Evaluation of Potential Risks and Benefits of Municipal Broadband

DRAFT

Prepared for

Seattle City Light

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1. Executive Summary

This Report presents an evaluation of the feasibility of municipal Fiber-to-the-Premises (FTTP) network in Seattle under a range of business and technology plans.

Access to broadband is the most important infrastructure issue of our time—for purposes of economic development and competitiveness, innovation, healthcare, education, and environmental sustainability. In less than a decade, broadband access has become a necessity – not a luxury. The City of Seattle (City) recognizes the need for broadband and is deeply engaged in evaluating means by which to facilitate it. To assist the City, Seattle City Light (SCL) is exploring ways it can assist given its charter and operating rules and regulations.

At the same time, municipal FTTP involves risk for both SCL and the City. Intertwined with the risk, there may be a business case for SCL to participate in the project, depending on the nature and extent of that participation.

This Report was prepared by Columbia Telecommunications Corporation (CTC) in the Summer and Fall of 2008 at the request of SCL. The goals of this Report are to:

- Evaluate the various means by which SCL could participate
- Identify and quantify the risk of each model for SCL and the City
- Identify and quantify SCL's business interests that may be served by this project

To evaluate feasibility, benefits, and risks, CTC reviewed, in light of SCL's parameters and circumstances, a range of business models that various municipalities and municipal electric utilities have pursued across the country and in Europe. To adequately evaluate these options, CTC's staff of engineers and analysts undertook the following tasks:

- Meet with SCL officials and stakeholders
- Evaluate the current state of communications offerings on the market
- Conduct market research of Seattle residents and businesses to :
    - Analyze satisfaction levels with existing services—and determine importance of services to consumers
    - Analyze and quantify the potential market for new services
    - Gauge public interest in City facilitation of FTTP deployment
    - Explore feasibility of new models for fiber ownership
- Formulate strategies calculated to meet SCL's own internal needs and other business interests
- Formulate strategies involving various levels of SCL participation to meet the business goals of the Mayor's FTTP initiative
- Consider the risks of each of the identified strategies, particularly in light of the results of the market analysis

- Consider the business case for SCL of each of the identified strategies
- Determine and document the risk as well as the business benefits for SCL of various levels of involvement in a City broadband initiative

1.1 Project Background

The City of Seattle has been evaluating the feasibility of a Public/Private Partnership to build and own an 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 population in excess of 560,000 and covering nearly 84 square miles.[1]

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 Taskforce 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.*[2]

The Task Force Report concluded that Seattle would require symmetrical (both upload and download) speeds of 20 to 25 Mbps in the short run and 100 Mbps and more in the longer run.[3]

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."[4]

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."[5]

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[1] 2000 Census, http://factfinder.census.gov/home/saff/main.html?_lang=en,.
[2] Report of the Task Force on Telecommunications Innovation, May 2005, www.seattle.gov/cable.
[3] 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.
[4] Report of the Task Force on Telecommunications Innovation, May 2005, www.seattle.gov/cable.
[5] Ibid.

On the basis of these findings,[6] 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.[7] 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.[8]

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, financing was available for such projects.

In the wake of the Task Force's work, Seattle Mayor Greg Nickels directed Seattle City Light and DoIT to investigate strategies by which to facilitate deployment of FTTP. SCL commissioned this Report as part of that investigation. Mayor Nickels also directed DoIT to release a Request for Proposals to solicit proposals from the private sector for participation in an FTTP project. DoIT and SCL are currently working together to determine the parameters of the RFP.

1.2 Industry Background

The scope of Seattle's efforts to spur FTTP deployment is unusual for a large American city, but not unique. For the past 15 years, American communities have considered building FTTP and hybrid fiber/coaxial infrastructure to compete with existing coaxial and copper networks owned by commercial carriers. The majority of these "overbuilds" positioned the municipality as a

[6] 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," issued May 2006, www.seattle.gov/cable.

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

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

voice, video, and data provider. The value proposition promoted in most of these overbuild projects was consumer cost savings, focused initially on cable television and introduction of first generation broadband data access.

This "retail-overbuild" model has succeeded in a variety of communities, primarily in small rural communities that own an electric utility. However, as in any business, there is a life cycle and transitions to new models are required to meet consumers' evolving needs and expectations. Today, progressive communities are focusing on the need for higher speed connectivity and greater consumer choice—not just on cable pricing. These interests have spurred interest in open access municipal FTTP networks.[9] Over the past few years alone, other innovative municipalities such as Portland, San Francisco, and Palo Alto have begun evaluating whether municipal, open access fiber is advisable and feasible for their respective communities.

