111] of $200 per passenger departure, this also represents a potential direct savings of $42 million for all passengers and $7.4 million for Seattle residents.

[107] "Long Trips by Purpose, TABLE a-24A," U.S. Department of Transportation, Research In Innovative Technology Administration, Bureau of Transportation Statistics.http://www.bts.gov/publications/highlights_of_the_2001_national_household_travel_survey/html/table_a24a.html.

[108] Seattle Post-Intelligencer, June 20, 2009. (Seattle population in April, 2009: 602,000). *See also* Office of Financial Management/Forecasting, June 29, 2009. (Total SMA population, 2009: 3,427,200).

[109] 2007 Seattle-Tacoma International Airport Activity Report.

[110] Data found using Geobytes: City Distance Tool. http://www.geobytes.com/CityDistanceTool.htm?loadpage.

[111] Savings is the difference of airfare, hotel, meals, and other travel expenses versus the cost of a video conference. A $200 savings is quite conservative, since the avoided airfare is likely greater.

Table 10: CO_2 Emissions Avoided by Teleconferencing (Seattle Passengers)

City	Number of Aircraft Departures (2007)	Percent of Total Passenger Departures	Seattle Passenger Departures Avoided by Teleconferencing	One-Way Distance (Miles)	Round-trip Passenger Airline Miles Avoided	CO_2 Emissions Factor[112] (kg CO_2 /Mile)	CO_2 Emissions Saved (kg)
Bay Area, CA	14,088	9.40	3,765	684	5,150,695	0.20	1,030,139
Los Angeles	13,834	9.20	3,685	960	7,075,237	0.20	1,415,047
Portland, Oregon	13,589	9.00	3,605	147	1,059,844	0.29	307,355
Spokane, WA	8,632	5.70	2,283	229	1,045,664	0.29	303,243
Chicago	6,336	4.20	1,682	1733	5,830,822	0.18	1,049,548
Anchorage	6,328	4.20	1,682	1453	4,888,739	0.18	879,973
Denver	5,789	3.80	1,522	1017	3,095,897	0.18	557,261
Las Vegas	5,354	3.60	1,442	872	2,514,785	0.20	502,957
Phoenix	5,227	3.50	1,402	1112	3,117,847	0.18	561,212
New York City	4,093	2.70	1,081	2404	5,199,722	0.18	935,950
Dallas/Ft Worth	4,029	2.70	1,081	1680	3,633,749	0.18	654,075
Salt Lake City	3,714	2.50	1,001	701	1,403,912	0.20	280,782
Boise	3,555	2.40	961	405	778,661	0.20	155,732
Sacramento, CA	3,548	2.40	961	625	1,201,637	0.20	240,327
Minneapolis	2,778	1.80	721	1382	1,992,794	0.18	358,703
San Diego	2,687	1.80	721	1062	1,531,366	0.18	275,646
Houston	2,634	1.80	721	1889	2,723,870	0.18	490,297
Atlanta	2,565	1.70	681	2179	2,967,482	0.18	534,147
Pasco, WA	2,518	1.70	681	181	246,496	0.29	71,484
Bellingham, WA	2,366	1.60	641	78	99,976	0.29	28,993
Reno, Nevada	2,312	1.50	601	571	686,135	0.20	137,227
Yakima, WA	2,181	1.40	561	106	118,882	0.29	34,476
Washington, DC	1,818	1.20	481	2324	2,234,083	0.18	402,135
Eugene, OR	1,668	1.10	441	247	217,656	0.29	63,120
Wenatchee, WA	1,632	1.10	441	94	82,833	0.29	24,022
Redmond	1,503	1.00	401	236	189,058	0.29	54,827
Honolulu	1,481	1.00	401	2681	2,147,725	0.18	386,591
Juneau	1,355	0.90	360	898	647,442	0.20	129,488
Ketchikan, AK	1,312	0.90	360	699	503,966	0.20	100,793
Pullman, WA	1,184	0.80	320	249	159,577	0.29	46,277
Detroit	1,166	0.80	320	1931	1,237,526	0.18	222,755
Walla Walla	1,036	0.70	280	213	119,443	0.29	34,638
Cincinnati	998	0.70	280	1970	1,104,705	0.18	198,847
Boston	963	0.60	240	2488	1,195,869	0.18	215,256
Missoula, MT	917	0.60	240	393	188,897	0.20	37,779
Medford, OR	911	0.60	240	367	176,400	0.20	35,280
Fairbanks	886	0.60	240	1522	731,556	0.18	131,680
Kalispell, MT	756	0.50	200	384	153,809	0.20	30,762
Fresno, CA	737	0.50	200	761	304,815	0.20	60,963
Palm Springs	732	0.40	160	999	320,116	0.18	57,621
TOTALS			**37,091**		**68,079,686**		**13,037,408**

[112] Data found using TerraPass: Calculator Methodology. http://www.terrapass.com/carbon-footprint-calculator/methodology-popup.html#air.

5.2.4 E-Commerce

The purchase of goods and transmission of information through the Internet also has potential environmental benefits. By downloading videos and movies, consumers avoid travel to retail and video rental stores. Similarly, the American Consumer Institute reports that online grocery shopping with home delivery can decrease emissions by 18 to 87 percent, depending on the capacity of the delivery truck and distance from market.[113] The same report estimates that shifting newspaper subscriptions to online media will lead to 57.4 million tons of cumulative emissions reductions over a decade.[114] It concludes that e-commerce generates 36 percent fewer air pollutants and 9 percent lower GHG emissions, and requires 16 percent less energy than conventional shopping.[115]

It is worth noting, however, that the "off-the-balance sheet" benefits that accrue from e-commerce are counteracted by a potentially significant reduction in local sales tax revenue. To the extent that Seattle residents buy goods from out-of-state retailers (which, in general, are not required to collect sales taxes), and that those residents do not report their purchases on their annual tax returns (for the purpose of paying "use tax"), the City will lose its portion of $0.03 of tax revenue for every dollar its residents spend, based on the current combined city/county sales tax rate.[116] (The state, county, and city combined stand to lose $0.095 per dollar.) Given that sales tax revenue is the second-biggest source of general government revenue, this reduction could become a significant issue; in 2003, the City collected more than $115 million in local sales tax.[117] Using that figure as a baseline, if retail sales in Seattle were to decline 10 percent due to increased Internet shopping, City tax revenue would decline by $11.5 million.

5.2.5 Enabling Smart Grid Technologies

By allowing two-way communication and the transmission of real-time information between consumers and utilities, utilities are better able to manage the power grid as an integrated system and adjust supply to changing demand. At the same time, end-users can make informed decisions about energy consumption. This is particularly effective where prices vary depending upon demand.

The potential benefits of such a "Smart Grid" approach are dramatically illustrated in a case study of 112 homes in the Olympic Peninsula, west of Seattle. Participating houses were given a digital thermostat and a computer controller for their water heaters and clothes dryers. Residents used an Internet website to set their favorite home temperature and pre-determine an allowed variance from that temperature. On average, participating houses reduced their electric bills by 10 percent, with some participants reporting even

[113] Fuhr and Pociask. 9.
[114] Fuhr and Pociask. 34.
[115] Fuhr and Pociask. 9.
[116] "Local Sales and Use Tax Rates by City/County, Tax Rates Effective July 1 - September 30, 2009," Department of Revenue, Washington State, http://dor.wa.gov/Docs/forms/ExcsTx/LocSalUseTx/LocalSlsUseFlyer_09_Q3_alpha.pdf.
[117] "Sales and Use Tax: Overview of Seattle's retail sales and use tax," City of Seattle Finance Department, March 2003, http://www.seattle.gov/financedepartment/docs/March_2003_SalesTax.pdf

greater savings.[118] The environmental benefits of this approach are enormous. For example, the Pacific Northwest National Laboratory reports that, over a 20-year period, this simple technology could save $70 billion on spending for power plants and infrastructure, and avoid the need to build the equivalent of 30 large coal-fired plants.[119]

Although fiber is not specifically mentioned as an enabling technology for most Smart Grid applications, fiber is a critical, growing component of facilitating customer and distribution automation/Smart Grid technologies. Fiber is essential for robust and secure backhaul communication to distribution substations, data concentrators, and other demarcation points.

Table 11 outlines the backhaul connectivity—preferably fiber—required by various Smart Grid networks.

Table 11: Smart Grid Opportunities for Fiber

Smart Grid Communication Network	Vendor Example	Backhaul Demarcation Location
Power Line Carrier (PLC)	Aclara (TWACS)	Distribution Substation
Broadband-over-Powerline (BPL)	Current Technologies	Distribution Substation
Point-to-Multipoint Radio	Sensus Systems	Data collection nodes (base stations), which cover a 2- to 7-mile radius
Meshed Radio	Silver Spring Networks	Data collection nodes—2 to 4 per square mile. One data collection mode is required per four to eight mesh nodes, which are placed to form a grid with 500- to 2,000-foot spacing.
Fiber-to-the-Premises (FTTP)	Tantalus Systems	Requires fiber drop for every 15 to 25 premises served. Uses an FTTP-connected meter as a gateway to communicate via RF to other meters in the area.
Consumer Broadband Connection	MuNet	Not required

Note: These vendor examples are just examples—not a complete list, vendor endorsement, or recommendation of the use of the communication media.

[118] Steve Lohr, "Digital Tools Help Users Save Energy, Study Finds," *The New York Times*, Jan 10, 2008. http://www.nytimes.com/2008/01/10/technology/10energy.html?_r=1&pagewanted=print.
[119] Lohr, "Digital Tools Help Users Save Energy, Study Finds."

5.2.6 Good Will and Fulfillment of Climate-Reduction Obligations

Seattle has long been a leader in the area of climate protection. In fact, Mayor Nickels has publicly called on the City's residents, businesses, and government to make Seattle "the most climate-friendly city in the nation."[120] By investing in FTTP, the city can pave the way, setting the standard for Seattle stakeholders and cities nationwide.

Seattle is also a member of several local, national and international public initiatives designed to establish best practices for mitigating climate change. Each of these provides a platform to leverage the City's investment in FTTP.

Seattle Climate Action Now. The City launched Seattle Climate Action Now to provide information and tools for Seattle stakeholders to help mitigate climate change. The City guides this grassroots climate protection campaign by working through partnerships with businesses, organizations, and residents. The campaign is intended to promote climate protection, with a short-term focus on consumer energy use and transportation. Investing in fiber will advance these priorities. Climate Action Now has been lauded for its "comprehensive approach to engaging all Seattle residents, organizations and businesses to modify their behavior to substantially reduce GHG emissions."[121] Dependable, high-speed broadband connections will increase stakeholder engagement by enabling them to adopt appropriate policies (like telework and teleconferencing). Seattle can deepen this partnership and provide new ways for stakeholders to reduce emissions by investing in FTTP. The Climate Action Now website (http://www.seattlecan.org/index.htm) also provides a forum to promote the City's investment.

U.S. Conference of Mayors' Climate Protection Agreement. In 2005, Mayor Greg Nickels launched an initiative urging mayors nationwide to commit to reduce emissions in their cities to 7 percent below 1990 levels by 2012, in accordance with the Kyoto Protocol. The U.S. Conference of Mayors unanimously endorsed this Climate Protection Agreement. Today, more than 960 mayors have signed on.[122]

Seattle continues to set the pace for climate action among the Conference of Mayors. Last year, the Conference of Mayors issued a first-place award to Seattle for its leadership in helping to mitigate climate change through its grassroots climate campaign, Seattle Climate Action Now (discussed above).

FTTP will also help Seattle satisfy its commitments under the Climate Protection Agreement. As discussed above, Seattle has committed to reducing annual carbon emissions by 680,000 metric tons (or 680 million kilograms).[123] According to CTC's

[120] "Seattle Creating 'Climate of Change' to Battle Global Warming," News Release, Mar 24, 2006. http://www.seattle.gov/mayor/newsdetail.asp?ID=5982&dept=40.
[121] "Climate Protection: Featuring 2008 Mayors' Climate Protection Award Winning Entries," Mayors Climate Protection Center. 5. http://www.usmayors.org/climateprotection/documents/08%2012%20Best%20Practices%20D2.pdf.
[122] For a full list of signatories and text of the Agreement, *see* http://www.usmayors.org/climateprotection/agreement.htm. Date of Access: July 16, 2009.
[123] "Seattle Creating 'Climate of Change' to Battle Global Warming," News Release, Mar 24, 2006. http://www.seattle.gov/mayor/newsdetail.asp?ID=5982&dept=40.

market research, the projected increase in telework associated with improved broadband could satisfy 16 percent of the city's reduction goals, considering reduced vehicle use alone (see Section 5.2.1).

Clinton Climate Initiative. Seattle is one of only 13 U.S. cities represented in the Clinton Climate Initiative. The Clinton Climate Initiative is working with 40 of the world's largest cities on a variety of large-scale programs intended to improve energy efficiency and reduce GHG emissions in buildings, waste management, transportation, outdoor lighting, ports, and other areas. While FTTP has not yet been identified as a program for participating jurisdictions, this is another area where Seattle can exercise leadership and develop best practices.[124]

ICLEI—Local Governments for Sustainability. Seattle has joined more than 700 local governments that are participating in the ICLEI Cities for Climate Protection Campaign. The Campaign helps cities "adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability."[125] Participating cities conduct a baseline emissions inventory, adopt an emissions reduction target, develop a Local Action Plan describing the measures that the local government will adopt to achieve its target, implement those measures, and monitor and verify results.

No one CTC spoke with at ICLEI was aware of any cities that have committed to installing FTTP as a component of their Local Action Plans to date, although several cities have included other green ICT investments. Seattle's plan affirms the City's intention to continue its "strong leadership example" and "generate the experience and best practices to promote action by others."[126] By investing in FTTP, Seattle could help pioneer this technology and shape best practices for other ICLEI members.

Although the Seattle Climate Plan does not expressly mention FTTP, it includes several programs, such as reducing congestion and promoting teleconferencing, which would be advanced through broadband technology.[127] Thus, this project is consistent with Seattle's ICLEI commitments. Moreover, omission from the plan does not preclude implementation of the program under ICLEI. To the contrary, ICLEI staff urge participating governments to continually expand their commitments. Because the Local Action Plan is not a static document, ICLEI encourages its members to periodically revisit and revise their plans and provides support to facilitate that process. Seattle could expressly revise its ICLEI plan to include an investment in broadband.

Notably, ICLEI's communications team is eager to work with Seattle to draw publicity to such accomplishments as further demonstration of the City's commitment to climate

[124] For more information, see the Clinton Climate Initiative homepage: http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/.
[125] For more information, see the ICLEI website: http://www.iclei.org/index.php?id=global-about-iclei.
[126] "A Climate of Change: Meeting the Kyoto Challenge," Seattle Climate Action Plan, Sept 2006. 20. http://www.seattle.gov/climate/docs/SeaCAP_plan.pdf.
[127] "A Climate of Change: Meeting the Kyoto Challenge," 15, 37.

protection. ICLEI has a regional capacity center in Seattle, giving the City easy access to these resources.

5.3 Reduced Cost and Enhanced Quality of Healthcare

The U.S. healthcare system is expensive, overburdened, and inefficient.[128] In 2006, national healthcare costs grew 6.7 percent to $2.1 trillion, or $7,026 per person, and accounted for 16 percent of gross domestic product (GDP). Similar growth is projected to continue until 2017, at which point healthcare will account for nearly 20 percent of GDP.[129] Some of this expense can be attributed to the inappropriate reliance on costly hospital emergency rooms, which are often sought after traditional office hours or in communities with a shortage of physicians. In fact, over half (55 percent) of the 114 million emergency room visits Americans make each year are for non-emergencies, accounting for $31 billion annually, or $300 per American household.[130] Broadband technology can dramatically reduce these expenses by providing the tools to remotely monitor patients, allow collaboration between medical professionals, facilitate the transfer of medical data and images, and increase access to emergency services in remote areas.[131] By one estimate, these services can lead to savings of $165 billion per year.[132] "Always-on broadband" is "essential" for some of these applications and greatly improves others that "depend on uninterrupted real-time transmission."[133]

5.3.1 Medical Information

Broadband allows users to access medical information online, avoiding costly trips to medical professionals. Approximately 20,000 health-related websites provide information to the more than three-quarters of online Americans who access medical information over the Internet.[134] More than 10 percent of broadband users use the Internet for this purpose

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[128] Many individuals are using emergency facilities for general care, increasing the burden on those facilities and compromising service for others.

[129] Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, 2008.15. http://www.benton.org/initiatives/broadband_benefits/action_plan. *See also* "National Health Expenditure Projections 2008-2008," Centers for Medicare and Medicaid Services. http://www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2008.pdf. (Projecting annual public health-care expenditures to reach $2.9 trillion by 2012 and continuing to grow at an average annual rate of 7.2 percent, reaching $4.4 trillion, or 20.3 percent of GDP, in 2018).

[130] Devon Herrick, Convenient Care and Telemedicine, National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov 2007. At 3-5. http://www.heartland.org/custom/semod_policybot/pdf/22678.pdf.

[131] Rintels. 15. (Broadband can "revolutionize medical treatment"). *See also* Carlton Doty, "Delivering Care Anytime, Anywhere; Telehealth Alters the Medical Ecosystem." Forrester Research for the California Healthcare Foundation, Nov 2008. *See also* "Benefits of Telemedicine," Telemedicine Association of Oregon, Jan 16, 2004. http://www.ortcc.org/PDF/BenefitsofTelemedicine.pdf.

[132] Rintels. 15.

[133] Alexander H. Vo, "The Telehealth Promise: Better Health Care and Cost Savings for the 21st Century," University of Texas Medical Branch, May 2008. 13.

[134] Devon Herrick, "Convenient Care and Telemedicine," National Center for Policy Analysis, NCPA Policy Report No. 305 (ISBN #1-56808-179-0), Nov 2007. 14. http://www.heartland.org/custom/semod_policybot/pdf/22678.pdf. *See also* Rintels.

on a given day.[135] Broadband users can also avoid scheduling (and driving) to multiple appointments by using the Internet to get a second opinion based on their medical records or by exchanging e-mails with their doctors. Notably, Kaiser Permanente reduced appointments with primary care physicians by 7 percent to 10 percent by allowing its enrollees to e-mail questions to their doctor through a secure messaging system.[136] Thirty-seven percent of Kentucky broadband users report that access to online information has saved them an average of 4.2 unnecessary trips for medical care in a single year.[137]

5.3.1.1 Seattle Application

Although high-speed broadband access is not a requirement for e-mailing doctors or conducting health-related Internet research, "home broadband users are twice as likely as home dial-up users to do health research on a given day."[138] So to the extent that FTTP would bring broadband to residents who currently have dial-up access, it would double the likelihood that those residents would access online health information. And, potentially, about 10 percent of the net new Internet users connected by a Citywide network would go online to obtain medical information that previously would have required a trip either to a doctor or, perhaps, a public computing center.

5.3.2 Remote Monitoring

Telehealth holds particular promise for remote monitoring of chronic conditions. Nearly half of Americans (45 percent or 130 million people) suffer from at least one chronic condition, such as arthritis, asthma, cancer, depression, diabetes, heart disease, and obesity. Combined, treatment of these conditions accounts for 75 percent of healthcare spending—$1.5 trillion annually.[139] Despite this enormous expense, most Americans with chronic conditions suffer from inadequate treatment. For instance, according to the National Center for Policy Analysis, less than one-fourth of patients with high blood pressure control it adequately. Twenty percent of patients with Type-1 diabetes fail to see a doctor annually, with 40 percent of diabetics failing to regularly monitor their blood sugar level or receive recommended annual retinal exams.[140]

Through remote monitoring, tens of millions of Americans can manage and address their chronic illnesses at dramatically lower cost. In fact, both the Benton Foundation and the University of Texas estimate that remote monitoring could lower hospital, drug, and out-patient costs by 30 percent, reducing the length of hospital stays from 14.8 days to 10.9

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[135] Rintels. ("On an average day, one in nine of those with a broadband connection uses it to research online medical information.")
[136] Herrick. 14.
[137] Ross and Zager. 31.
[138] "The Engaged E-patient Population," Pew Internet & American Life Project. http://www.pewinternet.org/Reports/2008/The-Engaged-Epatient-Population.aspx.
[139] Partnership to Fight Chronic Disease, 2008 Almanac of Chronic Disease. 7. http://www.fightchronicdisease.org/pdfs/PFCD_FINAL_PRINT.pdf. (Foreword by Richard Carmona, 17th U.S. Surgeon General.)
[140] Herrick. 8.

days, office visits by 10 percent, home visits by 65 percent, emergency room visits by 40 percent, and hospital admissions by 63 percent.[141]

Remote-monitoring applications are incredibly varied. Patients with chronic obstructive pulmonary disease can improve lung function with the use an inhaler and monitor airflow to and from their lungs with a spirometer, lowering hospital readmissions to 49 percent as compared to 67 percent for patients lacking home monitoring. Similarly, remote monitoring of a group of congestive heart failure patients in one study cut re-hospitalizations in half over a six-month period.[142] Diabetics in Pennsylvania using home-monitoring systems for their glucose levels were able to reduce hospitalization costs by more than 60 percent from a control group with traditional in-person nurse visits.[143] The Veterans Administration reports similar savings from its home-monitoring system, which has reduced emergency room visits by 40 percent and hospital admissions by 63 percent.[144] As discussed more thoroughly in Section 5.4, remote monitoring holds particular promise for the elderly, by allowing them to defer or avoid institutionalization, thereby enhancing quality of life and reducing medical costs.