Our competitor nations in Europe and Asia (and Seattle's competitor cities on those continents) are increasingly adopting FTTP as the inevitable, essential broadband medium. Significant private sector and central government initiatives for FTTP are underway throughout the Pacific Rim and Western Europe. In addition, variations of municipal FTTP projects are underway or under consideration in numerous major European and Asian cities including Paris, Vienna, Amsterdam, Stockholm, Zurich, Milan, Singapore, and Hong Kong.[10]

High-bandwidth broadband is widely-recognized as a key driver of future economic competitiveness,[11] and is also regarded as a facilitator of political discourse and activity – the most important medium for communication and expression of political ideas since the advent of television.

But private-sector networks are not meeting this growing demand for bandwidth and speed in an affordable and timely manner. Though there are private-sector FTTP deployments underway in some, limited areas of the United States, none is planned or foreseen for Seattle. Neither Qwest nor Comcast currently plans to deploy FTTP facilities throughout the City. The networks they currently operate (and those for which they have announced future plans) cannot compare to FTTP. Verizon is responsible for the major, private FTTP projects underway in other parts of the country. Seattle is not within Verizon's service area and, to our knowledge Verizon has no plans to expand service, either through FTTP or other technologies, to Seattle (though Verizon is

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[9] In "open-access" or "wholesale" networks, the network owner leases capacity to retail providers, who deliver voice, video, and data products to consumers. This Report uses the terms to refer to networks that allow competing service providers to compete over network infrastructure at competitive prices, consistently applied.

[10] These projects span a wide variety of models, ranging from municipal ownership to public/private partnership to municipal attempts to stimulate private fiber builds. A number of these projects and their associated models are presented as case studies below.

[11] The calls for greater broadband deployment come from organizations as diverse as the U.S. Chamber of Commerce, AARP, the National Association of Chief Information Officers, Google, and major equipment manufacturers such as Nortel and Cisco--all of whom recognize that the United States' position as a technological and economic leader require networks that enable growth applications such as teleconferencing, distributed/remote collaboration and development, and distance learning.

building FTTP in its existing footprint in eastside Puget Sound communities where it is the incumbent local exchange carrier.)[12]

1.3 Summary of Findings

Generally, this Report concludes that

- 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.

- Both the "retail" and "open access/wholesale" models for municipal FTTP in Seattle entail risk with respect to recovery of capital and operating costs. The market research does suggest that an FTTP network could attain significant market share, particularly in Internet services, but there is still risk that small decreases in market share or pricing would lead to net losses.

- 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. For example, our market research demonstrates a

[12] Historically, Verizon and the other incumbent local exchange carriers (such as AT&T and Qwest) do not overbuild each other; in other words, they do not build networks that would compete in each others' existing geographic footprints. We know of almost no exceptions to this unstated practice, other than Verizon's build in Plano, Texas, a high-end Dallas suburb. Further, Verizon fiber buildouts are typically earmarked for higher income neighborhoods and business parks.

potential consumer gas, vehicle, and time savings of $94 million per year based simply on enabling greater telework (rather than commuting) over fiber. These consumer cost savings are in addition to an estimated potential reduction of carbon dioxide emissions of 42.3 million kilograms per year.

The following is a description of the key finding. Further detail and analysis are provided in the body of this Report.

1.3.1 SCL's Own Internal Needs Merit More Fiber, but Not to the Premises

SCL has an increasing need for robust communications capabilities to distribution and transmission assets including substations, field devices, and customers. In our estimation, SCL's key communications priorities would be well served by continued deployment of fiber to distribution substation, for purposes of backhaul. We do not, however, see a business case for FTTP based on SCL's needs alone. Alternative, cheaper technologies are adequate for SCL's "last-mile" connectivity needs—so long as robust fiber in the core of the network is available to adequately backhaul the transmissions from those alternative technologies.

In summary, our analysis suggests that, for purposes of SCL's own needs, the utility would be well served by constructing additional fiber as dictated to support utility substation automation efforts and by increasing the count of the fiber it is currently deploying.

Simply put, the business case for FTTP cannot be made on SCL's internal needs alone. Rather, the primary beneficiaries of fiber to the neighborhood and FTTP are the City and consumers of Seattle, not SCL.