5.3.2.1 Seattle/Washington Application

With Seattle's 2009 population of 602,000[145] and a statewide inpatient hospital admission rate of 89 per 1,000 residents in 2007,[146] Seattle's residents could be expected to experience 53,578 admissions during 2009. Based on a Veterans Administration study[147] that reported a 63 percent reduction in hospital admissions and 40 percent cut in emergency room visits resulting from its remote home monitoring system, remote monitoring facilitated through broadband availability might have avoided 33,754 of Seattle residents' inpatient admissions during 2009. With an inpatient daily expense of $2,332[148] and an average annual inpatient stay of 399 days per 1,000 population,[149] the 2009 cost savings accruing to Seattle residents could be as great as $352.9 million. Similarly, because 362 out of every 1,000 Washington residents visited a hospital

[141] Rintels. 16.
[142] Herrick. 16. *See also* Rintels. 16.(Discussing a New York case study that reduced health care costs for home-bound patients with congestive heart failure to cut overall health care costs by 41 percent).
[143] Rintels, 15.
[144] Neal Neuberger, "Advancing Healthcare Through Broadband: Opening Up a World of Possibilities," Internet Innovation Alliance, 2007. Date of Access: July 28, 2009. http://internetinnovation.org/factbook/entry/small-pilot-projects/.
[145] Seattle Department of Planning and Development, http://www.seattle.gov/dpd/Research/Population_Demographics/Seattle_at_a_Glance/default.asp .
[146]The Kaiser Family Foundation, *statehealthfacts.org*. Data Source: Washington: Hospital Outpatient Visits per 1,000 Population, 2007, accessed 8/20/09.
[147] Neal Neuberger, "Advancing Healthcare Through Broadband: Opening Up a World of Possibilities," Internet Innovation Alliance, 2007. Date of Access: July 28, 2009. http://internetinnovation.org/factbook/entry/small-pilot-projects/.
[148] The Kaiser Family Foundation, *statehealthfacts.org*, Data Source: Washington: Hospital Adjusted Expenses per Inpatient Day, 2007.
[149] The Kaiser Family Foundation, *statehealthfacts.org*, Data Source: Washington: Inpatient Days per 1,000 Population, 2007

emergency room in 2007 (for a total of 217,924 visits by Seattle residents),[150] remote monitoring might have made 87,170 emergency room visits unnecessary, thus saving an additional $87 million for Seattle residents.[151]

5.3.3 Lowered Transportation Costs

Broadband can also reduce transportation costs between medical facilities by allowing doctors to remotely monitor patients and collaborate with one another. As the Center for Information Technology Leadership ("CITL") notes, widespread adoption of telehealth technologies can "bring the collective wisdom of the entire healthcare system to any patient, anywhere, any time," allowing "quantum leaps in the efficiency of the healthcare system."[152] These efficiency gains are accompanied by dramatic cost savings.

In fact, CITL estimates that telehealth technologies can prevent:

- 39 percent (850,000) of transports between emergency departments, with an annual savings of $537 million.
- 43 percent (40,000) of transports from correctional facilities to emergency departments and 79 percent (543,000) of transports from correctional facilities to physician office visits, with an annual savings of $280 million.
- 14 percent (387,000) of transports from nursing facilities to emergency departments and 68 percent (6.87 million) of transports from nursing facilities to physician office visits, with an annual savings of $806 million.[153]

It should be noted that the costs and benefits associated with avoided medical transport are not necessarily borne by the same people. The underlying costs of installing the telehealth technology (elaborated in Section 5.3.5.1) are borne by the physician office or hospital. Savings associated with avoided transports because of this technology, however, accrue to the payer, which (with the exception of correctional institutions), is likely the patient, the state, or insurance provider. Moreover, these savings will only accrue if both institutions (e.g., the correctional facility and hospital) have adequate bandwidth.

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[150] The Kaiser Family Foundation, *statehealthfacts.org*, Data Source: Washington: Hospital Emergency Room Visits per 1,000 Population, 2007.

[151] "Forget Cost-Shifting, Try 'Giving Back' to Decrease Health Care Costs," Peg Carver, *Workspan Magazine*, June, 2008. (Quoting a BlueCross BlueShield/WellPoint report.)

[152] Caitlin M. Cusack, et al., "The Value of Provider-to-Provider Telehealth Technologies," Center for Information Technology Leadership, November 2007, at 4 (available online at http://www.citl.org/_pdf/CITL_Telehealth_Report.pdf).

[153] Cusack, et al. at 2-3; *See also* Jonathan Rintels, "An Action Plan for America: Using Technology and Innovation to Address Our Nation's Critical Challenges," The Benton Foundation, Nov 2008, at 16 (adopting CITL's analysis) (available online at http://www.benton.org/initiatives/broadband_benefits/action_plan); Alexander H. Vo, "The Telehealth Promise: Better Health Care and Cost Savings for the 21st Century," University of Texas Medical Branch, May 2008, at 2. It should be noted that Cusack et al.'s analysis was funded by the AT&T Foundation, among others. As such, the authors may have applied somewhat generous assumptions about telehealth potential and savings. As indicated here, the Cusack analysis has been embraced by others and forms the basis of our analysis below.

There are five general categories of avoided medical transport costs associated with telemedicine. CTC estimated associated savings for the Seattle residents below.

1. Benefit of Avoided Transport Between Emergency Departments

According to the Centers for Disease Control and Prevention (CDC), approximately 38 percent of the U.S. population (110 million) visited an emergency room in the United States in 2004.[154] Approximately 2 percent of these patients were transported to another emergency facility, for a total of 2.2 million baseline transports between emergency departments.[155] The average cost of such transports is $632. CITL estimates that telehealth could prevent 38.6 percent of these transfers, for a savings of $537 million nationwide each year. Extrapolating from these estimates to Seattle, CTC estimated that there were 214,445 emergency room visits and 4,289 transports between emergency departments in Seattle during that same period.[156] Telehealth could prevent 1,656 of these transfers, for a savings of $1.05 million annually.

It is unclear to what extent such savings would be realized because of an investment in FTTP in the City of Seattle. Transfers between emergency rooms are most likely to occur between rural and urban facilities, rather than between hospitals that are both located within Seattle.[157] Also, transport savings can only be realized if both facilities have sufficient bandwidth to support the televisit; while a Citywide investment in broadband could improve the capacity of Seattle-based hospitals, it would have no effect on the capabilities of emergency departments outside the City. Determining the capabilities of such facilities is beyond the scope of this analysis. As such, this potential future benefit is worth noting here, but is not included in our calculation of Seattle savings associated with broadband.

2. Savings Due to Avoided Visits from Correctional Facilities to Emergency Departments

The Washington average daily correctional population is 16,303.[158] CITL calculated a national average of 6.2 percent transports to emergency rooms annually, or

[154] CDC/NCHS/1992-2004 National Hospital Ambulatory Medical Care Surveys) (http://www.cdc.gov/nchs/data/ahcd/ed19922004trend.pdf) (visited Aug. 6, 2009); U.S. Census (data available at http://www.factmonster.com/ipka/A0004986.html) (reporting U.S. population of 293,655,404 in 2004). For purposes of our analysis, we rely on CITL's estimates of savings from the "hybrid" approach to telehealth. This approach combines both real-time video interactions and "store and forward" whereby clinical data is collected and forwarded for interpretation offsite.
[155] Cusack et al. at 27.
[156] This estimate is based on a 2004 population of 571,360. U.S. Beacon. Date accessed: Aug. 6, 2009. (http://www.usbeacon.com/Washington/Seattle.html).
[157] Capacity constraints, however, are not limited to rural facilities. In fact, CITL reports that up to 50 percent of the 4,516 emergency facilities in the United States have difficulty providing at least one type of physician specialty for consultation, leading to transfers where rapid diagnosis and treatment is necessary. Cusack et al. at 25.
[158] State of Washington, Department of Corrections, July 31, 2008, Statistical Brochure. http://www.doc.wa.gov/aboutdoc/budget/docs/statistics/DOCStatisticalBrochure-Jul08.pdf.

approximately one transport per 16 inmates each year.[159]Applying this average to the Washington correctional population, there are roughly 1,019 transports in Washington state annually. As noted above, telehealth could allow a 43 percent reduction of transports from correctional facilities to hospitals—or 432 fewer transports statewide. CITL further assumes $1,678 in costs for a face-to-face visit (including fees for the hospital, ambulance, and security escort) as compared to only $119.77 for a televisit, for a net savings of $1,558.23 for each avoided transport. Applying these estimates, televisits would allow annual statewide savings of $673,201 for avoided transfers from correctional facilities to emergency rooms.

There are 61 hospitals in Washington state,[160] including those in the City of Seattle. Thus 23 percent of the hospitals in Washington are located in Seattle. Applying this ratio to the data above, televisits could allow Citywide savings of $154,505, assuming that the correctional facilities had sufficient bandwidth to support the necessary technology.

To confirm the above logic, CTC contacted Cassandra Chalmers of the Department of Corrections. She provided Seattle-specific data. The numbers are significantly lower than the CITL estimates. In 2008, she reports 62 transports from correctional facilities to Seattle hospitals (Harborview, Providence, and Valley General) and only six transports to Seattle-based physician offices. While these numbers are for a single correctional facility (the Monroe Correctional Complex), Ms. Chalmers indicated that this was the only facility that would transport a meaningful number of inmates into Seattle.[161] As noted above, telehealth could allow a 43 percent reduction of transports from correctional facilities to hospitals—or 26 fewer transports statewide, for a net savings of $1,558.23 for each avoided transport. Applying these estimates, televisits would allow annual savings of $40,963 for avoided transfers from correctional facilities to emergency rooms in Seattle. Estimated annual savings from avoided transports to Seattle-based physician offices are even more modest: $1,830. Moreover, such savings would only be realized if the Monroe Correctional Complex had sufficient bandwidth.

3. Savings Due to Avoided Visits from Correctional Facilities to Physician Offices

CITL found a baseline rate of 0.45 transports from correctional facilities to physician offices per inmate per year. Such visits cost an estimated $391.13 (including medical transport, security escort, and office fees) as compared to $51.27 for a televisit, for a net savings of $386 for each avoided physician visit.[162] Applying these numbers to the Washington state correctional population (16,303 inmates), there are roughly 7,336 transports from correctional facilities to physician offices annually at a cost of $3.2 million (including transport, security escort and office fees). Applying the author's estimates, broadband could eliminate 5,796 of these visits, for a statewide savings of $2.24 million annually.

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[159] Cusack et. al. at 31.
[160]American Hospital Directory, Hospital Statistics By State. Date accessed: Aug. 7, 2009. http://www.ahd.com/state_statistics.html.
[161] E-mail from Cassandra Chalmers, Department of Corrections, to Jennifer Kefer of CTC, Aug. 10, 2009.
[162] Cusack et al. at 37.

It is unclear to what extent such savings would be realized because of an investment in FTTP by the City of Seattle. As noted above, transport savings can only be realized if both facilities have sufficient bandwidth to support the televisit. While a Citywide investment in broadband could improve the capacity of area hospitals and physicians' offices, it would have little effect on correctional facilities located outside city limits. Nor would this benefit apply if transports occurred from Washington correctional facilities to physician offices outside Seattle. Determining the capabilities of such facilities is beyond the scope of this analysis. As such, this potential future benefit is worth noting here, but is not included in our calculation of Seattle savings associated with broadband.

4. Savings Due to Avoided Visits from Nursing Homes to Emergency Departments

According to the CDC, approximately 38 percent of the U.S. population (110 million) visited an emergency room in the United States in 2004.[163] Roughly 2 percent (2.7 million) of these visits originated from nursing facilities.[164] Extrapolating from these figures to Seattle, CTC estimated that 5,253 emergency room visits in the City originate from nursing homes each year.[165] CITL reports that telehealth can reduce 751 (14.3 percent) of these transports. They further assume $1,342 in costs for a face-to-face visit (ambulance plus emergency room) for each transport as compared to only $120 for a televisit, for a net savings of $1,222 for each avoided visit.[166] Applying these estimates, televisits would allow annual savings in Seattle of $918,173 for avoided transfers from nursing homes to emergency rooms.

Another approach is to start with the 1.6 million certified beds in nursing homes in the United States,[167] with 2.7 million emergency room visits originating from these facilities in 2004.[168] There are 3,485 certified beds in the City of Seattle.[169] Extrapolating from this national data, CTC estimated that 5,666 visits to Seattle emergency rooms originate from nursing homes annually. Applying CITL's methodology, 14.3 percent (810) of these visits could be avoided through telemedicine, with an estimated savings of $990,287 each year.

[163] CDC/NCHS/1992-2004 National Hospital Ambulatory Medical Care Surveys) (http://www.cdc.gov/nchs/data/ahcd/ed19922004trend.pdf) (visited Aug. 6, 2009); U.S. Census (data available at http://www.factmonster.com/ipka/A0004986.html) (reporting U.S. population of 293,655,404 in 2004).
[164] Cusack et. al. at 41.
[165] This estimate is based on a 2004 population of 571,360. U.S. Beacon, Visited Aug. 6, 2009 (http://www.usbeacon.com/Washington/Seattle.html).
[166] Cusack et al. at 41-42.
[167] Medicare data (http://www.medicare.gov/Download/NHCAboutNH_flatfiles.zip).
[168] Cusack et al. at 41.
[169] Department of Social and Health Services, Aging and Disability Services Administration (visited August 6, 2009) (http://www.aasa.dshs.wa.gov/).

5. Savings Due to Avoided Visits from Nursing Facilities to Physician Offices

The average U.S. resident aged 65 or older visits a physician 6.75 times each year. CITL estimates that the average cost to transport a nursing home resident to a physician office is $76 and assumes that the cost of a televisit ($51) is equal to the cost of a face-to-face visit for such individuals.[170] Applying these figures to the Seattle nursing home population,[171] CTC estimates that there are 20,936 annual physician visits from Seattle nursing homes. FTTP could eliminate 14,278 of these face-to-face visits, with a savings of $1.09 million annually.

As with the analysis of correctional facilities above, these estimates only apply if both the nursing home and emergency room or physicians' office have sufficient bandwidth to support telehealth technology

5.3.4 Enhanced Medical Access for Rural Residents

There has been a great deal of research on the potential benefits of broadband for rural medical care. While Seattle is unlikely to benefit in this way, CTC thought it helpful to highlight some of these applications. Notably, the Federal Communications Commission (FCC) has already authorized over $400 million to 25 states to use telemedicine networks to provide medical care to rural areas.[172] This allows rural doctors to provide timely medical care while avoiding costly—and potentially risky—transfers to urban hospitals. In Georgia, for instance, telemedicine allows doctors at academic centers to participate remotely in the examination of patients at rural hospitals, cutting transports by 60 percent to 80 percent.[173] This program enables doctors at the Medical College of Georgia's neurology department to use videoconferencing to examine, diagnose, and treat stroke patients at 10 rural hospitals.[174] Broadband also improves the quality of medical care in rural areas by providing access to in-service training without requiring costly participation in distant conferences.[175]

[170] Cusack et al. at 45-46.
[171] There are 35 licensed nursing facilities with the capacity to support 3,485 people in the City of Seattle. Department of Social and Health Services, Aging and Disability Services Administration (visited August 6, 2009) (http://www.aasa.dshs.wa.gov/) (based on DSHS/ADSA/RCS & ORM licensing and annual Medicaid cost report data files). Applying the Seattle nursing home occupancy rate (89 percent) (e-mail from Ken Callaghan, Chief Office of Rates Management, Dep't of Social and Health Services, to Jennifer Kefer, Aug. 10, 2009), we assume there are roughly 3,102 nursing home residents in the City of Seattle.
[172] Robert LaRose *et. al*., "Closing the Rural Broadband Gap," Department of Telecommunication, Information Studies, and Media, Michigan State University, Nov 30, 2008. https://www.msu.edu/~larose/ruralbb/.
[173] Dr. Jay Sanders, President and CEO, the Global Telemedicine Group and Professor of Medicine (Adjunct) at Johns Hopkins School of Medicine (cited in the Broadband Factbook). http://internetinnovation.org/factbook/entry/application-of-telemedicine-to-rural-healthcare/.
[174] Rintels. 16.
[175] Fuhr and Pociask. 39.

5.3.5 Improved Medical Efficiencies

Broadband can help cut costs by improving efficiency in a number of ways. In hospitals, remote monitoring with high-resolution video allows a single doctor to simultaneously observe and treat multiple patients. The American Consumer Institute reports that this application reduced ICU deaths by 50 percent at Johns Hopkins.[176] The potential benefits of telemedicine outside a single institution are even greater. Because the current medical system is fragmented, doctors seldom have comprehensive information about a patient's medical history, leading to costly and invasive duplicate procedures. This disjointed system means that "[p]atients may be treated at multiple locations by multiple doctors who keep multiple paper records and fill out multiple paper forms seeking reimbursement from multiple insurance carriers."[177] By creating a universal repository for medical records, caregivers can coordinate treatment, easily provide second opinions, streamline billing, and avoid duplicative procedures. Online access to medical records could help doctors avoid such inefficiencies, with savings totaling $81 billion annually—or $670 per household.[178] Of course, these savings will require a significant up-front investment from medical professionals who will have to upload medical histories and transition to electronic record keeping.

5.3.5.1 Seattle Application

According to Rintels,[179] health information technology (HIT) could save $670 per household annually. There are 267,254 households in Seattle. Thus, online medical records enabled by broadband access could lead to yearly savings of $179.1 million in health care expenditures for Seattle residents.

The calculation of savings realized by residents, however, does not include the costs likely to be incurred by individual physicians and hospitals in implementing HIT in their practices. The RAND Corporation projected costs for HIT over a 15-year period.[180] The costs for initial outlays and maintenance are considerably higher for inpatient treatment in hospitals than for outpatient treatment and ambulatory care.[181] The RAND study found that a hospital may spend between 1.8 percent and 3 percent of its annual operating expenditures for three to five years to implement an HIT system.[182] The study's estimate for one-time (capital) costs for an HIT system in an individual physician's office was $22,000; maintenance costs (software licensing, hardware repair and replacement) were set at 20 percent of the one-time cost or about $4,400 annually.

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[176] Fuhr and Pociask. 37.
[177] Rintels. 17.
[178] Rintels, 18. (Citing Rand Health, "Extrapolating Evidence of Health Information Technology Savings," 2005 Public Medical Research data from the National Health Expenditure Data, HHS and "Upgrade America's Health Care System: Pass Health IT Legislation Now," Business Roundtable, April 2, 2008).
[179] Rintels.
[180] Girosi *et al.,* "Extrapolating Evidence of HEALTH Information Technology Savings and Costs," RAND Health, 2005.
[181] Girosi.
[182] Girosi, summary, xii.

It is estimated that there are 1,104 individual physicians[183] and 12 hospitals in Seattle.[184] Total income for Seattle hospitals is $8.1 billion.[185] The Harborview Medical Center reported total revenue of $1,253,852,097 and an annual operating budget of $568 million in 2007.[186] Assuming a similar ratio of total operating budget to revenue (45.3 percent) for all Seattle hospitals, the total operating budget for Seattle hospitals is $3.7 billion. Taking a conservative (high) estimate of 2.5 percent of annual operating budgets over four years for projected costs of HIT systems and assuming the operating budget remains unchanged during this period, the total capital outlay for these institutions to establish these systems for their patients' care would amount to $367 million. The initial capital outlay for physicians to institute HIT record-keeping systems in their practices would be $24.3 million. In total, then, the health care industry in Seattle would spend $391.2 million over four years to implement HIT systems.[187] Thereafter, these systems would cost $78.2 million annually to maintain,[188] offsetting the projected annual savings to residents of $179.1 million, for a net savings of $100.9 million.

The RAND study also cautions that savings could be reduced if implementation and uptake of HIT were to be delayed; conversely, savings could be increased if these systems were to be installed and made operational much sooner.[189] This analysis assumes a conservative installation rate of four years, with savings deferred until the HIT systems (for both physicians and hospitals) were operational in year 5.

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[183] In 2000, there were 11,614 active patient care physicians, or 196 physicians per 100,000 residents, in Washington. U.S. Department of Health and Human Services, Health Resources and Services Administration, "State Health Workforce Profits Highlights: Washington" (available online at ftp://ftp.hrsa.gov/bhpr/workforce/summaries/Washington03.pdf). There were 563,374 people in Seattle in 2000. U.S. Census Bureau, 2000 (available online at http://www.ofm.wa.gov/census2000/profiles/place/1605363000.pdf). Applying the statewide average, there were thus 1,104 physicians ((563,374*196)/100,000) physicians in Seattle in 2000.

[184] These include one county hospital (Harborview Medical Center), nine not-for-profit institutions, one privately owned, for-profit facility, and one state-owned facility. Hospital data is not available for the VA Puget Sound Health Care System, which is not required to submit financial information to the state. Personal communication between Thom Rees, Washington State Hospital Association, and Jennifer Kefer, July 31, 2009.

[185] American Hospital Directory, Seattle profile. Data based on 2007 Medicare cost report for 12 Seattle hospitals; data for VA Puget Sound Health Care System not available. http://www.ahd.com/freelist.php3?mname=&mcity=Seattle&mstate[]=&mzip=&mphone=&submitted=Search.

[186] Harborview Medical Center, Facilities Overview, http://uwmedicine.washington.edu/uwmed/Templates/content/uwmedicine_storyNoContact.aspx?NRMODE=Published&NRNODEGUID={591000E9-41C8-40F5-A7AF-EA4B641547A8}&NRORIGINALURL=%2fFacilities%2fHarborview%2fOverview%2f&NRCACHEHINT=Guest#2.

[187] This is a conservative estimate, which assumes that no physicians or hospitals have independently implemented an HIT system to date. It further assumes that there are no economies of scale for physicians practicing as a group. Because many hospitals have, in fact, implemented HIT systems, the actual costs are likely lower.

[188] This analysis assumes that the 20 percent maintenance cost for individual physicians reported in the RAND study would extend to hospital HIT systems.

[189] Girosi *et al.* xiii.

5.4 Aging in Place and Other Supports for Seniors

In 2005, 12 percent (35 million) of the U.S. population was over 65. By 2030, that number will rise to 21 percent (71 million).[190] This growing demographic also represents a rapidly growing segment of the broadband market. In fact, the Pew Internet and American Life Project reports that the largest increase in Internet use since 2005 occurred in the 70- to 75-year-old age group, with online use for this age group increasing from 26 percent in 2005 to 45 percent in 2009.[191] Broadband use has increased by about half for Americans ages 12 to 24, roughly doubled for 25- to 64-year-olds, and more than tripled for seniors 65 and older. Notwithstanding this dramatic increase, broadband use by seniors 76 and older remains relatively low, at only 16 percent.[192] By contrast, 61 percent of those aged 50 to 64 have broadband at home.[193] Broadband use will undoubtedly continue to rise as younger users age. This provides a tremendous opportunity for extending the benefits of broadband access. Moreover, the City can help expand these benefits by accelerating broadband development and promoting its use among seniors.

Broadband promises a range of applications that can benefit an aging population. In particular, broadband access can lower medical costs and prevent hospitalization through home-based monitoring; extend employment opportunities through telework; and foster ongoing relationships by allowing homebound seniors to connect to the outside world.[194] These benefits translate to dramatic savings in Medicaid and Medicare expenses for the federal and state governments, reduced demand for limited space in Seattle hospitals and long-term care facilities, and increased income and savings for Seattle residents. Because 60 percent of U.S. healthcare spending is on seniors,[195] initiatives that target this population translate to significant government savings. In fact, considering only three categories of benefits (lower medical costs, lower costs of institutionalized living, and additional output generated by more seniors and individuals with disabilities in the labor force), economist Robert Litan identified up to $927 billion in cost savings and output benefits from "business as usual" broadband deployment and an additional $532 billion to $847 billion in economic benefits from accelerated broadband deployment.[196] Even the low end of this estimate is equal to half of what the United States currently spends annually for medical care for all its citizens ($1.8 trillion).