1.3.2 Market Research Demonstrates a Need for Higher Broadband Speeds and Greater Choice

The market research conducted for this Report indicates that Seattle businesses and residences are not satisfied with the status quo in the telephone, cable television, and Internet markets. The research also demonstrates that a majority believes the City should play a role in addressing the shortcomings of the market structure: limited choices of providers and lack of availability of innovative products and services. Most significantly, the market research demonstrates that competing for traditional voice and video market-share would be very difficult for a new entrant such as an FTTP operator. However, a significant, unmet market exists for high-speed, high-capability Internet/data services—a market that the existing providers are not meeting and cannot meet, given the technical limits of their existing networks.

In summary, the following are the key findings of the market research:

- **Consumers value choice more important than bundling or purported "convenience."** Both the residents and businesses surveyed consider the ability to choose services from a variety of providers more important than the "convenience" of bundled telephone, cable television, and Internet services. Incumbent cable and phone companies have, in recent years, strongly promoted the convenience benefits of bundling (specifically, they claim that consumers want to deal with one bill and one provider only for communications services), but the market research demonstrates that consumers do not prioritize bundling and are more interested in choice of providers and choice of evolving Internet-based voice and video alternatives.

- **A majority of respondents believe there is a role for the City to play in addressing the shortcomings of the broadband market.** The market research demonstrates that 85 percent of Seattle residents believe the City should have some role in the development of a broadband communications network. Sixty percent believe that the City should install a network[13] and 25 percent believe the City should encourage a private firm to build a fiber network. Approximately 75 percent of businesses believe the City should have a role regarding broadband access. Fifty-five percent of businesses believe the City should install a network[14] and 18 percent of businesses believe the City should encourage a private firm to build a fiber network.

- **New providers can compete in the shrinking market for traditional voice services only with lower prices.** Telephone/voice has become a commodity product—in a market that is shrinking annually. The market research demonstrates that Seattle businesses and residents are motivated to select voice providers on the basis of price rather than user features. This is quite common in mature markets such that, for example, service attributes such as voice mail are a competitive necessity--not a distinguishing feature. As a result, the only way to compete for voice market-share is by offering lower prices. Compounding the weakness of the voice market, the market research demonstrates that the size of the residential landline market is shrinking; a significant share of residential consumers are using wireless alternatives as their only or primary telephone connection.

- **Residential consumers are frustrated with cable television options and pricing—but these are not areas where new providers are likely to be able to offer change.** The market research demonstrates that rising prices and forced bundling of channels have resulted in significant consumer dissatisfaction with cable television choices. Consumers want lower prices and the choice of paying only for the channels they watch rather than for hundreds of channels they barely use. But new entrants to the traditional cable television market have limited (if any) flexibility to meet these consumer demands. Content-owners (such as Disney, ESPN, and other programmers) charge cable television providers for the right to broadcast their programs. These payments have historically increased substantially each year--and are the main cause of rising subscriber costs. Further, the content-owners generally can set terms with respect to (1) bundling of their

[13] Forty-two percent a fiber network, 18 percent a wireless network.
[14] Forty-one percent a fiber network, 14 percent a wireless network.

channel with others, (2) what channel the program is on, and (3) the percentage of all subscribers that receive the program. These requirements have the effect of precluding cable providers from offering "a la carte" programming and limit the ability to hold down consumer costs.

- **The greatest market opportunity for a new entrant is Internet/data services.** The market research demonstrates that residential consumers are dissatisfied with the value of carrier Internet services. Consumers are looking for higher reliability, greater capacity, and faster speeds. Residential respondents to the surveys demonstrate a clear need for symmetrical (up and downstream) 100 Mbps, high capacity, high reliability, unfettered Internet offerings in a price-range of $40 per month.[15] The market is currently not meeting these needs—not only with respect to price, but also with respect to symmetry, speed, reliability, and openness. Frankly, it is unlikely that these market deficiencies will be addressed absent City action, in light of the existing market structure, the legacy copper and coaxial networks operated by Qwest and Comcast, and the incumbents' political efforts to protect old business models. The incumbent carriers around the country benefit from lower, asymmetric Internet speeds, which prolong the lives of their cable television and telephone offerings by limiting the ability of Internet-based applications to meet consumer video and data needs.

1.3.3 The Risk of Various Fiber Plans Increases in Proportion to Ambitiousness and Benefit

The market and other research in this Report suggest that a business case exists for SCL to expand its fiber reach and count with relatively little risk, but that the more ambitious FTTP scenarios entail greater financial risk for the City and SCL—even as they enable enormous direct and indirect benefits for the City and consumers.[16]

To address the needs identified by the market research and the goals set forth by the Mayor and the Task Force, this Report investigates the risks and rewards of five business/technical approaches for SCL's consideration. Section 7 includes a detailed comparative matrix of the various options as well as discussion of financial aspects of each model. The following is a brief summary of the analysis and conclusions.