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[190] Robert Litan, "Great Expectations: Potential Economic Benefits to the Nation From Accelerated Broadband Deployment to Older Americans and Americans with Disabilities," New Millennium Research Council, Dec. 2005. 6. http://newmillenniumresearch.org//archive/Litan_FINAL_120805.pdf.

[191] Sydney Jones and Susannah Fox, "Generations Online in 2009," PEW INTERNET PROJECT DATA MEMO, Jan 2009. 2. http://www.pewinternet.org/~/media//Files/Reports/2009/PIP_Generations_2009.pdf.

[192] Jones and Fox.

[193] John Horrigan, "Home Broadband Adoption 2009," Pew Internet and American Life Project, June 2009.http://www.pewinternet.org/Reports/2009/10-Home-Broadband-Adoption-2009.aspx. (The chart at p. 13 illustrates use among all age groups.)

[194] Richard Adler, "Older Americans, Broadband and the Future of the Net," Senior Net, 2006. http://www.seniornet.org/research/SeniorNetNNPaper060606.pdf.

[195] Charles Davidson and Michael Santorelli, "The Impact of Broadband on Senior Citizens," U.S. Chamber of Commerce, Dec 2008. 22-23 http://www.uschamber.com/assets/env/broadbandseniors.pdf.

[196] Davidson and Santorelli, 18. Additional savings may be possible because broadband can help homebound residents comparison shop for best prices. For instance, a New York-based program helped lower-income seniors save $19,000 on their drug costs alone.

CTC market research has ascertained that 89 percent of Seattle homes have a computer. In addition, 86 percent have Internet access and 81 percent have high-speed Internet service. ("High-speed" has been defined in our survey as the typical performance of cable modem and DSL service in Seattle.)

However, in the case of Seattle respondents ages 65 and older, these figures are not as promising. Only 69 percent of Seattle seniors own a computer and just 53 percent have access to high-speed Internet service in their homes. Although these figures are markedly higher than national averages, they suggest that there is room for increased market penetration in this demographic. Because fewer seniors own computers, it is likely necessary that an aggressive program to promote computer ownership among seniors be implemented. If such a program were not initiated, then the benefits of high-speed broadband access would have to await the aging of younger, more computer-savvy Seattle residents.

5.4.1 Medical Cost Savings

Broadband access allows seniors to search for medical information online, rather than scheduling costly appointments with their physicians. Approximately 20,000 medical websites exist for online research,[197] with a substantial subset targeted toward senior users. For instance, both the Mayo Clinic and the National Institutes of Health (NIH) have Web pages dedicated to senior health information. Similarly, AARP recently launched a series of online tools designed to help seniors select a physician or hospital and understand and diagnose their symptoms.[198] Seniors are already taking advantage of these services. Pew estimates that 70 percent of online adults (ages 64 to 72) and 81 percent of those aged 55 to 63 have used the Internet to find medical information.[199] Seniors are more likely to seek information online if they have a dependable, high-speed broadband connection. Such access empowers seniors by allowing them "to be preemptive and interactive in their efforts to combat the harmful effects of aging."[200] It also translates to reduced medical expenses. In fact, as noted previously, Kaiser Permanente found that allowing enrollees (of all ages) to e-mail questions to their doctor through a secure messaging system led to a 7 percent to 10 percent reduction in primary care visits.[201]

Broadband also reduces medical costs for seniors by facilitating remote monitoring. Through the use of remote monitoring devices like ECG electrodes or blood glucose sensors, healthcare providers can continuously observe cardiac performance, food intake, and glucose levels, without requiring costly medical examinations or hospitalization. One

[197] Herrick. 14.
[198] Davidson and Santorelli. 21-22.(Citing www.mayoclinic.com/health/seniorhealth/HA99999, http://nihseniorhealth.gov/, and News Release, "AARP Launches Four Online Health Tools to Empower Consumers To Make Informed Choices in Care," AARP, Aug 22, 2008. http://www.aarp.org/research/presscenter/presscurrentnews/aarp_launches_four_online_health_tools_to_empower.html).
[199] Jones and Fox.
[200] Davidson and Santorelli. 21.
[201] Herrick. 14.

study reports that 3.4 million seniors will be using such devices by 2012.[202] Remote monitoring is particularly useful for chronic diseases (such as coronary heart disease, chronic obstructive pulmonary disease, mental health disorders, diabetes, hypertension, and asthma), which require continued medical care and coordinated treatment among physicians. Chronic illness is prevalent among seniors. In fact, 45 percent of Medicare beneficiaries nationwide suffer from at least one chronic condition, representing nearly 80 percent of national healthcare spending—more than $1 trillion each year.[203] Economist Robert Litan estimates that remote monitoring could cut Medicare expenses for the chronically ill by 30 percent, or $350 billion each year.[204] As indicated previously, data from the Veterans Administration supports this estimate. The VA has cut hospital admissions by up to 60 percent for participants in its remote monitoring program, which relies on a network of "care managers" who track patient data online and contact participants if records indicate a need for immediate medical attention.[205]

5.4.1.1 Seattle Application

Chronic illnesses affect a significant number of people in Seattle and King County. To the extent that broadband can enable remote monitoring of chronically ill residents, FTTN in Seattle could significantly reduce the costs of managing and treating these conditions.

According to a Seattle and King County public health report, 9 percent of adults and 5.5 percent of children in King County have current asthma.[206] Assuming similar asthma rates for Seattle, CTC estimated 42,794 adults and 4,834 children in the city suffer from current asthma.[207] In fact, this is a conservative estimate, as the County reports that the highest rates of asthma hospitalization in the County are found in Southeast and Central Seattle. King County reports 2004 asthma hospitalization costs for all King County residents of $11.8 million.[208] Of this, CTC estimates that roughly $3.72 million can be

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[202] Davidson and Santorelli. 23. ("Senior Citizens to See High Tech Sensors in Homes, on Bodies to Monitor Health," Dec. 6, 2007, Senior Journal. http://www.seniorjournal.com/NEWS/Features/2007/7-12-06-SenCit2See.htm.)

[203] Litan, 16.

[204] Litan, 16-17.

[205] Neal Neuberger, "Advancing Healthcare Through Broadband: Opening Up a World of Possibilities," Internet Innovation Alliance, 2007. Date of Access: July 28, 2009. http://internetinnovation.org/factbook/entry/small-pilot-projects/.

[206] "Asthma in King County," Public Health Data Watch, Public Health—Seattle & King County, November 2005, at 4, http://www.kingcounty.gov/healthservices/health/chronic/~/media/health/publichealth/documents/data/asthma_2005.ashx; *see also* "Core Indicator: Current Asthma Prevalence, Age 18 and Older, King County." http://www.kingcounty.gov/healthservices/health/data/chi/environmental/AdultAsthmaPrevalence.aspx. (indicating that 7.8 percent of King County seniors report having asthma).

[207] U.S. Census Bureau, 2000 Census (reporting population size under 18 and over 18) (http://quickfacts.census.gov/qfd/states/53000.html).

[208] "Asthma in King County," Public Health Data Watch, Public Health—Seattle & King County, November 2005, at 6, http://www.kingcounty.gov/healthservices/health/chronic/~/media/health/publichealth/documents/data/asthma_2005.ashx.

attributed to Seattle residents.[209] Using Litan's research as a guide, telemedicine could potentially reduce those and other expenditures on treatment for chronic illnesses by 30 percent, or $1.12 million annually for asthma alone.

Diabetes affects 13.4 percent of King County seniors and 5.3 percent of all King County adults.[210] Assuming a similar incidence rate in Seattle, CTC estimates that 25,200 adult Seattle residents have diabetes. According to the Centers for Disease Control and Prevention (CDC), statewide hospitalization costs for diabetes-related care amounted to $1.8 billion in 2005.[211] There are 61 hospitals in Washington state,[212] including 12 in the City of Seattle. Thus 20 percent of the hospitals in Washington are located in Seattle. Applying this ratio to the data above, diabetes-related hospitalizations result in annual costs to Seattle hospitals of $360 million. Remote monitoring could reduce these costs by $108 million.

The CDC further estimates statewide 2005 hospitalization costs for cardiovascular disease of $6.5 billion.[213] Extrapolating this data as above, annual hospitalizations for cardiovascular disease cost Seattle an estimated $1.3 billion, with potential annual savings from remote monitoring of $390 million.

5.4.2 Reduced Cost of Institutionalized Living

Medical monitoring enabled by broadband may also delay and potentially eliminate the need for institutionalized living, with dramatic savings. As of 2002, 5 percent of Medicare-eligible seniors (1.6 million) lived in nursing homes.[214] This number is expected to increase as baby boomers retire and life-span increases. In fact, 44 percent of seniors will live in nursing homes at some point during their lifetime.[215] This care comes at a significant cost. In 2004, the federal government spent $135 billion on long-term care for the elderly.[216] Nationally, the annual cost is nearly $78,000 for a private room in a nursing home.[217]

Internet applications that are designed to "sharpen brain function" could lead to even greater potential savings. (At a minimum, these applications can help reduce isolation and

[209] Estimate based on 2004 population data indicating Seattle population is 32 percent of King County.
[210] "Core Indicator: Diabetes Prevalence, Age 18 and Older, King County." http://www.kingcounty.gov/healthServices/health/data/chi/health/DiabetesPrevalence.aspx.
[211] Centers for Disease Control and Prevention, State and Program Examples (http://www.cdc.gov/nccdphp/examples/pdfs/washington.pdf#page=2) (visited Aug. 7, 2009).
[212] American Hospital Directory, Hospital Statistics By State (http://www.ahd.com/state_statistics.html) (visited Aug. 7, 2009).
[213] Centers for Disease Control and Prevention, State and Program Examples (http://www.cdc.gov/nccdphp/examples/pdfs/washington.pdf#page=2) (visited Aug. 7, 2009).
[214] Litan, 21.
[215] Litan, 21. *See also* Davidson and Santorelli. 22-23. (Projecting 69 percent of seniors will need eventual long-term care.)
[216] Litan. 21. This includes $92 billion (68 percent) for nursing home care and $43 billion (32 percent) on home care.
[217] Litan, 21.

depression among seniors.[218]) Neurologists have reported that mental exercises, like puzzles, logic games, and reading material available for free through the Internet, can reduce an individual's chance of developing Alzheimer's disease by 70 percent.[219] Accessing such sources of "mental exercise" online also means that elderly people with limited mobility are not dependent on driving to a store or library to get what they need. According to one analysis, "interventions that could delay the onset of Alzheimer's disease by as little as one year would reduce prevalence of the disease by 12 million fewer cases in 2050."[220] Because Alzheimer's and dementia currently cost the United States more than $148 billion annually in Medicaid and Medicare services,[221] the potential savings are significant. In addition to these economic benefits, such applications will help allay the concerns of nearly 60 percent of seniors who worry about "staying 'mentally sharp.'"[222]

5.4.2.1 Seattle/ Washington Application

On average in the United States, a private room in a nursing home costs $168 per day.[223] In Seattle, however, this number is closer to $204 per day, which equates to a yearly fee of $74,460.[224] Given that the average time a senior citizen will live in a nursing home is projected to be two and a half years, the total cost of the stay would be around $186,150.[225] Assuming that 44 percent of Seattle's senior citizens (who number 62,771 according to the latest census estimate[226]) will live in nursing homes for that length of time, they will collectively pay more than $5 billion. If at-home broadband-enabled health monitoring were able to reduce the average resident's length of stay in a nursing home by six months, residents would save more than $1 billion in nursing home fees. The normalized annual savings is a function of turnover of the seniors living in a nursing home.

The savings in nursing home expenses would be offset by the cost of additional at-home health care, but those fees are a small fraction of the daily cost of nursing home care. Private at-home care in Seattle averages $23 per hour ($4 higher than the national

[218] Davidson and Santorelli. 15. The same Internet applications can help improve quality of life for seniors who often complain of isolation and experience depression. In fact, studies have found that "seniors who master computer skills appear to have fewer depressive symptoms."
[219] "Four Pillars of Alzheimer's Prevention: Exercise Physical, Mental and Mind/Body," Alzheimer's Research and Prevention Foundation. http://www.alzheimersprevention.org/pillar_3.htm.
[220] Davidson and Santorelli. 22.
[221] Davidson and Santorelli.
[222] Davidson and Santorelli, 12.
[223] Debra Caruso and Christina Tso, "LTC Cost by City," Business Wire. http://www.assn-insurance.com/pdf/LTCCostByCity.PDF.
[224] Caruso and Tso.
[225] Caruso and Tso.
[226] "Seattle city, Washington," Fact Sheet, U.S. Census Bureau. http://factfinder.census.gov/servlet/ACSSAFFFacts?_event=&geo_id=16000US5363000&_geoContext=01000US%7C04000US53%7C16000US5363000&_street=&_county=seattle&_cityTown=seattle&_state=04000US53&_zip=&_lang=en&_sse=on&ActiveGeoDiv=&_useEV=&pctxt=fph&pgsl=160&_submenuId=factsheet_1&ds_name=null&_ci_nbr=null&qr_name=null&reg=null%3Anull&_keyword=&_industry=

average).[227] With broadband in the homes of patients, medical monitoring could make it possible to need as little as one hour every day of in-home care.

In fact, according to AARP, Medicaid funding can support an average of three people in home and community-based settings for the same cost as supporting one person in a nursing home.[228] Litan's estimates are consistent with these figures, finding that the difference between institutionalized and home care is at least $50,000 per person.[229]

Litan further assumes that home-based monitoring will prevent institutionalization for 1 percent of seniors in 2010, rising to 2 percent to 3 percent by 2030, for an estimated cumulative savings of nearly $1 billion in 2010 and $17 to $32 billion in 2030.[230] This approach represents an improvement in the quality of life for seniors in addition to the obvious economic benefits of home-based care. Indeed, an AARP study found that 87 percent of seniors would prefer to have help provided to them in their homes rather than in an institution.[231] Applying this approach to Seattle's senior population, this represents an annual savings to Seattle seniors of $1.95 million, growing to $33 million to $62 million in 2030.

In terms of Alzheimer's, while broadband-assisted reduction in deaths caused by the disease is speculative, broadband could postpone or potentially reduce the incidence of the disease. And to the extent that broadband access does postpone the incidence of Alzheimer's, those Seattle residents who are spared will save on medical expenses: On average, individuals affected by Alzheimer's disease are paying three times as much in health care costs as those who do not have Alzheimer's or dementia.[232]

5.4.3 Increased Productivity Through Telework

Seniors represent a sizable and growing percentage of the workforce. According to the U.S. Census and the Bureau of Labor Statistics, 14.8 percent of seniors (ages 65 and up) were working or looking for work in 2005.[233] These numbers are projected to increase given the current economic crisis, which has affected retirement savings; trends away from defined pension plans; and longer life expectancies, which increase the amount of savings required to sustain a constant quality of life into retirement. According to the Social Security Administration's actuarial office, delayed retirement is expected to increase the U.S. labor force by one million additional workers, or 1.5 percent, by 2030. Several analyses by the Urban Institute project an additional 6.2 million workers (4.4 percent). Assuming that the midpoint of these estimates can "plausibly" be "attributed to

[227] Caruso and Tso.
[228] Ari Houser, Wendy Fox-Frage, and Mary Jo Gibson, "Across the States: Profiles of Long-Term Care and Independent Living," AARP, 2009. http://assets.aarp.org/rgcenter/il/d19105_2008_ats.pdf.
[229] Litan. 21. (Reporting a price differential of $48,000 to $64,000, depending upon whether the individual is placed in a private or semi-private room).
[230] Litan, 23.
[231] Davidson and Santorelli. 25.
[232] Alzheimer's Facts and Figures, Alzheimer's Association. http://www.alz.org/alzheimers_disease_facts_figures.asp?gclid=CIjG-KO705sCFRd75Qodi28qJQ.
[233] Litan. 24.

broadband technology," Litan projects an increase of roughly 3.6 million workers (roughly 2 percent of the total workforce) by 2030.[234] Using a 2005 median income figure of $29,000 for working seniors and assuming comparable earnings for the additional members of the workforce, Litan projects additional output gains of $121.51 billion in 2010 and $822.40 billion in 2030.[235]

(The potential for increased output through telework is also great for disabled Americans, whose unemployment rate was 62.5 percent in 2004.[236] While it is difficult to project the precise effect of broadband on this population, the flexibility afforded through telework would allow some additional disabled workers to enter the workforce. Assuming a modest, 1 percent increase in employment and a median income of $30,000—scaled up in future years at a growth rate of 2 percent—output could increase by $11.37 billion nationwide in 2010.[237])

5.4.3.1 Seattle/ Washington Application

According to the Puget Sound Regional Council, in 2006 there were 470,698 employed individuals in Seattle.[238] If broadband access were to enable more seniors to stay in the workforce—leading to a 2 percent increase in the overall workforce—Seattle would have 9,414 additional employees and, assuming a median income of $29,000, roughly $273 million in additional output.

Likewise, if broadband access were to enable a 1 percent increase in employment among Seattle residents with disabilities, Seattle would see a fairly substantial level of increased economic output. In 2007, there were 525,000 residents aged 18 to 64 with disabilities in Washington, comprising 18.1% of the state's population.[239] Applying this same percentage to Seattle's total population, 48,713 disabled persons reside in the City. Using Litan's analysis, with a projected 1 percent increase in employment and a median income of $30,000, output would increase by $14.6 million.

5.5 Enhanced Video Surveillance and Security

Broadband allows a range of video surveillance applications. Using a digital camera, either a wired or wireless Internet Protocol ("IP") network, and a back-end monitoring system, communities can remotely monitor people, buildings, and traffic to enhance public safety and reduce crime. Outdoor Wi-Fi mesh network are "transform[ing]" the field of video surveillance by offering "easy-to-install, highly-scalable solutions."[240]

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[234] Litan, 25-26.
[235] Litan, 28.
[236] Litan, 28. *See also* Fuhr and Pociask. 5, 21. (Citing Ted Balaker, "The Quiet Success: Telecommuting's Impact on Transportation and Beyond," Reason Foundation, Los Angeles, Nov. 2005). (Reporting 25 percent employment for the disabled).
[237] Litan. 29.
[238] The Great Seattle Data Sheet, http://www.cityofseattle.net/oir/datasheet/Datasheet2008.pdf .
[239] AARP. 323.
[240] "Video Surveillance: Application Note," Next Wave Wireless. http://www.nextwave.com/sites/Corporate/images/media/1022_NextWave_WiFi_AP_VideoSurv_071508.pdf.

Fiber is needed for high-quality video surveillance. Depending on bandwidth, surveillance cameras can provide information ranging from simple black-and-white still images to high-resolution, 30-frames-per-second color video.[241] Surveillance cameras can be hardwired into the network via Ethernet, directly connected through Ethernet to a collocated Wi-Fi base station, or deployed as Wi-Fi clients. Bandwidth requirements will vary, depending on the application and the quality of the video. Inadequate bandwidth could result in unstable and insecure signals.[242]

Video surveillance is attractive because it enables a low-cost solution to monitor public spaces "without adding any more feet on the street." A single employee can simultaneously observe multiple cameras and deploy personnel where they are most needed. Surveillance cameras can be used to detect trespassers, loitering, illegal parking, dumping, and theft, and help with crowd control. These services have been deployed on roads at industrial construction sites, in crowded public spaces such as airports, train stations, and public festivals, and in remote open areas, such as parks.

Potential applications include:[243]

- Remote monitoring of construction sites after hours to prevent vandalism, trespassing and theft.[244]
- In-vehicle cameras to enable security officers to identify where they are most needed, efficiently deploy staff, and be prepared to act appropriately when they arrive on the scene.
- Forensic evidence to expedite legal proceedings to apprehend criminals.
- Video monitoring to ensure compliance with safety procedures (thereby reducing liability).
- Remote monitoring of vehicle and equipment "health" to ensure that maintenance is provided as needed.
- Inventory tracking to facilitate just-in-time equipment transfers and detect theft if it occurs.
- Internet access for employees to expedite paperwork and remote communications.
- Virtual neighborhood watch to cost-effectively monitor and deter crime.
- Crowd control and observation at large public gatherings.

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[241] "Video Surveillance: Application Note," Next Wave Wireless.

[242] "Frost & Sullivan Observes that Wireless Video Surveillance's Cost and Maintenance Benefits Hold it in Good Stead," PRNewswire, Mar 30, 2009. http://asia.tmcnet.com/news/2009/03/30/4092437.htm.

[243] "Video Surveillance for Industrial Security," Potential applications are elaborated on the Tropos Network website. See, e.g., Tropos Networks. http://www.tropos.com/pdf/solutions/IndustrialVideoSecurity.pdf. *See also* "Video Surveillance for Public Safety," Tropos Networks. http://www.tropos.com/pdf/solutions/videopublicsafetyl.pdf. *See also* "Video Surveillance," Tropos Networks. http://www.tropos.com/solutions/Video_Surveillance.html.

[244] Brett Martin, "Theft Costs Construction Industry More than $1 Billion Annually," Masonry Magazine, 2006. http://www.masonrymagazine.com/8-06/theft.html. This application is particularly attractive as the National Insurance Crime Bureau reports that the U.S. construction industry loses $1 billion annually to theft.

- Observation of forested areas during times of high fire danger, to allow rapid detection and response.
- Real-time communication between emergency medical technicians and emergency room doctors to help prepare hospital staff for new arrivals and to allow hospital staff to recommend treatment during transport.

Many municipalities are already employing surveillance cameras for these purposes. Of particular note, Chicago has used a combination of unified fiber and wireless mesh networking to create a "virtual shield" around the city. The network covers the entire city with thousands of real-time, high-quality video access points. These cameras (which cover both private and public sector establishments) are combined into a single unified system, with bandwidth requirements that would exceed the capabilities of a simple wireless network. The Chicago system is state-of-the-art, featuring some cameras that will automatically film in the direction of gunshot sounds before dialing 911. The network can capture, monitor, and index footage for safety and forensic applications. The system "entailed building a unified fiber network throughout the downtown Chicago area, deploying a critical wireless infrastructure to offer flexibility as required, installing hundreds of new surveillance cameras, linking thousands of preexisting cameras to the network, and creating a fully redundant backend system to monitor the video, store the images and allow for business continuity and disaster recovery applications."[245] The results have been dramatic. Before the system was installed, from January to May 2003, there were 24 murders in the city's District 11. In 2005, there were only four murders during the same period—an 83 percent decline.[246]

Other municipalities have used more modest networks to enhance public safety, despite a shortage of police officers. In Savannah, Georgia, surveillance cameras monitor the City's 22 historic squares and "increase[e] police visibility in key problem areas" around the city. Cameras also supplement security by providing "eyes in the sky" during large public gatherings, such as the City's Saint Patrick's Day Festival. Cameras have helped improve the efficiency of the limited police force, allowing officers to locate problem areas, witness crimes in progress, reduce response time, and enable access to criminal and DMV records in the field.[247]

The City of Laguna Beach, California has deployed a state-of-the-art wireless video network for a variety of applications around a 20-square-mile area that encircles the city. Solar-powered cameras are stationed at areas with high fire risk and monitored by park rangers to allow early detection of—and rapid response to—wildfires. The same network can also be used to monitor wildlife activity. The surveillance system supplements a streamlined staff during the winter by providing virtual lifeguards focused on the most

[245] "The City of Chicago's OEMC and IBM Launch Advanced Video Surveillance System," Press Release, Sept 27, 2007. http://www-03.ibm.com/press/us/en/pressrelease/22385.wss. *See also* W. David Gardner, "Chicago Taps IBM, Firetide to Install 'Operation Virtual Shield,'" InformationWeek, Sept 27, 2007. http://www.informationweek.com/news/mobility/security/showArticle.jhtml?articleID=202102357.
[246] *See also* "Success Story: Chicago Police Department," Wave Wireless Corporation. http://www.speedlanwireless.com/ChicagoPD.pdf.
[247] "Success Story: Virtual Eyes on Crime in Savannah, Georgia," Tropos Networks. http://www.tropos.com/solutions/Video_Surveillance.html.

dangerous locations, allowing lifeguards to spot—and approach—swimmers as they enter. The same network provides webcast coverage of local events, such as historical society meetings and the Patriot's Day Parade. The city plans to expand the network to allow for automated utility meter reading and mobile city operations, whereby city staff can submit field reports remotely.[248]

Seattle is already using video surveillance cameras at several municipal parks and public events.[249] In addition to monitoring of public locations for possible criminal activity, Seattle departments have identified several innovative applications for video surveillance technology that a ubiquitous fiber-optic network can enable. For example, CTC's interviews with City employees identified the following additional functions for video surveillance:

- Monitoring rising water levels in City-operated retention ponds during severe storms.
- Forwarding of security video images from private facilities to their owners after an intrusion alarm has been received by the 911 center.
- Remote viewing of fire incident scenes by commanders to identify additional needed resources.

5.6 Enhanced Government Services

Broadband can make myriad services available to improve government efficiency and performance. While many of these individual services can be performed through a wireless network, these and the wide array of other services require a fiber backhaul to provide sufficient speed and capacity.

Examples of innovative services that could be provided over a broadband fiber-optic network include expanded monitoring and control of the City's water systems. Claims against the City for flood damage caused by waste and storm water average $500,000 annually, with a recent year's claims amounting to $2 million. Officials within Seattle Public Utilities estimate that such claims can be reduced by up to 50 percent with the enhanced remote monitoring and control capabilities that a ubiquitous fiber-optic network can provide.

A representative from the City's Human Services Department estimates that her department could utilize a broadband fiber-optic network to extend educational and

[248] "Success Story: Virtual Lifeguards and Fire Watch for Community Protection in Laguna Beach, CA," Tropos Networks. http://www.tropos.com/pdf/success_stories/tropos_success_story_laguna_beach.pdf.
[249] *See* Dominic Holden, "In Case You Forgot the City Is Recording Your Picnic," Slog News and Arts, July 24, 2008 http://slog.thestranger.com/2008/07/in_case_you_forgot_the_city_is_recording. *See also* Erica Barnett, "Council Committee to Approve Park Cameras," Slog News and Arts, May 29, 2008. http://slog.thestranger.com/2008/05/council_committee_to_approve_park_camera. *See also* "Seattle Police Department Monitors Mardi Gras Festivities with Wireless Video Surveillance Network From Azalea Networks," PRNewswire, Mar. 24, 2009. http://news.prnewswire.com/ViewContent.aspx?ACCT=109&STORY=/www/story/03-24-2009/0004993758&EDATE=.

vocational training programs into served communities. Similarly, patrons of Seattle's public library system would benefit from improved connectivity and larger telecommunications "pipes" among library locations to support additional applications. These applications include streaming digital media, distance learning, and connectivity of portable devices such as laptops and PDAs via wireless networks supported by a fiber backhaul network.

A common theme found among City workers interviewed by CTC was that video-based teleconferencing capabilities would improve the efficiency of their daily work. The employees cited a reduced need for travel throughout the City to attend meetings at various locations as an obvious potential benefit. Some employees postulated further that having a robust broadband network available to City workers would permit many employees to work from their homes, either on a routine basis or possibly during medical emergencies such as an influenza outbreak.

Broadband can be used to improve emergency medical response, too. By accessing real-time video while patients are en route, emergency room doctors can ensure that appropriate treatment is ready when patients arrive. Such in-field assessment (enabled by wireless connectivity supported through a robust fiber optic backbone network) expedites treatment and gives doctors more time to consider an appropriate response for critically ill patients. If necessary, staff can consult by teleconference with multiple doctors before patients arrive to better inform the diagnosis. In field-diagnosis also allows emergency room doctors to identify (and re-route) non-emergencies before patients arrive at the hospital. This helps avoid unnecessary and costly emergency room visits, ensuring that medical staff is available to assist with true emergencies. Broadband also improves diagnoses en route by providing electronic access to patient information. This could allow staff to process vital information regarding the patient's condition to expedite treatment upon arrival. Moreover, by alerting emergency medical technicians of drug reactions, allergies, and medical history, the EMTs can improve patient care and safety. Finally, traffic management can improve travel time, speeding access to appropriate medical care. (See Section 5.2.2 for further discussion of traffic management.) Tucson, Arizona is already realizing many of these medical benefits in the nation's first video-based Emergency Medical Services telemedicine system.[250]

Broadband access also improves the performance and efficiency of municipal employees, while reducing overall staffing needs, by allowing a virtual presence. Surveillance cameras allow remote monitoring of wildlife, high-fire areas, and high-crime areas. (See Section 5.5 for additional discussion of broadband's application to surveillance.) Similarly, automated utility meter readings and real-time management of networked parking meters can reduce staffing requirements while increasing revenue. Broadband access improves emergency response and allows employees to spend more time in the community by enabling them to access information and file paperwork from the field. This also facilitates simultaneous filing for multiple departments, such as building

[250] See "Success Story: Saving Lives with Video EMS and Eliminating High Cost of Leased Lines in Tucson, AZ," Tropos Networks. http://www.tropos.com/pdf/success_stories/tropos_success_story_tucson.pdf.

inspections and building permits. Broadband also allows the City to track its vehicles and staff, reducing response time when problems occur and improving safety for City staff. For instance, GPS can improve safety by tracking a firefighter's location within a building during an emergency. Mobile voice-over-IP phones can further reduce costs.

Broadband can be used to reduce congestion and manage traffic. Traffic management allows a city to synchronize lights to improve traffic flow. The same networks can support videos to detect traffic violations, without employing additional staff. Network connectivity to electronic highway signs allows a city to provide real-time messages about detours, closures, and traffic conditions. (See Section 5.2.2 for further discussion of traffic management.)

5.6.1 Seattle Application

As discussed above, many City managers expressed an interest in making work-from-home programs available for some of their employees. A ubiquitous fiber-optic network throughout Seattle would enable more employees to avoid traffic delays and reduce their CO_2 emissions by working from home. One City manager even went so far as to say the availability of broadband fiber throughout the City might be viewed as a recruiting tool to attract technology professionals looking to move to the Seattle area.

If a Citywide medical emergency were to be declared due to an outbreak of influenza, significant numbers of City workers would be able to support continuity of government programs from their homes. In another scenario, emergency dispatchers would be able to continue their duties from an alternate location or locations if downtown Seattle were to be devastated by collapsed buildings after an earthquake.

Significant numbers of City employees rely on wireless services to provide them access to data resources needed throughout the business day. Expansion of these wireless services would require backhauling of all these vast amounts of data from user terminals such as BlackBerrys, PDAs, and video cameras to central servers. A City-owned fiber-optic network would provide such backhaul service at affordable costs.

The City would also be able to expand its Park-and-Pay program of centralized parking meters in downtown by increasing the availability of fiber-optic connections near public parking lots. Citations for parking and other violations (e-tickets) could be uploaded from public offices throughout the city, rather than requiring all officers to return daily to a central point, as is currently required.

5.7 Workforce Preparedness and Education

Broadband offers a variety of educational applications for students and professionals alike. With "the most wired" schools in the nation,[251] Seattle is already taking advantage

[251] Christopher Dawson, "Seattle Schools to Build Wide-Are Fiber Net," ZDNet Education, Mar 15, 2007. http://education.zdnet.com/?p=922.

of many of these opportunities; however, FTTP will strengthen and deepen these applications by allowing children to continue to learn outside the classroom.

The nation's schools suffer from inadequate Internet access and IT training. Many schools continue to use dial-up Internet access. For most, access is too slow, with insufficient bandwidth to allow creative and expansive online learning, such as video conferencing or collaborative work. Such schools are restricting classroom use of IT applications, such as streaming video, to preserve bandwidth. As the Benton Foundation explains:

> Distance learning over broadband is a distant dream. Online curricula is offline. Teachers are insufficiently trained to use technology in their classrooms, so that whatever technology is available to them languishes. Students are taught the basic 3 Rs, as required by the No Child Left Behind Act, but not the digital skills that will enable them to translate those 3 Rs into success in today's Information Age.[252]

"The content-rich world in which we live requires bandwidth to view it."[253] Yet, according to the 2008 America's Digital Schools report, 37 percent of school districts anticipate a problem obtaining sufficient bandwidth and the majority have implemented policies to conserve bandwidth by limiting student Internet use.[254] Despite these problems, Internet proficiency is assumed at the college level, leaving many children at an educational disadvantage.

The potential applications for broadband are varied. Interactive whiteboards are growing in popularity. By connecting these interactive displays to a computer and projector, teachers can operate software loaded on the computer, including Internet browsers. Users can also digitally capture notes written on the whiteboard, control the computer through the whiteboard, translate cursive writing to text, and, in some systems, connect to an audience response system, whereby students can remotely respond to questions and generate a graphic depiction of responses on the whiteboard. The interactive whiteboard industry is growing rapidly, with global sales expected to reach $1 billion last year.[255] A survey of British schools found that 98 percent of secondary and 100 percent of primary schools had interactive whiteboards by 2007.[256] These devices are now viewed as

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[252] Rintels. 20.
[253] Edwin Wargo, "2008 Digital Schools Report and Bandwidth," The Brute Thing, May 16, 2008. http://edtecheconomics.blogspot.com/2008/05/ed-tech-trends-report.html.
[254] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," eSchoolNews, May 15, 2008. http://www.eschoolnews.com/news/top-news/index.cfm?i=53795&page=1. (Summarizing Thomas W. Greaves and Jeanne Hayes, "America's Digital Schools Report 2008: The Six Trends to Watch.")
[255] Wikipedia, Interactive Whiteboard. http://en.wikipedia.org/wiki/Interactive_whiteboard. Date of Access: April 8, 2009.
[256] Becta, "Harnessing Technology Schools Survey 2007: Analysis and Findings," July 2008. http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/ht_schools_survey07_key_findings.pdf.

"standard equipment" in schools and are likely to be in "nearly every" U.S. school by 2013.[257]

American schools are also increasingly embracing one-to-one computer programs (also known as "ubiquitous computing"), whereby each student and teacher has one Internet-connected wireless computing device for use both in the classroom and at home. A 2006 survey found that 31 percent of superintendents are implementing ubiquitous computing in at least one grade, up from an historical average of 4 percent. Moreover, over 75 percent of superintendents recognized the potential benefits of one-to-one computing, agreeing with the statement that "ubiquitous technology can reduce the time, distance, and cost of delivering information directly to students and that teachers can spend substantially more one-on-one time with each student and personalize the education experience to each student's needs."[258]

By 2007, 78.7 percent of U.S. school districts reported moderate to significant improvement in one-to-one computing programs,[259] with potentially significant benefits for student learning. A 2006 report by America's Digital Schools found that one-to-one computing programs correlated with increased student retention and attendance, improved writing skills, and reduced disciplinary problems.[260] As Michael Davino, Superintendent of Schools in Springfield, New Jersey explains, "[a] wireless laptop program provides up-to-date information, access to virtual experiences, instant feedback, individualized attention for all learning styles, student independence, and constant practice. And it's highly adaptable to individual, small group, or whole class instruction."[261]

Many schools are using the Internet to expand course offerings. For instance, in Greenville, South Carolina, students are enrolling in an online Latin course taught by a teacher at another district school. Elsewhere, students can use the Internet to take higher level or better-quality courses than those available at their home schools.[262] The Greaves Group has found that many schools are even offering core courses over the Internet, with vocational technology (91 percent) leading, followed by science (78 percent) and social studies (76 percent). Online learning is often used for advanced-placement courses, including art and music (38 percent), math (35 percent), and science (31 percent), which may not have sufficient student enrollment to support a live course.[263]

The Internet helps break down the walls of the classroom, allowing students to participate in virtual fieldtrips and better visualize their lessons. Students are going online and "touring the Smithsonian National Air and Space Museum, experiencing a tribal dance in

[257] Meris Stansbury, "Researchers Identify Key Ed-Tech Trends," eSchool News, Mar 30, 2009 http://www.eschoolnews.com/news/top-news/index.cfm?print&i=53795&page=1.
[258] "America's Digital Schools 2006: A Five-Year Forecast, 2006," The Greaves Group and The Hayes Connection. 15, 18. http://www.ads2006.net/ads2006/pdf/ADS2006KF.pdf.
[259] Stansbury.
[260] "America's Digital Schools 2006: A Five-Year Forecast, 2006." 15.
[261] "America's Digital Schools 2006: A Five-Year Forecast, 2006." 18.
[262] Rintels. 21.
[263] "America's Digital Schools 2006: A Five-Year Forecast, 2006." 19.

Africa, or scouring the depths of the Pacific Ocean in a submarine." Users are exploring the digital archives at the Library of Congress and collaborating with students, professors and government officials in other states and around the world.[264]

Outside school, online learning allows workers to "overcome the barriers of time and distance" by providing access to continuing education and professional training at the convenience of the individual users.[265] E-learning has also helped corporations reduce costs for employee training by avoiding direct travel expenses and lost productivity during travel.

Research by the International Society for Technology in Education (ISTE) and the Consortium for School Networking confirms that these applications have meaningful results. In particular, technology has:

- Led to measurable improvements in school performance (as measured on the Adequate Yearly Progress Tests under the No Child Left Behind Act of 2001).
- Improved attendance, decreased dropout rates, increased graduation rates, and allowed increased parental involvement.
- Improved school efficiency and productivity.
- Helped teachers satisfy professional requirements by helping develop lesson plans and providing continuing education opportunities.
- Enhanced students' problem-solving and independent-thinking skills.
- Enabled schools to meet the needs of special education children.
- Increased equity and access in education by creating learning opportunities for geographically isolated students.
- Improved workforce skills.[266]

Case studies bear out these benefits. For instance, elementary school students in the "Enhancing Missouri's Instructional Networked Teaching Strategies" (eMINTS) program consistently scored higher on standardized achievement tests than students who did not have access to the same technology. Participants' classrooms are equipped with a teacher's desktop computer and laptop computer, a scanner, a color printer, a digital camera, an interactive white board, a digital projector, and one computer for every two students. In New York, middle and high school students enrolled in the "Points of View media project" used Webcams to access museums and historical collections, streaming video and video conferencing, and primary documents to explore the Theodore Roosevelt era. Seventy-five percent of program participants reported that they learned more than they would have from a traditional class.[267]

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[264] Rintels. 21.
[265] Rintels. 21.
[266] "Why Technology in Schools?" Ed Tech Action Network. www.edtechactionnetwork.org/technology_schools.html.
[267] "Ed Tech and Student Achievement," Ed Tech Action Network. http://www.edtechactionnetwork.org/student_achieve.html.

Notably, Seattle students are already experiencing these benefits. In fact, the Seattle school system has an enhanced fiber network interconnect that covers about 200 miles, serving 10 high schools with gigabit Ethernet connections; nine middle schools with 300 Mbps; and, eventually, 70 elementary schools with 100 Mbps each.[268] In time, this infrastructure will provide high-speed access (in excess of 100 Mbps) to Seattle's 47,000 elementary, middle, and high school students.[269] Nonetheless, home connectivity remains "the major unresolved issue for technology directors."[270] As one-to-one computing allows students to take computers out of the classroom, FTTP will provide the technological resources to help them extend the school day and continue their lessons. In this way, Seattle's schools will benefit from FTTP.

5.8 "In-Sourcing" of Tele-Jobs

Millions of American jobs have been outsourced—or "offshored"—to companies abroad. By some estimates, half of the Fortune 500 companies have exported jobs overseas with projections that an additional three million jobs will be sent overseas by 2015.[271] Offshoring provides access to low-cost labor, the ability to continue operations 24 hours a day, and an entry into the global marketplace. At the same time, offshoring limits quality control and may compromise customer relations. This, in turn, has led some to explore ways to retain business in the United States. One mechanism is through the creation of virtual domestic call centers, a practice called "homeshoring." Broadband is a necessary prerequisite for successful homeshoring.[272]

Homeshoring offers a range of benefits. Significantly, homeshoring creates opportunities for individuals who would otherwise be excluded from the workforce, because the elderly, disabled, and parents of young children can work as agents from a home office. As a consequence, homeshore agents are often a "higher caliber" than those attracted to a "traditional call center environment." For instance, one provider reports that the average age of its agents is 38 and that 80 percent have received some college education.[273]

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[268] Christopher Dawson, "Seattle Schools to Build Wide-Are Fiber Net," ZDNet Education, Mar 15, 2007. http://education.zdnet.com/?p=922.

[269] David Kopf, "Seattle Public School System Flexing Fiber Muscle," T.H.E. Journal, Mar 15, 2007. http://www.thejournal.com/articles/20385/.

[270] "America's Digital Schools 2006: A Five-Year Forecast, 2006."19.

[271] Fuhr and Pociask. 21.

[272] *See "*Sabio Highlights Five Key Factors for Successful Homeshoring," ContactCenterWorld.com, Nov 20, 2008. http://www.contactcenterworld.com/view/contact-center-news/Sabio-Highlights-Five-Key-Factors-For-Successful-Homeshoring.asp. (Additional requirements include appropriate technology (i.e., separate broadband and phone connections and a computer that can run an organization's existing contact center); a culture that supports homeshoring; security; and appropriate office space and a system for monitoring). *See also* Lori Bocklund, "VoIP Breaks Down the Walls of the Call Center," Network World, May 10, 2004. http://www.networkworld.com/research/2004/0510contact.html.

[273] Martha Frase-Blunt, "Call Centers Come Home," HR Magazine, Jan 2007. 85. http://www.ucn.net/portals/0/ArticlesWhitepapers/WP_Telework_Call_Centers_Come_Home_1-07_HR%20Magazine.pdf. (Reporting data for Alpine Access, a Denver-based provider of call center services.)

Companies also benefit from reduced costs, because they do not need to provide security, heat, electricity, or office space.[274] These savings are significant. In fact, the American Consumer Institute estimates that home-based agents reduce call-center employee costs by more than one-third.[275] Office Depot projects that its domestic call center will result in a $15 million annual savings.[276] Homeshoring even offers savings over offshoring. Indeed, the Telework Coalition asserts that homeshoring can reduce property and IT costs by as much as 80 percent over offshoring.[277] Research also suggests that homeshoring improves employee satisfaction, dramatically improving retention and increasing productivity by 10 percent to 20 percent.[278]

Many domestic companies are beginning to recognize these benefits. As a consequence, homeshoring agents are reporting record growth.[279] In 2008, IT industry analyst IDC documented more than 112,000 homeshored workers in the United States, with numbers expected to nearly triple to 330,000 by 2010.[280]

JetBlue Airways is one of the best known, and perhaps most successful, homeshoring case studies. The New York-based airline has relied exclusively on home-based agents in its virtual reservation center in Salt Lake City, Utah, since the company was launched in 2000. The company employs 1,500 home-based agents, the majority (70 percent) of who are part-time, stay-at-home moms. Although all "crew members" work from a home office in the Salt Lake City area, they are required to report monthly to a brick-and-mortar reservation center to meet with team supervisors and bimonthly for ongoing training. Unlike many homeshoring models, JetBlue offers its staff medical coverage and profit sharing as well as flight benefits. The flexibility afforded by the company's home-based operation allows it to benefit from a demographic that would otherwise be unable

[274] Tracey E. Schelmetic, "A Victory For The Home Agent Business Model," TMC News, Jan 20, 2006. http://www.tmcnet.com/news/2006/01/20/1302729.htm. *See also* Theresa Sweeney, "Remote Call Centers," All Business, June 1, 2006. http://www.allbusiness.com/technology/telecommunications-phone-systems-voip/4092765-1.html.
[275] Fuhr and Pociask. 22.
[276] Adam Geller, "'Homeshoring' means that call center might be in someone's bedroom," The Seattle-Post Intelligencer, May 9, 2005. http://www.seattlepi.com/business/223367_homecall09.html.
[277] Frase-Blunt. 84.
[278] "Sabio Highlights Five Key Factors for Successful Homeshoring," ContactCenterWorld.com, Nov 20, 2008. http://www.contactcenterworld.com/view/contact-center-news/Sabio-Highlights-Five-Key-Factors-For-Successful-Homeshoring.asp). *See also* Fuhr and Pociask. 22. (Reporting employee retention of 85 percent, compared to 10 to 20 percent at a traditional call center.)
[279] *See* Information Technology Association of America (ITAA), "The Impact of Offshore IT Software and Services Outsourcing on the U.S. Economy and the IT Industry." http://www.itaa.org/news/pubs/product.cfm?EventID=1037. *See also* Tracey E. Schelmetic, "A Victory For The Home Agent Business Model," TMC News, Jan 20, 2006. http://www.tmcnet.com/news/2006/01/20/1302729.htm. (Reporting record growth in 2005, with virtual call centers in 37 states).
[280] "U.S. Home-Based Agent 2008-2012 Forecast: Homeshoring in an Underwater World," (IDC #214736). *See also* Peter Davy, "The Home Connection," Charity Times, June 2008. http://www.charitytimes.com/pages/ct_features/june08/articles/ct_june08_feature1_the_home_connection.htm.

to enter the workforce, lowering costs and turnover and improving employee satisfaction.[281]

Other companies offer variations on the JetBlue model. For instance, many home-based models forego face-to-face interactions, allowing employees to complete training online, either through independent programs or real-time interactions with another virtual agent. While some companies follow JetBlue's approach of employing specialized agents to work for dedicated clients, others allow agents to complete training for dozens of different clients simultaneously. Many offer a range of employee benefits, including supplemental health benefits and paid training, although others cut costs further by treating agents as contractors, thus saving on healthcare.[282]

These benefits can easily be enabled through FTTP. Agents must have a quiet room in which to conduct business, a separate phone line, and a personal computer (which may or may not be provided by the employer). The "host" corporation can use its existing Voice over Internet Protocol (VoIP) technology to monitor performance. Agents can interact with one another in online chat rooms set up by the parent corporation, creating a "virtual water cooler."