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[15] Such residential offerings may seem like wishful thinking to many Americans, but in major European and Pacific Rim cities, such prices and service attributes are standard. Indeed, in Tokyo, approximately $45 per month buys a reliable, symmetrical one gigabit per second product—10 times the speed discussed in this Section and 500 to 1,000 times the speed of many broadband services in the US.

[16] This Report primarily addresses the quantifiable, direct financial factors that are relevant to the potential internal business plan for the models under consideration. It is important to recognize that the business case for municipal fiber networking extends far beyond the pro forma income statements—indeed, such projects are undertaken not to realize revenues but rather to realize the economic and community development benefits of next generation broadband infrastructure--such key items as competition, economic competitiveness, small business growth, environment protection, job creation, livability, education, increased property values, and digital inclusion. Given the considerations at issue in this Report, the Report addresses primarily the direct cost and revenue aspects of the business case for the alternative business models.

1.3.3.1 Infrastructure Participation Model: Expanded Internal SCL Fiber

In this conservative model, SCL assists the City by expanding available fiber assets and adding spare conduit during underground construction. SCL simply expands the reach and volume of backbone fiber it is currently building to connect its substations and meet North American Electric Reliability Corporation (NERC) requirements. For now, SCL plans to build fiber to meet its own needs and to satisfy NERC requirements for security. SCL could potentially dramatically increase the fiber count in the new construction at relatively modest incremental cost. At the same time, SCL could add additional fiber for its own needs, as it likely needs to expand the reach of the fiber to meet its own strategic goals and objectives.

The increased fiber could prove an attraction to a private sector investor or operator. CTC's engineers estimate that if the fiber count were increased, a private sector FTTP provider could lease that dark fiber and avoid approximately $3.5 million in construction costs. We estimate that 144 additional fibers in the backbone network would help facilitate construction of an FTTP network (or other kinds of communications distribution).

In this model, these assets are made available to the City or other provider through a lease. This model entails almost no risk to SCL or the City.

1.3.3.2 Key Account Model: Modest SCL Fiber Backbone and Dark Fiber Leasing

In this model, SCL seeks to offer dark fiber[17] connections, through a lease, to institutions and businesses in Seattle. This model entails very little risk for SCL and the City, while still offering technology advancement, infrastructure, future proofing, and encouragement for private sector innovation. As a result, this model modestly facilitates the goals of the City while still minimizing risk.

SCL could lease the excess fiber and thereby recover incremental investments, so long as the lease is structured so as not to violate NERC requirements.[18] Under the lease, SCL would receive a revenue stream with very little risk associated.

This model requires a smaller capital investment than does more extensive fiber deployment and the available data suggest that SCL could realize a modest revenue stream from this model—at the same time as meeting its own communications needs and reducing the cost of leasing circuits.

[17] Dark fiber refers to the lease of point-to-point fiber strands. The lessee of dark fiber is responsible for adding electronics to "light" the fiber.
[18] Under NERC requirements, SCL must maintain physical access to any strands in SCL routes, and prohibit access to substations to non-SCL employees. In addition, SCL may have to own all equipment located in the substation.

This model for fiber construction and leasing has been successfully implemented by another large city municipal electric utility for nearly a decade. A case study of this utility's fiber leasing experience is provided in Section 7 below.

Although some dark fiber exists in Seattle, the existing providers are generally unwilling to lease to new, competing providers or themselves to offer dark fiber as an alternative to their lucrative provisioned circuits such as Ethernet.

Significantly, though this model will fill a market vacuum for selected business customers, it will not address the needs of consumers and small businesses throughout the City. Like the infrastructure participation model, this Key Account model does offer some incentives for a private provider to construct FTTP infrastructure, but is unlikely to be enough to attract private sector investment in FTTP because it does not significantly lower the costs of market entry. That scenario (described in the options below) will entail greater financial risk but also potentially enable far greater long-term direct and indirect benefits to the community.

1.3.3.3 Fiber-to-the-Neighborhood Model: Extensive SCL Fiber Backbone, Leasing

In this model, SCL or the City builds a Fiber-to-the-Neighborhood infrastructure to lease to a private provider. This infrastructure is financed through City funds or other non-SCL revenue source. 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 their own 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 year 1 construction costs.

The City of Palo Alto is currently negotiating with a consortium of companies for FTTP financing, construction, and operations. According to information available as of this writing, the City will be required to provide substantial fiber assets but not financing, although it may be asked to guarantee the private Consortium's investment.