Companies exploring homeshoring are not limited to urban areas, either. Broadband availability has led some companies to explore rural sourcing as an alternative to offshoring. This practice offers some economic advantage over locating in a metropolitan center, while offering greater security, client access, and customer relations as compared to offshoring alternatives.[283] Pleasant Prairie, Wisconsin, for example, attracted several large organizations to its business park, primarily due to the availability of open-access fiber and the ability to choose from a variety of retail provider services.

5.8.1 Seattle Application

Like many cities, Seattle could conceivably entice a company to establish a virtual call center if it had FTTP and the right mix of other attributes (e.g., attractive tax rates, workforce availability, suitable office space for training or meeting centers). With its highly educated population, though, Seattle may have an advantage over some other urban areas; Seattle residents are almost twice as likely to have earned a bachelor's degree or higher than the U.S. population as a whole.[284] The city's location in the Pacific time zone could also be a benefit. Call center employees working a standard day, for example, could provide coverage of "evening hours" for customers phoning from the East Coast and parts of the Midwest, as well as regular business hours for West Coast callers.

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[281] Frase-Blunt. 84-89. *See also* Davy. For more on Jet Blue's experience, listen to NPR story. http://www.npr.org/templates/story/story.php?storyId=5187431.
[282] Frase-Blunt. 84. (Describing each of these models).
[283] Indrajit Basu, "Broadband Growth Helps Rural Areas Compete With Offshore Outsourcers," Digital Communities, Mar 10, 2008. http://www.govtech.com/dc/articles/271854?id=271854&full=1&story_pg=2.
[284] U.S. Census Bureau, 2005-2007 American Community Survey 3-Year Estimates, http://www.census.gov/.

5.9 Immediate Employment Stimulus and Multiplier

Perhaps one of the greatest immediate benefits of broadband is its potential to stimulate economic growth. The U.S. Department of Commerce has found that "communities in which mass-market broadband was available … experience more rapid growth in employment, the number of businesses overall, and businesses in IT-intensive sectors, relative to comparable communities without broadband at that time."[285] The Department of Commerce also found a statistically significant impact on property values. While projections of the precise economic effects vary, studies consistently find that "at the individual, local/ community, and national levels, the deployment of fast, reliable, and affordable broadband will stimulate tremendous economic development and creates hundreds of thousands—if not millions—of good-paying jobs that might otherwise be lost or go offshore."[286] Notably, direct jobs related to the "building and manufacture of broadband networks" pay 42 percent more than the average for manufacturing jobs in other sectors,[287] and IT jobs, on average, pay 85 percent more than other private sector jobs.[288]

Studies identify three categories of job growth from broadband. The first is attributed to the "direct labor" associated with construction and deployment of the network. This includes the technicians and construction workers who lay the broadband pipes and asphalt.[289] The second is comprised of the direct labor associated with manufacturing the infrastructure components and equipment that take the fiber to the premises. The third category of jobs is derived from indirect labor associated with the services and applications that will emerge once the network is deployed. These include various applications that rely on high bandwidth, such as interactive media, games and entertainment, surveillance, multi-videoconferencing, and switched digital video broadcasting.[290] Some studies also include a fourth category of indirect "induced jobs" in restaurants or retail, which are supported by the economic growth associated with broadband.[291]

Broadband has also been found to increase property values. In fact, the U.S. Department of Commerce found that rental rates were 7 percent higher in communities with broadband.[292]

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[285] Sharon Gillett *et al.*, "Measuring Broadband's Economic Impact," U.S. Department of Commerce, Feb 28, 2006. 3, 10. http://www.eda.gov/PDF/MITCMUBBImpactReport.pdf.
[286] Rintels. 13.
[287] Robert D. Atkinson, Daniel Castro and Stephen J. Ezell, "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America," ITIF Study, Jan 7, 2009. http://www.itif.org/files/roadtorecovery.pdf.
[288] Stephen Pociask, "Building a Nationwide Broadband Network: Speeding Job Growth," TeleNomic Research, LLC, Feb 2002. 3. www.newmillenniumresearch.org/event-02-25-2002/jobspaper.pdf. *See also* "Digital Economy 2000," U.S. Department of Commerce, June 2000. http://www.esa.doc.gov/Reports/DIGITAL.pdf.
[289] Atkinson, Castro, and Ezell. 2.
[290] Pociask. 4, 6-7. (Projecting 4.1 indirect jobs would be created for every direct job created by broadband investment).
[291] Atkinson, Castra, and Ezell. 2.
[292] Sharon Gillett *et al.,* "Measuring Broadband's Economic Impact," U.S. Department of Commerce, Feb 28, 2006.22. http://www.eda.gov/PDF/MITCMUBBImpactReport.pdf.

The cumulative effect of these direct and indirect jobs is quite large. In fact, a 2002 study by TeleNomic Research for the New Millennium Research Council found that a national broadband network would lead to the creation of 1.2 million permanent jobs, specifically:

- 166,000 jobs in the telecommunications sector.
- 71,700 manufacturing jobs generated by the direct purchase of network plant and equipment and customer premises equipment.
- 974,000 indirect jobs created if a next-generation network were built.[293]

While broadband access will undoubtedly create jobs, precise estimates vary. The Department of Commerce has found that communities with broadband added 1 percent to 1.4 percent to their employment growth rate, 0.5 percent to 1.2 percent to the growth of business establishments, and 0.3 percent to 0.6 percent to the share of IT establishments.[294] Others, such as the Information Technology and Innovation Foundation, project as much as twice this level of growth because of broadband's "multiplier" or "network" effect.[295]

The Brookings Institution has measured the marginal value of increased broadband access, concluding that every 1 percent increase in broadband penetration leads to a 0.2 percent to 0.3 percent increase in annual employment growth.[296] A study by the Sacramento Regional Research Institute found more modest job growth, with each 1 percent increase in broadband use triggering 0.075 percent growth in employment and 0.088 percent increase in payroll. Even this modest projection translates to significant gains. The study concluded that a 3.8 percent increase in broadband use over the next decade would result in a cumulative 10-year gain of 1.8 million jobs and $132 billion in payroll.[297] The Communications Workers of America embrace a simpler model, projecting that each $1 million invested in broadband creates 20 jobs.[298]

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[293] Pociask.

[294] William Lehr, Carlos A. Osorio, Sharon E. Gillett, and Marvin Sirbu, "Measuring Broadband's Economic Impact," U.S. Department of Commerce, Economic Development Administration, Feb 2006. 4. http://www.eda.gov/ImageCache/EDAPublic/documents/pdfdocs2006/mitcmubbimpactreport_2epdf/v1/mitcmubbi mpactreport.pdf. (These numbers represent the average of the RIMS II Model multipliers for Construction and Broadcasting and Communications Equipment).

[295] Atkinson, Castro, and Ezell. 6.

[296] Robert Crandall, William Lehr, and Robert Litan, "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data," The Brookings Institution, Issues in Economic Policy, July 2007. 2. www.brookings.edu/views/papers/crandall/200706litan.pdf.

[297] "Economic Effects of Increased Broadband Use in California," Sacramento Regional Research Institution, Nov 2007. http://www.srri.net/AboutUs/EconEffectsBB_Research.pdf.

[298] Eric Auchard, "The Case for a Broadband Bailout," Reuters (Opinion), Feb 13, 2009. http://www.reuters.com/article/reutersComService4/idUSTRE51C2W920090213.

5.9.1 Seattle Application

Adopting the Communications Workers of America model,[299] a $500 million broadband investment in Seattle will lead to 10,000 jobs (20 jobs per $1 million of investment). There are three issues with this estimate. First, not all jobs would be created in Seattle or even in the United States. Second, there is no consideration of how long the job lasts. If a person gains one day of work with FTTP, that is considered one job. Third, this estimate appears quite optimistic when compared to other writings and estimates.

Another approach is to look at the jobs created in Seattle by the network implementation and then for ongoing operations. The estimate of jobs created during implementation is shown in Table 12. CTC estimates that at least 79 skilled tradespersons would be involved in the construction. This estimate does not include the installation of customer premises equipment.

Table 12: Estimate of Job Creation During Network Implementation

AERIAL CONSTRUCTION		
DESCRIPTION	CREW SIZE	COMPLETION TIME (days)
Project Management	1	2,702
Strand Map	2	141
Design	3	38
Pole Application/ make ready	6	188
Strand Placement	5	376
Cable Placement	5	376
FDC Placement	2	117
Fiber Splicing	4	733
Fiber Testing	8	733
TOTALS	36	2,702

UNDERGROUND CONSTRUCTION		
DESCRIPTION	CREW SIZE	COMPLETION TIME (days)
Project Management	1	4,270
Strand Map	2	53
Design	3	15
Permitting	1	211
Conduit Placement	8	2,105
Inner Duct Placement	5	421
Fiber Placement	5	211
FDC Placement	2	174
Vault Placement	4	532
Fiber Splicing	4	274
Fiber Testing	8	274
TOTALS	43	4,270

[299] Angela Galloway, "Blog: Seattle Getting Citywide Broadband?" Seattle Post-Intelligencer, Mar. 19, 2009 http://blog.seattlepi.com/seattlepolitics/archives/134669.asp

The estimated staffing requirement to support an FTTP retail network is shown in Table 13. As indicated, CTC estimates that operating a retail-based network would create more than 370 jobs. Some of the job functions listed, such as help desk support, may not necessarily be Seattle-based. Further, this estimate does not consider the potential of reduced staff levels of competing systems.

Table 13: FTTP Estimate of Retail Access Operating Staff

Service Position Total	Year 1	Year 2	Year 3+
Business Manager	1	1	1
Market & Sales Manager	1	1	1
Broadband Service Manager & Administrators	1	3	3
Headend Technician	1	2	2
Telephone Technician	1	2	2
Internet Technician	2	4	4
Customer Service Representative/Help Desk	54	105	183
Service Technicians/Installers	36	70	122
Sales and Marketing Representative	9	18	31
Contract Administrator	1	2	2
Fiber Plant O&M Technicians	21	21	21
TBD	0	0	0
Total Existing Staff	0	0	0
Total	128	229	372

The estimated staffing requirement to support an FTTP open access network is substantially lower. This estimate is shown in Table 14.

Table 14: Estimate of FTTP Open Access Operating Staff

Service Position Total	Year 1	Year 2	Year 3+
Business Manager	1	1	1
Market & Sales Manager	0	0	0
Broadband Service Manager & Administrators	1	1	1
Headend Technician	1	1	1
Telephone Technician	0	0	0
Internet Technician	1	1	1
Customer Service Representative/Help Desk	1	2	4
Service Technicians/Installers	2	4	6
Sales and Marketing Representative	1	1	1
Contract Administrator	1	2	2
Fiber Plant O&M Technicians	14	14	14
TBD	0	0	0
Total Existing Staff	0	0	0
Total	23	27	31

The above estimates do not consider the jobs created in other industries due to having advanced connectivity available. According to a Department of Commerce study, communities with broadband added one percentage point to their employment growth rates, 0.5 percent to the growth of business establishments, and 0.5 percent to the share of information technology establishments. Further, the Brookings Institution[300] has measured the marginal value of increased broadband access, concluding that every 1 percent increase in broadband penetration leads to a 0.2 percent to 0.3 percent increase in annual employment growth.

[300] www.brookings.edu/views/papers/crandall/200706litan.pdf

5.10 Enhanced Competition

The ability of FTTP to provide enhanced competition is not inherent with the technology, but in the business model pursued and its success at leveling market share across multiple retail service providers. Today two basic business models are:

1. **Retail Overbuild:** In this structure, the new entrant (typically a city or municipal electric utility) builds, owns, operates, and offers exclusive services over the FTTP network. The new entrant becomes a competitive provider of voice, video, and data services. This is the model used most frequently by municipalities in rural and suburban parts of the U.S. A variation of this structure is to segment key users or user groups for a retail offering.

2. **Open Access or Wholesale:** In this structure, the new entrant builds the FTTP network and wholly controls that asset. Private sector service providers are selected to offer data, voice, and video services over the network. In this model, the new entrant's role is limited to building and maintaining the FTTP network. The open access structure (also referred to as the "wholesale" structure) separates the infrastructure from the retail service. In this structure, the new entrant is in the business of infrastructure, not communications service provision. In the open access structure, the new entrant's customer is not the retail consumer, but rather the service providers. A common variation of this model is to construct FTTP to selected business parks or users and lease capacity or fiber strands to providers or large consumers. Another variation of this structure is to encourage a private sector provider to become an infrastructure provider by allowing access to key city assets or assisting in the network financing.

Each of these models is discussed below with respect to its capability to meet consumers' demonstrated need for provider choice and reasonable costs.

5.10.1 Retail Overbuild Model

In a mature market like Seattle, a retail FTTP overbuilder has the advantage of offering better communications services and products, but obtaining sufficient market share while holding down subscriber costs might be an insurmountable task. In addition, the retail overbuild model does not fully address consumers' desire to choose from a variety of providers, rather than just a select few.

If a new entrant pursued a retail overbuild model, it would become the third infrastructure provider and another choice for consumers.[301] The key concerns with the retail overbuild model include: 1) whether the retail overbuild structure will offer sufficient consumer

[301] In a given neighborhood the majority of Seattle voice, video, and data consumers are served by two existing infrastructure-based service providers; The telephone company (Qwest) and the cable television company (Comcast or Broadstripe). In addition, Clearwire offers wireless based data services in Seattle. Each of these providers maintains and operates independent networks. There is limited competition because residential and small businesses must select services among these existing providers. For large businesses, more competition is offered by non-facilities based competitors and private networks, but is still limited.

choice to create a competitive market structure; and 2) whether the retail overbuild structure can lower or control rising subscriber costs.

5.10.1.1 Provider Choice—Competitive Markets

The most commonly used measure of market concentration or market competition is the Herfindahl-Hirschman Index (HHI), which is used by the U.S. Department of Justice (DOJ) when reviewing potential mergers.[302] The HHI sums the squares of market share percentage for all companies, and uses an index to define the level of market concentration. Any industry with an HHI greater than 1,800 is considered to be "heavily concentrated" or to have "limited competition."

CTC conducted an HHI calculation for Seattle residential Internet. Given that Qwest and Comcast have a combined 84 percent market share, the HHI is quite high (4,089). If a new provider were to take a 50 percent share from Qwest and 50 percent share from Comcast (for a 42 percent market share), the HHI would drop dramatically to 2,975. But an HHI of 2,975 is still considered "heavily concentrated" or one with limited competition under the DOJ definition.

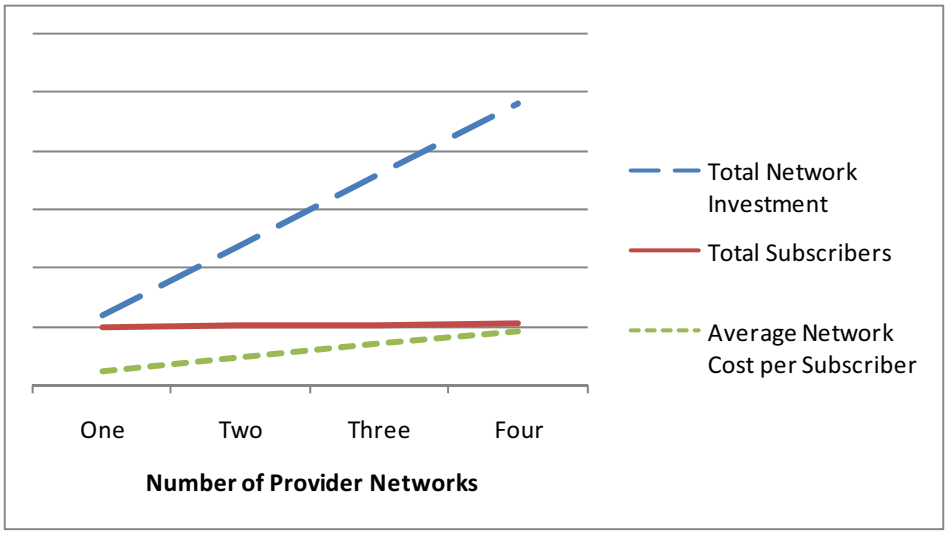
Provider choice also includes consumer ability to have more reliable access to the growing number of Internet-based video and telephone products. If a retail FTTP provider offers an unfettered 100 Mbps Internet connection, consumers have virtually unlimited voice and data options. For a municipal retail overbuild, consumer education and encouragement of use of Internet-based alternative voice and video products would help address consumer choice.

[302] http://www.usdoj.gov/atr/public/testimony/hhi.htm, accessed February 9, 2009.

5.10.1.2 Cost Control

Now consider the ability to lower costs, or at least slow down subscriber fee increases. In the overbuild structure, each provider invests in its own network to serve its own subscribers. In theory, each additional network built increases total network costs proportionally, but the total number of subscribers does not increase. As a result, the average network cost per subscriber increases as competing networks are added (Figure 2).

Figure 2: Average Network Cost per Subscriber



To cover financing and operating expenses, the FTTP retail overbuild structure requires the new provider to capture a large percentage of potential subscribers or charge a premium for enhanced services enabled by FTTP network capabilities. This is not a model that lends itself well to reduced costs.

To mitigate the increased cost per subscriber, Verizon, for example, deploys its FTTP (called FiOS) only in neighborhoods where residents are likely to subscribe to multiple high-end services. This strategy holds down the required total network investment and maximizes revenue per subscriber. In high-end neighborhoods, then, residents receive the benefits of enhanced data services, but lower-income neighborhoods do not have access to the new capabilities. For a private sector investor, this "cherry-picking" is justified by the primary objective of maximizing profits. However, this strategy creates difficulties for municipal overbuilds because their objective is to maximize user access and participation, not profits.

5.10.2 Open Access or Wholesale Model

The open access or wholesale network structure addresses consumer choice of providers. In this structure, the FTTP network is made available to any qualified service provider. Competition increases in theory because the cost of market entry for new providers is greatly reduced or eliminated. In addition, the subscriber cost issue is partially addressed because greater competition among retail providers will provide incentive for reduced

costs and improved services. In the retail model HHI calculation above, if the market share captured from Comcast and Qwest (50 percent) is spread across 10 other providers, the HHI drops to 1,343, which is considered moderately concentrated. If the FTTP network were to capture 75 percent of Comcast's and 75 percent of Qwest's market share, then spread that equally across 10 retail providers, the HHI drops to 838. Increased completion often results in lower consumer prices. Just a decrease of $10 per month per household would result in an overall annual savings of $33.07 million.

This structure, however, does not directly address the increased network cost per subscriber—unless the existing facilities-based providers decide to adopt the proposed FTTP network. As discussed above, the new entrant bears all of the costs of new construction, but the number of potential subscribers remains roughly equivalent to before the network was built. This means that each network owner receives a smaller piece of the same pie. Ideally, the aggregate size of the market will increase as new applications are enabled by the big pipe of FTTP. In that case, however, some revenues will go to online service providers—further limiting the amount of revenue available to network owners.

One potentially innovative way to address these high costs per subscriber is to allow residents and businesses to finance the costs of their own fiber connection (from the home to a point on the backbone network), thereby holding down the new entrant's deployment costs and potentially increasing return on investment. In one variation on this model, the new entrant would build the network to neighborhoods in which some significant percentage of residents or businesses agree to pay a one-time equity participation fee for their fiber connection. In another variation on this model, the consumers would own their fiber connection as personal property attached to their home or business premises.[303] One potential problem with this model is that some neighborhoods, potentially those that are lower income, will not have a sufficient number of consumers willing or able to pay the upfront fee for a fiber connection. As a result, alternative funding for some neighborhoods would be required.

[303] Derek Slater and Tim Wu, "Homes With Tails: What if You Could Own Your Own Internet Connection," New America Foundation, November 2008, http://www.newamerica.net/publications/policy/homes_tails, accessed February 9, 2009.

6. Case Studies

The experiences of the many cities and electric utilities that have developed and launched fiber-to-the-premises (FTTP) networks nationwide over the past decade offer an instructive look at the challenges, risks, and opportunities represented by high-speed municipal networks.

And there are many networks to observe. In the U.S., for example, there are more than 70 fiber networks operated by municipal utilities and municipalities (see Table 15). A more detailed table of these networks is included in Appendix D.

Table 15: Municipal Fiber Networks in the U.S.[304]

Provider	State	Municipality
Ashland Fiber Network	OR	Ashland
Auburn Essential Services	IN	Auburn
Barnesville Municipal Utilities	MN	Barnesville
Bellevue Municipal Utilities	IA	Bellevue
Blue Ridge Crossroads Economic Development Authority (Wired Road)	VA	Carroll and Grayson counties and the City of Galax
Bowling Green Municipal Utility	KY	Bowling Green and Warren County
Braintree Electric Light Department	MA	Braintree
Bristol Tennessee Essential Services	TN	Bristol
Bristol Virginia Utilities	VA	Bristol
Burlington Telecom	VT	Burlington
CC Communications	NV	Churchill County
CDE Lightband	TN	Clarksville
Cedar Falls Utilities	IA	Cedar Falls
Chelan County Public Utility District	WA	Chelan County
City of Danville Utilities Department	VA	Danville
City of LaGrange, Georgia	GA	LaGrange
City of Leesburg, Florida	FL	Leesburg
City of Philippi, West Virginia	WV	Philippi
City of Powell, Wyoming	WY	Powell
City of Salisbury, North Carolina	NC	Salisbury
City of Shafter, California	CA	Shafter
City of Wilson, North Carolina	NC	Wilson
Clallam County Public Utilities District	WA	Clallam County
Community Telecom Services	KY	Monticello-Wayne County
Crawfordsville Electric Light & Power	IN	Crawfordsville
Crosslake Telephone	MN	Crosslake
Dalton Utilities	GA	Dalton
Douglas County Public Utilities District	WA	Douglas County
Dover Utilities	OH	Dover
EPB Telecom	TN	Chattanooga
FiberNet Monticello	MN	Monticello
Gainesville Regional Utilities	FL	Gainesville
Glasgow Electric Plant Board	KY	Glasgow
Glenwood Springs Comm. BB Network	CO	Glenwood Springs
Grant County Public Utility District	WA	Grant County
Harlan Municipal Utilities	IA	Harlan
Holland Board of Public Works	MI	Holland
Holyoke Gas & Electric Department	MA	Holyoke
Hometown Utilicom	PA	Kutztown
Idaho Falls Power	ID	Idaho Falls
Jackson Energy Authority	TN	Jackson and Madison counties
KPU Telecommunications	AK	Ketchikan
Lafayette Utilities System	LA	Lafayette
LENOWISCO Planning District Commission	VA	Lee, Wise and Scott Counties and the City of Norton
Lenox Municipal Utilities	IA	Lenox
liNKCity	MO	North Kansas City
Loma Linda Connected Communities Program	CA	Loma Linda
Marshall Municipal Utilities	MO	Marshall
Mason County Public Utilities District	WA	Mason County
MINET	OR	Monmouth and Independence
Morristown Utility Systems	TN	Morristown
Murray Electric System	KY	Murray
NetQuincy	FL	Quincy (also serves surrounding areas)
Norwood Light & Cable	MA	Norwood
Okanogan Public Utilities District	WA	Okanogan County
Paducah Power System	KY	Paducah
Pend Oreille Public Utilities District	WA	Pend Oreille County
Pulaski Electric System	TN	Pulaski
Reedsburg Utility Commission	WI	Reedsburg
Rochelle Municipal Utilities	IL	Rochelle
Sallisaw Municipal Authority	OK	Sallisaw
Scottsboro Electric Power Board	AL	Scottsboro, Alabama
Shawano Municipal Utilities	WI	Shawano
Spencer Municipal Utilities	IA	Spencer
Sun Prairie Water & Light Commission	WI	Sun Prairie
Swiftel Communications (Brookings Municipal Utilities)	SD	Brookings
Sylacauga Utilities Board	AL	Sylacauga
Taunton Municipal Lighting Plant	MA	Taunton
Tifton CityNet	GA	Tifton
Tullahoma Utilities Board	TN	Tullahoma
UTOPIA	UT	Consortium of 11 cities
Vernon City Utilities	CA	Vernon, California
Windom Telecommunications	MN	Windom

[304] *BroadbandProperties* magazine, searchable database of independent telcos and municipalities that purport to be deploying fiber to the premises, accessed July 9, 2009. http://www.bbpmag.com/search.php.

These initiatives have been spearheaded by city governments, municipalities, and utility companies, working in conjunction with one another in some cases. The primary objective of these organizations, at a minimum, is to provide a fiber-based infrastructure that will encourage private providers to offer services to residents; in many cases, the municipal entities that build the networks provide voice, video, and data services to the end users, too.

Most of the networks, especially in the United States, have been built in smaller cities and municipalities in rural areas. The reason for this is simple: Traditional service providers have often shied away from expanding their networks into these areas for lack of a business case. The high costs of building a network are often not justified when viewed against the relatively low potential demand. This lack of private participation propelled the municipalities to build their own networks to provide retail and wholesale services.

The case studies below serve to establish an ongoing and successful trend, in the United States and across the world, of governments becoming more active in ensuring that their residents have access to broadband connectivity through a competitive, low-cost, future-proof network. The level of complexity for building an FTTP network in Seattle will be potentially greater than in a smaller city, but the experiences surrounding issues such as open access, managing network project risk, and off-the-balance-sheet benefits are universal. As a counterpoint, CTC has also included an overview of Verizon's FTTP efforts.

6.1 Västerås, Sweden

Västerås, Sweden, is one of the oldest cities in northern Europe. Home to approximately 130,000 residents, it is also a key logistical city in terms of Scandinavian trade, thanks to its central location, its large port on Lake Mälaren, and its access to rail lines and highways.

For almost a decade, Västerås has also been a key test bed for the benefits of an open access fiber-to-the-premises network. In 2000, the City-owned electric utility, Mälarenergi, created a subsidiary, Mälarenergi Stadsnat (or, in English, Malar Energy City Network) to build and operate the network. According to the hardware vendor that supported the project, the network now connects more than 50,000 homes and more than 5,000 businesses.

The benefits of the network have been wide-ranging. One published report pointed to an almost 10 percent growth in the number of businesses in Västerås as the network was built, with nearly 600 new companies being established.

Perhaps the most striking result, though, has been the competition among service providers. The availability of this open access network infrastructure has lowered the barriers to entry for many innovative small companies, and more than 20 service providers offer more than 60 services on the network—all of which are listed on the

network portal page that residents see when they log on to their computers or turn on their IP-enabled TVs.

On the consumer side, this means that residents and business owners have access to a range of services that were not previously available—not just voice, video, and data (the typical "triple play"), but "[l]ow cost services such as remote back-up, remote security and alarm, application renting, and financial services…."[305]

Consumers can choose the services they want directly from the portal page. This self-provisioning extends to automated deployment and billing setup, too. Having easy access to information about competing service providers has proved a crucial element of the network's commercial success; without that information, customers felt "locked in" to whichever provider and services they initially selected.

Another important innovation is the "on network" services, which use data packets that do not traverse the public Internet. Services using local packets are cheap and fast because there is no payment required to an ISP and packet routing is not subject to the slowest point in the public Internet. For these reasons, many new services were created. After the development of the community FTTP intranet it was reported that:

> "More than 80 percent of the traffic on local networks was outbound, pulling in and sending out information over the World Wide Web. After the fiber network came into being? That ratio basically flipped as now more than 80 percent of the bandwidth being consumed is for moving data around within the Västerås network, so neighbors are talking to neighbors rather than users pulling in data from all over the Internet."[306]

Of note, however, is the fact that the Västerås network was not an immediate success. In 2003, the City had less than a 10 percent take rate and was incurring heavy losses. In 2004, the network operator implemented a cooperative model and increased the take rate to 20 percent without adding staff or debt. In 2005, more services were added and bank financing became available. The take rate increased to 30 percent, again with no new debt or staff. The system continues under the cooperative model and currently enjoys a 75 percent take rate in connected areas.

Västerås is, in fact, often referred to as the first municipal fiber network to adopt a cooperative model—an arrangement that requires homeowners to pay for installation of the fiber drop to their homes and to purchase the customer premises equipment (CPE), such as the optical network terminal, or ONT, which acts as the interface between the fiber termination and the computer, television, or other devices connected to the network. Conventional wisdom has it that requiring residents to take a larger financial stake in their network participation led to a more committed user base—and enthusiasm for the benefits of the network, which influenced friends and neighbors to sign up, too.

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[305] "Case Study: Mälarenergi Stadsnät - Västerås, Sweden," PacketFront Inc.
[306] See http://www.saschameinrath.com/blog_tags/vasteras .

6.2 Australia

The government of Australia took a major step in April 2009 when it announced that it would move forward with its long-planned National Broadband Network (NBN), a high-speed network designed to connect 90 percent of the country's homes, schools, and businesses with access at up to 100 Mbps, and the remaining 10 percent with access at up to 12 Mbps.[307]

The government, which pledged AU$43 billion (about US$35 billion),[308] framed the decision to pursue nationwide connectivity this way:

> "Our future prosperity will be bound to the growth of the digital economy. Broadband will be crucial to business productivity, access to services and information, and to the way all Australians live. Broadband underpins the applications that businesses, our education and health institutions and consumers either require now, or will require into the future... The Australian Government will not let Australia be left standing while the rest of the world races ahead."

Australia's proposed broadband network is at once bold and thoroughly planned, focusing on specific measurements of success that encompass the government and private entities, as well as the country's nearly 22 million citizens. For example, as the original request for proposal outlined, the project's objectives include the creation of a network that "continues to promote the long-term interests of end-users."[309]

Indeed, the Australian authorities very clearly address their expected return on investment in terms that are not strictly related to short-term financial gain. While they expect the eight-year network construction project to support 25,000 or more jobs annually, they point out that "This is a major nation-building project… Given the productivity gains associated with this investment, the full benefits will continue to flow for decades beyond the completion of the project."[310]

And the government, in its efforts to education the population about the coming network, enumerates a range of benefits the network will deliver, from economic (including home-based and small businesses) to environmental, health, and education.[311] One of the environmental selling points is this: "A study undertaken in 2007 found that broadband

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[307] "New National Broadband Network," Government of Australia website. http://www.minister.dbcde.gov.au/media/media_releases/2009/022. Date of Access: June 29, 2009.
[308] "National Broadband Network: 21st century broadband," Department of Broadband, Communications and Digital Economy, Government of Australia website. http://www.dbcde.gov.au/communications/national_broadband_network. Date of Access: June 29, 2009.
[309] Request for Proposals to roll-out and operate a National Broadband Network for Australia, Request for Proposals, Number: DCON/08/18, Department of Broadband, Communications and the Digital Economy, April 11, 2008.
[310] "New National Broadband Network"
[311] "21st Century Broadband," brochure, Government of Australia.http://www.dbcde.gov.au/__data/assets/pdf_file/0005/110012/National_Broadband_Network_policy_brochure.pdf.

could help reduce Australia's annual emissions of greenhouse gas by 5 percent and save around $6.6 billion a year in energy and travel costs for both businesses and households."

In the realm of education, the Australian government expects its broadband network to "enable teachers and students of all ages to have better access to online curriculum content, from both their workplaces and homes. It will support the use of interactive content and enhance remote learning opportunities. In turn this will deliver better educational outcomes and better employment opportunities."

And as a benefit to the whole country, the network is expected to deliver "better emergency service and disaster relief systems, which allow people to communicate in critical situations where immediate access to information is vital."

6.3 Palo Alto, California

The City of Palo Alto Utilities (CPAU) has very successfully provided dark fiber connectivity to businesses in Palo Alto since 2000.[312] The fiber connections are owned, operated, and maintained by CPAU; customers provide and maintain equipment to light-up or provision the leased fiber strands.

Fiber planning started in 1996, and resulted in a backbone ring implementation to support dark fiber services. The backbone consists of 33 route miles (over 4,750 fiber-miles), with 144 or more strands of single-mode fiber along most routes. In addition to supporting city and utility needs, the fiber ring serves four wholesale customers (who lease dark fiber, then add electronics and provide a retail service) and 24 business customers. The majority of business parks and commercial properties are served by the fiber optic backbone.

By leveraging the dark fiber, businesses have access to connectivity services within Palo Alto that far out-perform cable modem and DSL services and are considerably more affordable than T3 or other high-end connectivity services.

The fiber ring was financed with an internal loan of $2,000,000 from the Electric Utility for a period of 20 years at a 0 percent interest rate. The financing included the initial build-out and working capital for the first four years of operation.

In 2000, bolstered by the economic success of the City's dark fiber ring, the City Council approved a FTTP trial to determine the feasibility of providing citywide FTTP in Palo Alto. The 48-month trial consisted of offering video and data services to 66 homes. The $600,000 trial, which was funded via electric utility reserves, proved successful from a technical perspective. Rather than the City pursuing an investment in FTTP and becoming a service provider itself, however, the City then initiated efforts to encourage a private provider to build the FTTP facilities.

[312] Unless otherwise noted, all data in this case study are based on CTC's interview with Josh Wallace, Key Account Manager for Commercial Fiber, City of Palo Alto Utilities, Nov. 30, 2006.

In January 2006, the City Council recommended that CPAU staff develop a Request for Proposal to assess whether any private entities would be interested in pursuing or partnering in citywide deployment of FTTP. The primary goals for the system requested in the RFP were:

- Capability of providing to each customer a minimum bandwidth of 100 megabits per second symmetrical service
- Provision of at least data, video, and telephony services
- Eventual city ownership of the physical system

A secondary goal for the system was to promote competition between multiple service providers. In addition, the following features were preferred:

- Open access
- Network neutrality
- Minimal financial risk to the city [313]

Though work continues toward the eventual goal of implementing an FTTP network in Palo Alto, a variety of legal and economic concerns have put the project on hold. Ultimately, the City decided that it was unwilling to increase its investment in its citywide network—for example, by expanding its dark fiber network with a fiber-to-the-neighborhood (FTTN) infrastructure. Such an investment would significantly reduce a private investor's cost to build FTTP; without the City's additional contribution, private investors have so far been unwilling to build the last-mile connections.

The City's reluctance to invest in FTTN or FTTP is based on a myriad of data. According to a City report, for example, the potential penetration rates for TV, video, and Internet services were determined to be the key risk factors on the revenue side; over the course of a 20-year plan, reducing the take rates by even a few percentage points would substantially reduce the network's operating income.

Similarly, long-term bond rates could have a significant impact on network financing costs. There are other risk factors on the cost side, too, including:

- The cost of manufacturing and installing the fiber network.
- The cost of manufacturing and installing customer premises equipment.
- Required customer service staffing levels.

And while the City believes that a FTTP network's last-mile fiber would represent a technological advantage over incumbent service providers, that same advantage is also seen as a potential target; the City believes that private competitors would be likely to take legal action to prevent the network from being built.

[313] City of Palo Alto RFP FTTH01.

Finally, the City's proposed FTTP network faces the risk associated with sustaining the support of the public and elected officials. As an internal report summarized, "The project's expected financial payoffs are long term. In the short term, there will be significant losses."

6.4 UTOPIA Network

A consortium of more than a dozen cities banded together in 2002 to form the Utah Telecommunication Open Infrastructure Agency (UTOPIA), which built and operates one of the largest fiber-to-the-premises (FTTP) networks in the country.

UTOPIA, which has an active Ethernet infrastructure, is an open access network. It does not sell services directly to customers; rather, it sells wholesale access to qualified service providers, which in turn offer services directly to customers. As UTOPIA explains it, this model "fosters competition among communication service providers who offer Internet, television, telephone and other services, giving customers the freedom to choose their own service providers, the best prices, and absolutely the best service." And supporting all of these services is UTOPIA's true value proposition: virtually unlimited broadband capacity to each subscriber.

UTOPIA reaches about 140,000 residences and businesses across Utah, and has achieved business success—but its future was not always as secure. The consortium's initial business model, in fact, did not produce the results its planners expected, in large part because end users did not have enough information to fully understand the network's value.

Unlike the Västerås network, which presents users with a log-in screen that lists every available service, UTOPIA customers did not initially have easy access to information on available providers. UTOPIA did not have a sales and marketing organization, so it was up to individual service providers to launch their own marketing campaigns. As a result, potential end users did not generally understand the depth and breadth of offerings. Worse, once consumers selected a provider, they often felt locked in.

Further exacerbating the problems caused by UTOPIA's lack of overall marketing, the UTOPIA consortium had different business objectives than the network's retail providers. UTOPIA had a 20-year timeframe for its investment, and needed to maximize the number of subscribers in a given neighborhood to meet its cash flow needs; the retail providers, by and large, needed to reach a profit in just 18 months—and focused on maximizing earnings per subscriber. So while the service providers aimed to sign up a given number of "profitable" customers, UTOPIA was counting on them to sign up as many customers as possible. In fact, the providers had no incentive to promote the network as a whole, because they benefited from customers' limited knowledge of competing providers.

UTOPIA ultimately took two important steps to improve its business plan. First, it funded a marketing division to create awareness and demand for its open access network. Second, it established a cooperative model, like Vasteras, that requires new customers to

pay a one-time fee for the fiber connection to their home and for their customer premises equipment (CPE). UTOPIA clearly states the benefit to customers of owning, rather than leasing, their fiber connections: "You also own your UTOPIA, meaning that when using UTOPIA's active [E]thernet infrastructure you never lose speed through a shared connection with other homes or businesses."[314]

6.5 Verizon FTTP Deployment

Of the incumbent carriers, Verizon is by far the most aggressive toward future-proofing with a FTTP deployment. Verizon has deployed FTTP in key markets in California, Connecticut, Delaware, the District of Columbia, Florida, Indiana, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, and Washington. In other areas, like Qwest, it has chosen to rely on its current copper plant and DSL technology.

Verizon's FTTP networks—called FiOS—are flexible and capable. Compared to other forms of communications transmission, FTTP boasts the highest theoretical capacity per user. It makes possible a wide range of potential applications and services, and enables the phone company to constantly upgrade capability and capacity simply by upgrading end equipment and software, while using the same fiber cable.

Verizon's network designs call for expanding its existing backbone fiber to deploy fiber throughout the system, replacing existing copper all the way to the curb (and into the homes of those customers who subscribe). FTTP systems are theoretically capable of virtually unlimited speeds for data, though current Verizon plans call for 10 Mbps to 50 Mbps downstream and 2 Mbps to 20 Mbps upstream.[315] Electronics and software changes make possible great increases in throughput without modification of outdoor fiber plant. In this way, fiber is considered a "future-proof" technology.

To support the FiOS deployment Verizon has made several strategic moves. First, with the exception of properties in Dallas suburbs,[316] the company is not overbuilding in markets where they are not the incumbent local exchange carrier. Second, they are targeting FiOS deployment in higher-income neighborhoods where they can maximize the revenue per home passed. Third, they are selling off more rural and non-consolidated service areas. For example, in 2008 Verizon sold off its service territories in Maine, New Hampshire, and Vermont for $2.3 billion to FairPoint Communications. And Verizon has proposed selling its wireline, long-distance, and broadband assets in 14 other states,[317]

[314] "Why Fiber Optics," Utopia website. http://www.utopianet.org/benefits/why-fiber-optics. Date of Access: July 9, 2009.
[315] Data obtained from www.verizon.com, accessed August 07, 2009.
[316] When the announcement of Verizon's overbuild of AT&T was made, many industry pundits predicted that a major shift in the telecommunications industry would occur. These predictions at this point seem premature.
[317] The transaction includes transfer of all of Verizon's wireline operations in Arizona, Idaho, Illinois, Indiana, Michigan, Nevada, North Carolina, Ohio, Oregon, South Carolina, Washington, West Virginia and Wisconsin. It also includes smaller operations in California that border on Arizona, Nevada and Oregon.

including Washington, for $8.6 billion to Frontier.[318] The sale continues Verizon's strategy of consolidation and allows it to focus on key geographic area, where it continues FiOS deployments. Prior to the proposed sale, Verizon was in the process of obtaining cable television franchises in the state of Washington. The Washington localities where Verizon had obtained cable television franchises and initiated FiOS services to residents were:[319]

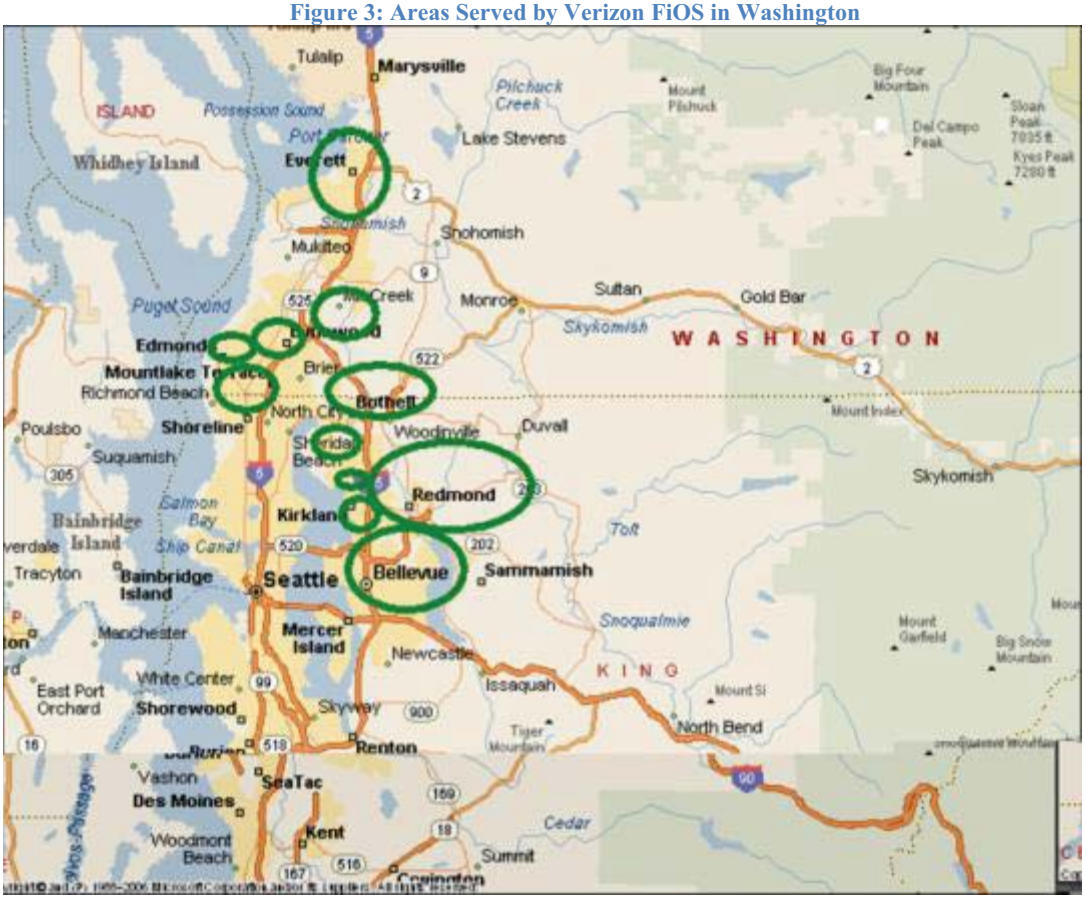
- Bellevue
- Bothell
- Camas
- Edmonds
- Everett
- Juanita
- Kenmore
- Kirkland
- Lynnwood
- Mill Creek
- Redmond
- Washougal

[318] Communications Workers of America, May 18, 2009 http://www.cwa2001.org/PDF%20Files/Fact%20Sheet%20on%20Verizon%20Sale%20to%20Frontier%205-19-09.pdf

[319] http://www.fiberexperts.com/washington-fios.html, accessed September 9, 2008.

Figure 3 shows the areas served by Verizon FiOS.

Figure 3: Areas Served by Verizon FiOS in Washington



Frontier has indicated it plans to continue to build out FiOS in areas where Verizon has started, to satisfy local cable TV franchise agreements.[320]

// Seattle FTTN Benefits Sept 8.docx

[320] "Verizon selling Washington state phone lines to Frontier," Peter Svensson, the Associated Press via the Seattle Times, May 13, 2009, http://seattletimes.nwsource.com/html/businesstechnology/2009217129_webfrontier13.html?syndication=rss.

Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle

Appendix A: Fiber-to-the-Neighborhood Business Model

Prepared for

The City of Seattle

September 2009

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Research suggests that a business case exists for Seattle to expand its fiber reach and count with relatively little risk, but that the more ambitious fiber-to-the-neighborhood (FTTN) and FTTP scenarios entail greater financial risk for the City—even as they enable enormous direct and indirect benefits for the City and consumers. This Appendix outlines a FTTN business model for consideration. It is important to note however, there is no working example in the U.S. to test or verify key assumptions made. Understanding the sensitivity of key assumptions is critical in the decision and negotiation process.

FTTN/Lease Model

In the FTTN model, the City builds the infrastructure to lease to a private provider. This infrastructure is financed through City funds. The private provider in return bridges the "last mile" to the home or business through any of a range of options such as emerging wireless technologies, investor-financed fiber, or customer ownership (the "Equity" model, in which consumers purchase their own fiber extensions and then are able to purchase competitive services over that fiber).

Extending fiber into the neighborhoods could prove a significant attraction to a private sector investor or operator. CTC's engineers estimate that if the fiber (designed to support FTTP) was extended into the neighborhoods, a private sector FTTP provider could lease that dark fiber and avoid approximately $135 million in construction costs.

In keeping with the Mayor's goal for this initiative, the FTTN model has the potential to stimulate private efforts to offer diverse, cost-competitive services to residents and businesses. The strategy creates a platform for broadband competition and innovation by separating network ownership from service-provision and by reducing the cost of deployment—eliminating the need for private sector providers to build backbone connectivity.

Although discussed as an alternative, this model has not been successfully initiated in the U.S. The City of Palo Alto entered into negotiations with a consortium of companies for FTTP financing, construction, and operations, but the resulting negotiations broke down due to commitments the consortium was requiring from the City. Not only was the City expected to provide substantial fiber assets, but it was also asked to guarantee the private consortium's investment.

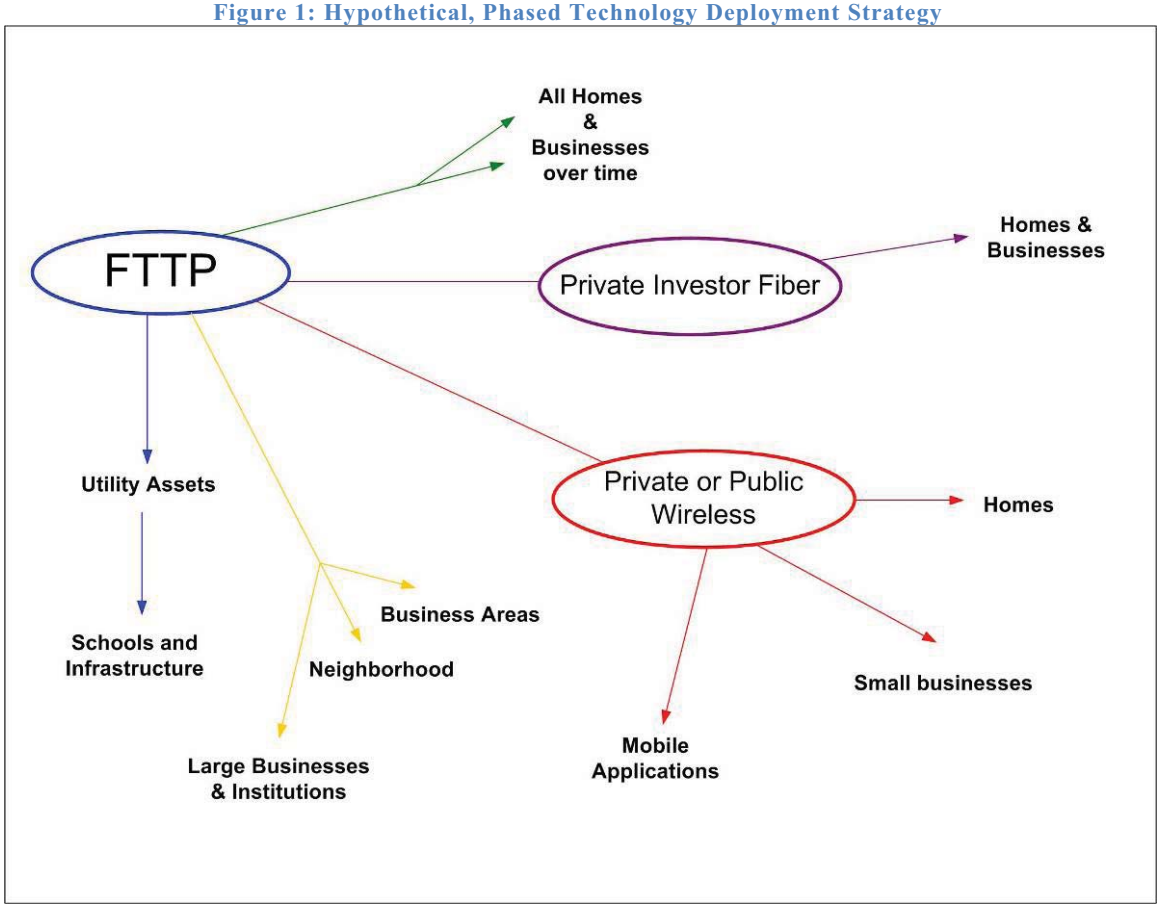
Even if no private sector investor offers to fully finance the FTTP network, this model can facilitate competitive connectivity all the way to the home and business through a variety of mechanisms:

1. **"Equity" or "customer ownership."** As above, the City or another entity would deploy fiber deep into neighborhoods. Financing of the last mile, however, is accomplished in part with one-time connection fees collected from the property owners who request that their homes be connected to the network. If the City were to fund the fiber to neighborhood implementation, it would be involved in the fiber layer only—private sector entities are selected to operate the network and offer services to

residences and businesses. This is a model that has met with some success in Europe and that is under consideration for the UTOPIA network of 16 communities in Utah.

2. **Long-term migration to FTTP and interim increase of broadband availability through complementary technologies**. The existence of the backbone fiber throughout the City might stimulate private or public investment in last mile technologies such as wireless (or even incremental FTTP) over time. A hypothetical, phased infrastructure deployment is illustrated in Figure 1.

Figure 1: Hypothetical, Phased Technology Deployment Strategy



Much of Phase 1 has already been accomplished by the City through the Joint-Use fiber and SCL's other existing fiber. Schools, key infrastructure, and City facilities are already available over fiber. That fiber can be increased in count and reach to offer carriage to large commercial users and potentially to carriers.

Phase 2 consists of significant additional fiber construction, connecting business areas, key large businesses (directly), and residential neighborhoods. This additional fiber would enable the City to realize a low-risk revenue stream through dark fiber leases.

Phase 3 encourages deployment of last-mile wireless technologies throughout the City. The existing fiber enables the City to offer reliable wireless and enables competitive providers to

lease high-speed capacity deep into the neighborhood, where they can then bridge the last mile with wireless, fiber, or other emerging technologies.

Phase 4 deploys emerging last-mile Broadband over Powerline[1] and wireless technologies to serve hard-to-reach neighborhoods and multi-dwelling units, expanding the availability and affordability of connectivity options.

Phase 5 results in the deployment over time of FTTP network to all residences and businesses.

FTTN/Lease Model—Business Plan

In a more modest variation on the open access model, this model entails the City deploying a network that delivers fiber deep into neighborhoods. This City fiber serves as an inducement for investment in further infrastructure by the private sector and by consumers.

The "last mile" is bridged in a number of ways through the investment attracted by the City fiber. Possibly, the private sector invests in last mile fiber and leases the City backbone fiber as part of that network. Alternatively, the private sector investment is for wireless service backhauled over City fiber.

In another emerging model, fiber is built to customers who pay one-time fee to purchase/own the fiber that connects their business or home to the network. The City is involved in the fiber layer only—private sector entities are selected to operate the network and offer services to residences and businesses. This is the model used by some European municipalities and that was recently introduced in the UTOPIA network of 16 communities in Utah.

The customer ownership/Equity model requires new customers to pay a one-time fee for the fiber connection to their home and for customer premises equipment at their home; the new customer owns, rather than leases, the connection and customer premises equipment.

The Equity model has the potential to facilitate true competition by allowing retail providers to share access to infrastructure; allowing retail providers access to consumers that is unfettered by the infrastructure owner; and empowering consumers to understand service and provider options.

It is important to note that this Equity model is very innovative. We cannot point to any data that verify that a community can expect to obtain and sustain the subscription numbers necessary to make this model work. Data provided by the Vasteras, Sweden network operator, PacketFront, are encouraging and do suggest that this model is seeing significant success in Europe. However, to CTC's knowledge, with the exception of UTOPIA, there is no existing municipal FTTP network in the United States that uses this model; as a result, there exist no empirical data

[1] Feasible Broadband over Powerline (BPL) technologies are today limited to those that create a Local Area Network on the low-side of the distribution transformer. BPL technologies that are designed to propagate on the medium voltage distribution system are in the experimental stage and are not currently deployable for the purposes contemplated here. Further, the 26KV distribution system used in Seattle may further limit the applicability of Broadband over Powerlines.

in the U.S. that could demonstrate or justify assumptions about consumer subscription levels, access fees paid, and other key assumptions under this model. In Sweden, and for that matter, most European countries, cable television is not as dominant as in North America. European citizens are more data-centric. If this model is pursued, negotiations with a management partner is required to finalize access fees, service attributes, hook-up fees, and other contract terms.

Technical Considerations

An overview of the conceptual FTTN design is contained in Appendix B.

Risks and Benefits

Table 1 presents a snapshot of the strengths and weaknesses of the Equity model. It shows several challenges (risks) that need to be addressed. Alternative approaches to financing the last mile each have their unique advantages and disadvantages, as do the various technology options. During negotiations with potential last-mile providers it is important to understand not only the upside (benefits), but the risks as well. As alternative "last-mile" approaches are considered, understanding potential strengths and weaknesses is one of the first steps in negotiating with private providers.

Table 1: Equity Model Strengths and Weaknesses

Advantages	Disadvantages
• Offers potential to support deployment and expansion of network with lesser amounts of financing/debt	• Unproven model in the United States; though the Swedish model is encouraging, the U.S. market appears more video-centric than Sweden's
• Directs new investment to "neighborhoods" that have sufficient demand to obtain a positive return on investment	• May increase "digital divide" as investment is directed to areas where households and businesses are willing to invest in fiber/ services—the model may therefore increase access inequities
• Provides a deployment strategy that supports the ability to apply grants or other funding sources directly in low-income neighborhoods	• Requires a substantial number of households to understand a new and complex value proposition (equity, choice, and capability vs. low cost voice, video, and data)
• Addresses differing market goals between the City and private providers	
• Has potential to increase home values	

Financial Analysis

Based on CTC's market research conducted in summer 2008, we project the City might obtain market shares of:

- 54 percent of residential Internet
- 36 percent of business Internet
- 15 percent of residential telephone
- 27 percent of business telephone
- 21 percent of residential cable television
- 21 percent of business cable television

If the above shares are obtained and each provider is charged a connection fee of $6 per month per service per customer, the City would have an unrestricted cash balance of approximately $4.1 million by the end of year 20. Increasing this fee by $1 per month would increase the year 20 cash balance to $74.1 million. However, decreasing the fee by $1 per month would result in a year 20 cash balance shortage of $32.9 million—which illustrates how critical market share and access fees are to maintaining cash flow.

Financing Costs

Our analysis estimates total financing requirements to be $150 million for the model. For financing, we assume two bonds[2] and an operating loan.

1. A $100 million bond[3] in year 1 to cover the cost of new fiber. This bond is issued at an interest rate of 4.50 percent and is paid off in equal principal and interest payments over the 20-year depreciable life of the fiber. Further we assume that principal payments do not start until year 4.

2. We assume a $40 million bond in year 1 to cover the remaining implementation[4] costs, including headend equipment, operating equipment, and other miscellaneous costs. All of this equipment initial investment is depreciated over seven years and the financial projections includes reinvestment and upgrades to keep the equipment useful over a twenty year life. This bond is paid off over 20 years[5] at an interest rate of 5.00 percent. Further principal payments do not start until year 4.

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[2] The scope of work for this Report does not include a review of the City's bonding capability or review of local or state bonding restrictions. A more detailed review and opinion from the City's accountants of bonding capability and restrictions is recommended in the business planning phase.

[3] Experience suggests that the financial community is unlikely to offer the required bonding based on the projected voice, video and data revenues. Securing the bonds through the general obligation of the City may be required.

[4] The outlined open access model allocates the customer premises equipment costs to the City. Development of CPE ownership and other policy issues is an important task in preparation of a business plan.

[5] Please note that the anticipated lifetime of some equipment is lower than the period of the bond repayment. This creates a situation where the debt associate with the asset is higher than the market value. To help negate this effect in years 5 and after, we have included expenses for equipment replenishment paid from incoming revenues.

3. We assume a $10 million loan in year 1 to cover operating expenses. The loan is paid off over 20 years at an interest rate of 6.0 percent. Further we assume that principal payments do not start until year 3.

We assume that issuance costs are equal to 1.0 percent of the principal borrowed on the long-and short-term bonds. A debt service reserve account is maintained at 5.0 percent of the total issuance amount. An interest reserve account equal to years 1 and 2 interest expense is maintained for the first two years. Further, no bond principal payments are made until year 4.

Interest earned on excess cash is assumed to be 4.0 percent of the previous year's ending cash balance.

The projected Income Statement is shown in Table 2.

Table 2: FTTN Model Income Statement

Year		1	10	20
a. Revenues				
Video		$ -	$ -	$ -
Internet		-	-	-
Voice		-	-	-
Provider Fee		4,701,456	15,168,240	15,168,240
Ancillary Revenues		9,117,469	45,447	45,447
	Total	$ 13,818,925	$ 15,213,687	$ 15,213,687
b. Content Fees				
Video		$ -	$ -	$ -
	Total	$ -	$ -	$ -
c. Operating Costs				
Labor Expense		$ 891,000	$ 1,107,000	$ 1,107,000
Operation and Maintenance Expenses		1,784,217	1,692,857	1,692,857
Pole Attachment Expense		-	-	-
Depreciation		10,230,991	8,889,206	8,877,777
	Total	$ 12,906,208	$ 11,689,063	$ 11,677,634
d. Operating Income		$ 912,717	$ 3,524,625	$ 3,536,053
e. Non-Operating Income				
Interest Income		$ -	$ 1,185,573	$ 179,946
Interest Expense (Headend and CPE Bond)		(2,000,000)	(1,473,544)	(168,951)
Interest Expense (Fiber Bond)		(4,500,000)	(3,278,338)	(367,827)
	Total	$ (7,100,000)	$ (4,003,351)	$ (409,109)
f. Net Income		$ (6,187,283)	$ (478,726)	$ 3,126,944
g. Taxes (Franchise Fees & In Lieu Tax)		$ -	$ -	$ -
h. Net Income After Fees & In Lieu Taxes		$ (6,187,283)	$ (478,726)	$ 3,126,944

Operating and Maintenance Expenses

Years 1, 10, and 20 operating and maintenance expenses are presented in Table 3.

Table 3: Operating and Maintenance Expenses

Year	1	10	20
Annual Fixed Operating Expense			
Insurance	$ 400,000	$ 400,000	$ 400,000
Utilities	200,000	200,000	200,000
Office Expenses	150,000	150,000	150,000
Contingency	200,000	200,000	200,000
Billing Maintenance Contract	25,000	25,000	25,000
Fiber Maintenance	473,577	473,577	473,577
Legal Fees	150,000	150,000	150,000
Content Aquisition	-	-	-
Marketing	150,000	50,000	50,000
Annual Variable Operating Expense			
Education and Training	35,640	44,280	44,280
Customer Handholding	-	-	-
Customer Billing (Unit)	-	-	-
Allowance for Bad Debts	-	-	-
Internet Connection Fee	-	-	-
PSTN Connection Fee	-	-	-
Total	$ 1,784,217	$ 1,692,857	$ 1,692,857

Facilities: the addition of new staff and inventory requirements will require allocation of office and warehousing space:

- Expand office facilities for management, technical and clerical staff.
- Provide warehousing for receipt and storage of cable and hardware for the installation and on-going maintenance of the broadband infrastructure.
- Establish location to house servers, switches, routers, and other core-network equipment.

Training: training of existing City staff is important to fully realize the economies of adding a business unit.

Billing and Collections: billing is simplified under the wholesale model. We estimate that billing costs are $25,000 per year for billing of service providers.

Marketing and Sales: marketing efforts in the open access model are directed towards encouraging new providers to enter the Seattle market place rather than at the consumer as in the retail access model.

Staffing Levels: Staff is required to maintain the core network and customer drops. The retail providers will handle day-to-day subscriber inquiries. Table 4 shows the estimated staffing levels.

Table 4: Estimated Staffing Requirements

Service Position Total	Year 1	Year 2	Year 3+
Business Manager	1	1	1
Market & Sales Manager	0	0	0
Broadband Service Manager & Administrators	1	1	1
Headend Technician	0	0	0
Telephone Technician	0	0	0
Internet Technician	0	0	0
Customer Service Representative/Help Desk	1	1	1
Service Technicians/Installers	2	4	6
Sales and Marketing Representative	1	1	1
Contract Administrator	1	1	1
Fiber Plant O&M Technicians	5	5	5
TBD	0	0	0
Total Existing Staff	0	0	0
Total	12	14	16

We assume benefits equal to 35 percent of base salary.

Summary of Assumptions

Key annual operation and maintenance assumptions include:

1. Salaries and benefits are based on estimated market wages. See Table 4 for the list of staffing requirements. Benefits are estimated at 35 percent of the base salary.
2. Insurance is estimated to be $400,000 in years 1 through 20.
3. Utilities are estimated to be $200,000 in years 1 through 20.
4. Office expenses are estimated to be $150,000 in years 1 through 20.
5. Contingency is estimated to be $200,000 in years 1 through 20.
6. Billing is estimated to be $25,000 in year 1 through 20.
7. Fiber maintenance fees are assumed to be $5,000 plus 0.5 percent of total fiber implementation cost annually.
8. Legal fees are estimated to be $150,000 per year.
9. Marketing and promotional expenses are estimated to be $150,000 in year 1 and $100,000 in year 2, and $50,000 in years 3 through 20.
10. Education and training are calculated as four percent of direct payroll expense.
11. No pole attachment fees are included since fiber cable is located on SCL poles.
12. The market size for residential telephone will continue to decline. The residential market size is 80 percent of households in year 1, declining to 65 percent by year 5. The market size for small business telephone will remain stable at 60 percent of businesses.
13. The market size for residential Internet will increase to 90 percent of households by year 2. The market size for business Internet will increase to 92 percent of businesses by year 2.
14. The market size for residential cable and satellite television will decline to 66 percent of households by year 9. The market size for business cable television will remain at 15 percent.

Inflation and salary cost increases were not used in the analysis as it is assumed that cost increases will be passed on in the form of increased prices.

Cash Flow Results

These assumptions lead to the year-end net income and cash flow results summarized in Table 5.

Table 5: Base Case (Equity) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (6,187,283)	$ (2,488,012)	$ (478,726)	$ 1,715,890	$ 3,126,944
Cash Flow	$ 4,296,737	$ 1,530,420	$ 1,072,637	$ (27,361,636)	$ (419,513)
Unrestricted Cash Balance	$ 4,296,737	$ 43,733,866	$ 23,711,963	$ (978,564)	$ (2,920,866)
Restricted Cash Balance (Debt Service Reserve)	$ 7,000,000	$ 7,000,000	$ 7,000,000	$ 7,000,000	$ 7,000,000

The cash flow balances are quite sensitive to the subscriber access fees and projected market shares. For example, let's look at the sensitivity of residential Internet (service with largest revenues) by maintaining all assumptions except for residential Internet access fee. If residential Internet access fee is decreased by $1 to $5 per month while leaving market share at 54 percent we net an end-of-year-20 cash shortage of $32.9 million.

As a further example, if we reduce the residential Internet market share by half, to 27 percent, cash flow balances drop considerably. This impact is shown in Table 6.

Table 6: Reduced Market Share (Equity Access) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (6,705,904)	$ (8,050,861)	$ (6,247,358)	$ (4,202,491)	$ (1,636,061)
Cash Flow	$ 3,778,117	$ (4,032,429)	$ (4,695,995)	$ (33,280,018)	$ (5,182,518)
Unrestricted Cash Balance	$ 3,778,117	$ 13,676,256	$ (35,902,305)	$ (89,912,394)	$ (115,824,984)
Restricted Cash Balance (Debt Service Reserve)	$ 7,000,000	$ 7,000,000	$ 7,000,000	$ 7,000,000	$ 7,000,000

This sensitivity to market shares is again a concern, but—unlike in the retail model—SCL is serving multiple providers that are selling to consumers. In theory, with an active portal that offers consumers the ability to find more retail providers, the probability of obtaining the required market shares increases.

Another issue is that eventually consumers may obtain all telephone and television programming through wireless or via the Internet. Removing all connection fee revenues from the models for telephone and cable television leaves a cash flow shortage of $123.5 million.

Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle

Appendix B: Conceptual Fiber-to-the-Neighborhood Design

Prepared for

The City of Seattle

September 2009

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The purpose of this document is to:

1. Provide an overview of the conceptual fiber-to-the-neighborhood (FTTN) core design model developed by CTC for the City of Seattle;
2. Demonstrate how this design is aligned with the primary objectives of the Mayor's office and the FTTN Benefits Study currently underway by CTC; and
3. Serve as a guideline for assessing the costs and benefits of other candidate designs.

Conceptual Design

CTC is designing an FTTN network core to respond to two key directives issued by the Mayor's office:

1. Facilitate the desired deployment of a Citywide fiber-to-the-premises (FTTP) network throughout Seattle; and
2. Minimize the City's own investment in a future FTTP network by limiting the City's role to deploying an FTTN network core, both as an initial step towards FTTP and to encourage private investment in FTTP.

The conceptual design prepared by CTC and outlined in this document is an FTTN architecture that can eventually become the core of a standards-based FTTP network capable of providing services to all premises, in line with the Mayor's objectives. This model calls for the construction of only a small, minimum portion of the total network from a cost perspective, calling only for minimum key backbone components. *The objective is for the FTTN network to be constructed at a minimum of cost while still reducing market entry costs sufficiently enough to make a private investor want to complete the FTTP buildout.*

However, if the City's effort pays for less than 10 percent of a network costing hundreds of millions of dollars, it is a valid question whether a private sector company will feel that the City's investment makes any difference in the company's choice to build the FTTP network. Lower-cost FTTN approaches are possible, but have some or all of the following drawbacks:

- High cost of completing the FTTP deployment
- Limiting the provider's choices in FTTP architecture
- Delaying the first subscriber activations
- Placing large, intrusive cabinets in public view
- Limiting the FTTP deployment to only certain parts of the city, which may be perceived as "red-lining"

If the FTTN core falls short of a minimum baseline of quality and performance, the total cost of building the FTTP network may in fact be increased, because the private sector entity may be forced to repeat or rebuild the City's construction. The City may also potentially lose its investment if it cannot find a favorable arrangement with a private sector company to complete the network.

This document outlines the conceptual design that we feel is appropriate for staff consideration, as well as our concerns with the alternative approach that has been proposed internally by City staff. Our proposed design makes it possible for a future FTTP provider to "plug in" to the City-constructed infrastructure, to relatively quickly begin serving customers near the initial City FTTN build area, and to minimize or eliminate the need to construct any additional fiber in the City-built FTTN area. While the City has not performed detailed surveys or business plans for potential private sector service providers, the proposed design has the following attributes for a service provider:

1. One-eighth to one-quarter of the total right-of-way construction cost paid by the City
2. Ability to immediately activate some customers in or near the initial FTTN build area, providing revenues to offset the cost of the remaining construction

Design Considerations

In order to minimize the need to repeat or rebuild construction, and to make the FTTN core desirable to a potential private sector company, it is critical to keep in mind the likely shape of the final, desired FTTP network. The FTTN core should be a logical first step to the completion of the FTTP network. The FTTN core design should not require the City to substantially rebuild the core in order for the FTTP network to be completed.

CTC prepared the conceptual fiber-to-the-premises (FTTP) design[1] based on a standard Passive Optical Network (PON) architecture. The PON architecture was selected for Seattle over the home run and active Ethernet alternatives as to avoid the high fiber counts required by the home run architecture (which comprises a pair of fiber strands to each premises) and to avoid having the large, climate-controlled cabinets in residential neighborhoods required by active Ethernet[2].

Feature of the PON architecture include:

- No active electronics (and therefore no power or climate control) required in the field
  - Optical line terminal (OLT) at hub
  - Optical network terminal (ONT) at subscriber premises
  - 16 to 32 homes served from each hub fiber, with each hub fiber split and combined in a Fiber Distribution Cabinet (FDC) (Figure 1)
  - FDCs (Figure 1)
    - Each serves up to 500 premises
    - Each measures roughly 4' x 3' x 3' and contains passive (no power) optical splitters
  - Taps located on overhead fiber lines or in small pedestals connect fiber to two to 12 homes premises
- Typical speeds per premises of 50 to 150 Mbps, depending on the details of the design

[1] *Evaluation of Potential Risks and Benefits of Municipal Broadband*, prepared by CTC, 2009.
[2] See the design section of the *Evaluation of Potential Risks and Benefits of Municipal Broadband*, for further details.

- Scalability of capacity to 1 Gbps and beyond without need to augment or modify the fiber, using more advanced electronics and DWDM technologies

Relative to PON, Active Ethernet is an alternative that may reduce fiber counts within certain segments of the network; however, it requires large cabinets (Figure 2) with power supplies and HVAC equipment to house outdoor electronics. A citywide deployment in Seattle would require hundreds of these cabinets, which would raise the project's installation and equipment costs; locating the cabinets in the field can be difficult, too, particularly in urban environments. The PON architecture also eliminates the need for acquiring external power and maintaining electronics in the field (and thus leads to lower operation and maintenance expenses).

Given that the eventual FTTP network will have the above architecture, *we suggest the FTTN core be built so that each constructed portion of the FTTN core is complete, so that no further fiber or cabinets are needed along those routes as they are converted to the final FTTP network.*

The reason for this recommendation is that, below a minimum level of FTTN completeness, converting the FTTN core to FTTP may be, to a private sector company, more trouble than it is worth, and thus may put the City at risk. As a practical matter, making the FTTN core *complete* means:

1. Starting first with a complete design of the eventual FTTP network, so that the needed fiber count along each street is known in advance, and the locations of cabinets and taps are known.
2. Ensuring that each street that is constructed as part of the FTTN core has the fiber count, conduit, cabinets, and taps in place for the *completed* FTTP network, so that the FTTP completion does not require adding cables, cutting fiber, and reopening streets along constructed routes. (Material costs for larger fiber counts are negligible compared to the potential costs associated with overlashing and overbuilding fiber routes.)
3. Selecting demarcation points in advance, so that the FTTP private sector company can interface with the FTTN core without redesigning the network.
4. Using standard design architecture, so that the network is consistent with the business plans and operations of private sector companies already operating FTTP.

Figure 1: Fiber Distribution Cabinet (PON Architecture)

Figure 2: Fiber Distribution Cabinet (Active Ethernet Architecture)

Attributes of a Complete FTTN Design

The conceptual Complete FTTN design and cost estimate is based on the following assumptions:

- The FTTN is designed to provide a foundation for an FTTP network (shown in Figure 3) that will ultimately reach 318,000 passings (potential subscribers)
    - The design minimizes City investment, yet provides a foundation that substantially reduces market entry barriers for a private FTTP builder and reaches all neighborhoods, avoiding red-lining
- The FTTN identifies the City's 10 substations as hub locations and establishes a redundant fiber backbone ring between them
    - Assumes space is available at each substation property to construct facility outside of the existing substation building (for security reasons)
    - Each hub requires approximately 3,500 square feet
    - Each hub must house redundant power, HVAC, and networking equipment
    - Hub sites are connected together through backbone fiber ring
    - 144- to 288-count fiber cable is suitable for backbone and other City and institutional purposes
    - Fiber backbone assumed to be primarily installed in the power space to minimize make-ready costs
- A total of 640 FDCs are required
    - On average there are 64 FDCs per hub, netting a total of 640 Citywide
    - One FDC serves approximately 500 passings
        - A 36-count fiber from the hub is used to serve each FDC
        - Spare fiber is run to each cabinet for future-proofing (i.e., to enable future home run Ethernet service)
- The FDC is the demarcation point between the City's infrastructure and a commercial FTTP provider. The FTTP provider will extend one fiber strand from the cabinet to every premise (by way of fiber taps), and must install an ONT at each premise as residents sign up for service. This design:
    - Allows the FTTP network provider to add infrastructure as service is required
    - Minimizes the potential for FTTP to avoid neighborhoods that may have a lower take-rate
    - Provides the City a level of control and influence over the FTTP provider

The optimal scenario for the total FTTP network involves constructing the network with fiber capacity that precisely reflects the take-rate and minimizes the need to overbuild or segment the network as subscribers are added. Building the FTTN network to support fewer-than-targeted subscribers is a false economy, because the total network cost will increase as the network must be overbuilt and possibly segmented into additional FDC service areas, ultimately diminishing the enticement value of the FTTN network as a basis for private FTTP investment.

The conceptual FTTP design is shown in Figure 3. The proposed FTTN core network (Figure 4) includes the backbone fiber, hubs, OLTs at hubs (not shown), distribution fiber, fiber counts for feeder fiber along selected routes, and FDCs. The FTTP provider will add taps, feeder fiber, drop fiber, and ONTs at the premises (ONT not shown).

Figure 3: FTTP PON Architecture

Figure 4: FTTN Core Architecture

Cost of Building the Proposed FTTN

The total estimated cost to build the FTTN core as described above is $135.1 million. The estimate includes:

- Headend and hub facilities (including minimum electronics): $37.5 million
- Backbone fiber ring: $3.6 million
- Distribution fiber and cabinet construction: $94.0 million

The FTTN distribution fiber construction includes an estimated total of 740 strand miles (not including backbone ring between hubs). Please note that CTC is not proposing that fiber be built to all premises in Seattle. Given the estimated penetration rates of services delivered over the FTTP network, the proposed FTTN represents slightly greater than 25 percent of the total required capital investment. If all homes and businesses were equipped, the proposed FTTN would cost less than 17 percent of the required $800 million-plus investment.

Concerns with Lower-Cost FTTN Approach

We have multiple concerns with the alternative FTTN approach presented by City staff. More importantly, we feel the need to direct the City's attention to the overall objectives of the project and away from the particular design at this stage. Of course, we recognize and share staff's concern that the more robust FTTN approach may have a price tag that is too high for City Council to give reasonable consideration. However, any alternative approach with a reduced infrastructure investment by the City may not reduce market entry barriers (cost, time to deploy, etc.) sufficiently enough to encourage private investment in completing an FTTP network—and is therefore itself a risk.

Other concerns with the alternative FTTN approach include:

1. Designing an FTTN network today that does not sufficiently support a future FTTP implementation has consequences.
    a. An FTTN network design that fully supports future FTTP deployment calls for 640 FDCs, which in turn requires 500-count fiber from hubs to the FDCs. Because a FTTN network with only 100 to 200 FDC locations would serve much larger "neighborhoods" with each location, it would require more than six times the fiber count to each FDC.
    b. Adding more FDCs over time will tend to require overlashing distribution fiber on previous distribution fiber. This will increase the need for pole replacement because of space and wind-loading considerations.
    c. The feeder fiber will require substantially longer runs, and will tend to see increased overlashing on other feeder fiber.
2. One alternative to mitigate the concerns outlined above is to increase the number of hubs. However, simply adding more hubs approaches the topology of an active Ethernet network.

a. Fiber counts would be greatly reduced
b. The amount of outdoor electronics (and the corresponding number of large cabinets required) would increase
c. Each hub essentially becomes a large version of an active Ethernet cabinet (see Figure 2).
d. Active Ethernet architecture increases operational and maintenance costs, and is not the industry "standard"—which may reduce the attractiveness of the City's investment to potential private FTTP providers.

Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle

Appendix C: Departmental Interview Guide

Prepared for

The City of Seattle

September 2009

Columbia Telecommunications Corporation • 10613 Concord Street • Kensington, MD 20895
301.933.1488 • www.CTCnet.us

City of Seattle Fiber-to-the-Neighborhood Benefits Study: *Departmental Interview Guide*

Purpose

Cities throughout the world are examining the feasibility of, or are constructing, fiber optic communications networks to serve internal needs and to potentially offer a platform for commercial services for the public. In most cases, the objective for these networks is to provide long-lasting infrastructure that enables advanced capabilities and reduces long-term operating costs, while encouraging faster and lower-cost competitive services for businesses and residents.

Along these lines, Mayor Nickels instructed staff to study the potential benefits of constructing a fiber-to-the-neighborhood (FTTN) network. It is the purpose of this survey to initiate the process of comprehensively identifying the telecommunications services and associated costs that could be reduced or avoided if the City were to deploy a ubiquitous fiber optic communications network Citywide.

We appreciate your time, and thank you in advance for your response. The analysis fueled by this information will play a key role in determining how the City approaches its internal communications needs and responds to opportunities for economic stimulus and infrastructure development.

Interview Questions / Discussion Points

Please note that we are not asking you to spend time gathering information. We do have details from DoIT on existing services and charges. The questions below are to explore for additional insights. We anticipate the majority of the interview to concentrate on question 8.

1. ***Existing leased services***: Does your department or agency directly procure any leased communications services (external to DoIT), such as phone lines, data links, or wireless services? If so, please itemize for each:
    a. Service type and/or speed (ex. DSL Internet service, point-to-point T1 circuit, etc.)
    b. Quantity
    c. Recurring cost (monthly)
    d. Location(s)

    Examples might include phone lines or low-speed data circuits for SCADA systems, ISDN lines for videoconferencing, and cable modems for Internet access.

2. ***Internal charge-backs***: Please itemize and identify the purpose of any expenses your department or agency regularly incurs through internal charge-backs or billing from DoIT, including connections and software licensing (for example, for

VPN or Citrix solutions needed for remote secure access or to enable access over lower-speed links). If so, please itemize for each:

a. Item description (ex. data connection, VPN software, server hosting, etc.)
b. Recurring cost (monthly)
c. Reason for requiring service

3. ***Internal IT infrastructure maintained***: Does your department or agency maintain any IT servers, devices, or other equipment outside of DoIT data centers because of a need for additional bandwidth, or any other operational or cost reasons? If so, please describe for each:
    a. The purpose or general description of the system
    b. Reason DoIT services or systems are not used for this purpose (for example, concern about reliability of connectivity, need for higher speed connectivity to resource than available, security, etc.)

4. ***Availability requirements***: For all of the systems and services identified in questions 1-3, what is your requirement for availability / reliability in terms of acceptable minutes/hours/days of outage you could withstand without resulting in increased loss of life or property damage? Of course, no level of outage is desirable, though we seek to understand the criticality of particular IT services in terms of the point at which temporary manual processes or backup measures begin to significantly impact your mission or costs in the event of an outage.

5. ***Future connectivity plans***: Does your department or agency have any plans or desire to procure any IT or communications services or systems in the near future, including any wireless networks? For each, please provide the following:
    a. Type of connectivity (ex. dedicated fiber construction, DSL Internet service, point-to-point T1 circuit, etc.)
    b. Actual funding or estimated cost (initial implementation and ongoing operations)
    c. Locations involved
    d. Number of users
    e. Any available documentation, such as design or bid specification documents

    Please consider unmet or unfunded needs that represent real requirements whether or not an official plan is in place. For example, backup or redundant systems and connections might be an unfunded requirement, such as to provide automatic database replication in a secondary location.

6. ***Future applications***: What types of applications might you consider if all bandwidth constraints were removed?? For each, please provide the following:

    a. Type of potential applications
    b. Locations involved
    c. Number of potential users/ user types

Please consider a wide range or "wish-list" of applications. For example, desktop videoconferencing (internal and external) might be an application that is constrained with current connections.

7. ***Funding for more effective services***: Would your department or agency be willing to reallocate any portion of your budget to fund enhanced telecommunications (as indicated in question 6) or IT connectivity for staff or with the public if greater economies of scale or functionality could be realized for these expenditures? If so, what percentage of your current budget (and dollar amount) do you estimate could be used for more effectively deployed IT resources or connectivity to enable greater productivity or efficiencies within your department?

8. ***Broader access for telecommuting and business connectivity***: Can you identify any potential cost savings, either now or in the future, if there were available low- or no-cost, high-speed connectivity for City personnel or contractors over a high-speed "intranet" comparable in speed and functionality to your internal network? For example, could Citywide access enable more telecommuting through the use of videoconferencing and secure access to central files, thereby reducing the need for City-funded travel and office space? Could there be any costs eliminated today, such as fees for Virtual Private Network (VPN) systems or collaboration tools such as WebEx or SharePoint?

Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle

Appendix D: Municipal Fiber Networks in the U.S.

Prepared for

The City of Seattle

September 2009

Columbia Telecommunications Corporation • 10613 Concord Street • Kensington, MD 20895
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Table 1: Municipal Fiber Networks in the U.S.

Name	State	Vendor	Model	Platform	Services
Ashland Fiber Network	OR		Overbuild		Video, Data
Auburn Essential Services	IN	Enablence	Overbuild	EPON	Voice, Data
Barnesville Municipal Utilities	MN	Calix	Overbuild	GPON	Voice, Data, Video
Bellevue Municipal Utilities	IA	Enablence, ETI Software Solutions	Overbuild	EPON	Voice, Data, Video
Blue Ridge Crossroads Economic Development Authority (Wired Road)	VA		Overbuild		Data
Bowling Green Municipal Utility	KY	Alloptic	Overbuild	GePON	Voice, Data
Braintree Electric Light Department	MA		Overbuild	Active Ethernet	Data
Bristol Tennessee Essential Services	TN	Alcatel-Lucent, ETI Software Solutions	Overbuild	BPON	Voice, Data, Video, Meter Reading
Bristol Virginia Utilities	VA	Calix, Alcatel-Lucent	Overbuild	BPON, GPON	Voice, Data, Video, Business services
Burlington Telecom	VT	Calix	Overbuild	GPON	Voice, Data, Video, Business services
CC Communications	NV	Enablence	Replace, Greenfield	EPON	Voice, Data, Video
CDE Lightband	TN	Ciena, Clearfield, ETI Software Solutions	Overbuild	Active Ethernet	Voice, Data, Video, Meter Reading
Cedar Falls Utilities	IA		Overbuild	Active Ethernet	Data
Chelan County Public Utility District	WA	Alcatel-Lucent	Overbuild	BPON	Voice, Data, Video
City of Danville Utilities Department	VA	PacketFront	Overbuild	Active Ethernet	
City of LaGrange, Georgia	GA	Calix	Overbuild	PON	
City of Leesburg, Florida	FL		Overbuild		Data
City of Philippi, West Virginia	WV	Motorola	Overbuild	BPON	Data, Video

Name	State	Vendor	Model	Platform	Services
City of Powell, Wyoming	WY	Calix	Overbuild	GPON	Voice, Data, Video
City of Salisbury, North Carolina	NC		Overbuild		
City of Shafter, California	CA		Overbuild		
City of Wilson, North Carolina	NC	ETI Software Solutions, Alcatel-Lucent	Overbuild	GPON	Voice, Data, Video
Clallam County Public Utilities District	WA	Cisco	Overbuild	Active Ethernet	Data
Community Telecom Services	KY				
Crawfordsville Electric Light & Power	IN	Enablence, ETI Software Solutions	Overbuild	EPON	Video, Data
Crosslake Telephone	MN	Calix	Overbuild	GPON	Voice, Data, Video
Dalton Utilities	GA	Alcatel-Lucent, ETI Software Solutions	Overbuild	BPON	Voice, Data, Video
Douglas County Public Utilities District	WA	Telco Systems	Overbuild	Active Ethernet	Voice, Data, Video
Dover Utilities	OH	Hitachi	Overbuild	BPON	Voice, Data, Video
EPB Telecom	TN	Enablence, Motorola	Overbuild	EPON	Voice, Data, Video
FiberNet Monticello	MN		Overbuild		
Gainesville Regional Utilities	FL	Cisco	Overbuild	Active Ethernet	Data
Glasgow Electric Plant Board	KY	Enablence	Overbuild	EPON	
Glenwood Springs Community Broadband Network	CO		Overbuild		Data
Grant County Public Utility District	WA	Cisco, (multiple)	Overbuild	Active Ethernet	Voice, Data, Video
Harlan Municipal Utilities	IA		Overbuild		
Holland Board of Public Works	MI		Overbuild		Data
Holyoke Gas & Electric Department	MA		Overbuild		Data, Videoconferencing, Voice
Hometown Utilicom	PA	Calix	Overbuild	BPON,	Voice, Data,

Name	State	Vendor	Model	Platform	Services
				GPON	Video, Meter Reading
Idaho Falls Power	ID		Overbuild		Voice, Data
Jackson Energy Authority	TN	Enablence	Overbuild	EPON	Voice, Data, Video
KPU Telecommunications	AK	Pannaway, Zhone Technologies	Overbuild	Active Ethernet, GPON	Data, Video, Voice
Lafayette Utilities System	LA	Alcatel-Lucent	Overbuild	GPON	Voice, Data, Video
LENOWISCO Planning District Commission	VA	Ciena	Overbuild	Active Ethernet	
Lenox Municipal Utilities	IA	Calix	Overbuild	PON	Voice, Data, Video
liNKCity	MO	Ciena	Overbuild	Active Ethernet	Data
Loma Linda Connected Communities Program	CA	Allied Telesis	Overbuild	Active Ethernet	Voice, Data, Video
Marshall Municipal Utilities	MO				Data, Meter Reading
Mason County Public Utilities District	WA	Telco Systems, Ciena	Overbuild	Active Ethernet	Voice, Data
MINET	OR	Alcatel-Lucent, ETI Software Solutions	Overbuild	BPON	Voice, Data, Video
Morristown Utility Systems	TN	Alcatel-Lucent, ETI Software Solutions	Overbuild	BPON	Voice, Data, Video
Murray Electric System	KY		Overbuild	Active Ethernet	Voice, Data, Video
NetQuincy	FL	Alcatel-Lucent	Overbuild	BPON	Voice, Data, Video
Norwood Light & Cable	MA		Overbuild		Voice, Data
Okanogan Public Utilities District	WA		Overbuild	Active Ethernet	
Paducah Power System	KY	Alcatel-Lucent, Allied Telesis	Overbuild	BPON	Voice, Data
Pend Oreille Public Utilities District	WA	Cisco	Overbuild	Active Ethernet	Data, Business services
Pulaski Electric System	TN	Enablence, ETI Software	Overbuild	GPON	Voice, Data, Video

Name	State	Vendor	Model	Platform	Services
		Solutions			
Reedsburg Utility Commission	WI	Calix	Overbuild	BPON, GPON	Voice, Data, Video
Rochelle Municipal Utilities	IL	Zhone Technologies	Overbuild	Active Ethernet	
Sallisaw Municipal Authority	OK	Enablence	Overbuild	EPON	Voice, Data, Video
Scottsboro Electric Power Board	AL		Overbuild	Active Ethernet	Data
Shawano Municipal Utilities	WI	Tellabs	Overbuild	GPON	Voice, Data, Video
Sherwood Broadband	OR		Overbuild, Greenfield		Data
Spencer Municipal Utilities	IA	Calix	Overbuild	GPON	Voice, Data, Video
Sun Prairie Water & Light Commission	WI		Overbuild		Data
Swiftel Communications (Brookings Municipal Utilities)	SD	Calix	Overbuild		
Sylacauga Utilities Board	AL	Alcatel-Lucent	Overbuild	Active Ethernet	Data
Taunton Municipal Lighting Plant	MA	Enablence	Overbuild	EPON	Data
Tifton CityNet	GA	Alloptic	Overbuild	RFOG	Voice, Data, Video
Tullahoma Utilities Board	TN	Enablence	Overbuild	GPON	Voice, Data, Video
UTOPIA	UT	Allied Telesis, Alcatel-Lucent	Overbuild	Active Ethernet	Voice, Data, Video
Vernon City Utilities	CA		Overbuild		Data
Windom Telecommunications	MN	Calix	Overbuild	GPON	Voice, Data, Video

Source: *BroadbandProperties* magazine, searchable database of independent telcos and municipalities that purport to be deploying fiber to the premises, accessed July 9, 2009. http://www.bbpmag.com/search.php.