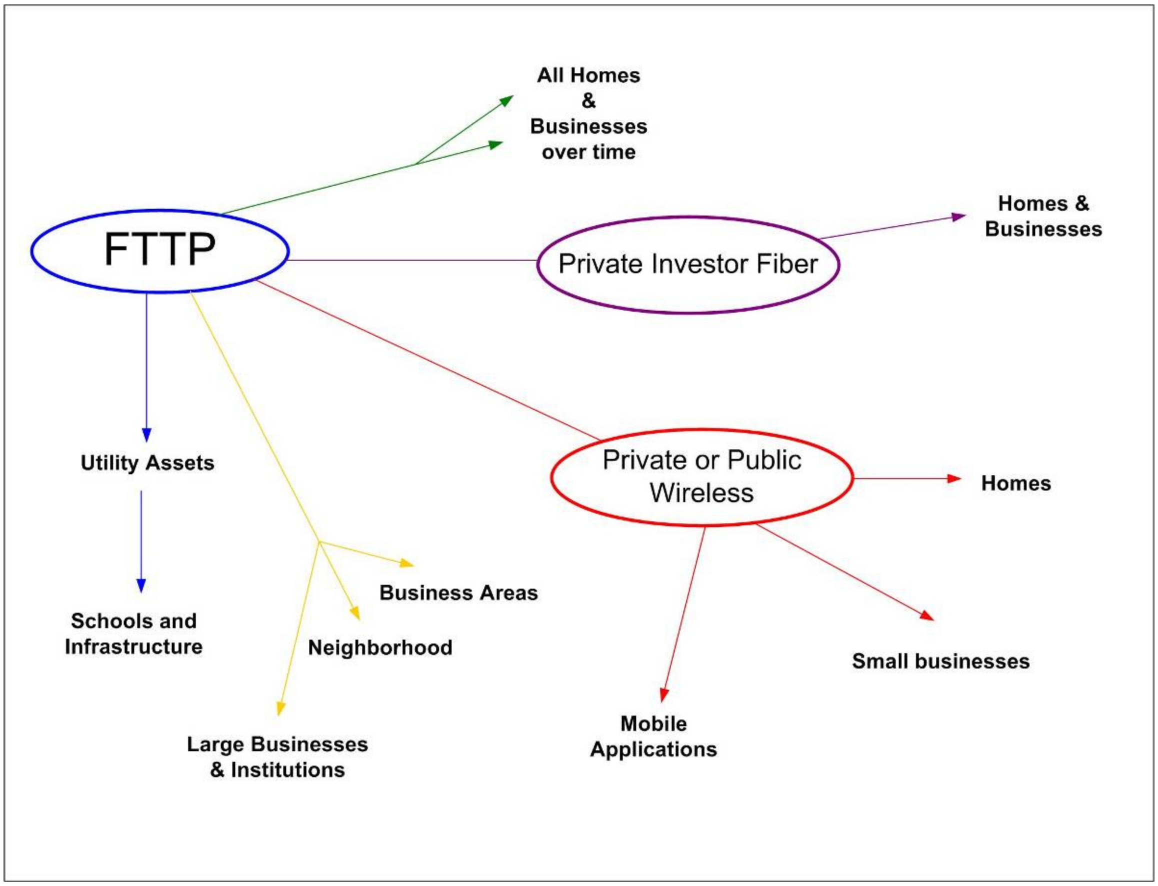
In keeping with the Mayor's goal for this initiative, the model has the potential to stimulate private efforts to offer diverse, cost-competitive services to residents and businesses. The strategy creates a platform for broadband competition and innovation by separating network ownership from service-provision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

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, SCL, the City, or other 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, SCL 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 SCL and 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 SCL 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[19] 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.

1.3.3.4 Open Access Model: FTTP Deployment and Leasing of Wholesale Services

In this model, which also involves City ownership of the "passive layer" of the network, SCL or the City builds, owns, and operates fiber all the way to the home and business. Retail providers lease access to the infrastructure which they use to deliver retail services to consumers. Financing of this network is secured through identified City funds or other non-SCL revenue source.

This model requires less SCL involvement in operations than does a "retail" model because it does not require SCL to go into the business of providing communications services itself. At the same time, the model leverages SCL's considerable right-of-way knowledge and utility maintenance capabilities.

This model does meet the objective of full FTTP deployment but involves significant risk with respect to recovery of project costs through network revenues. There does not yet exist in a major US city a case study or empirical data to demonstrate the potential success of this model relative to the risks of revenues failing to cover expenses. The business case for this model is based on its capability to enhance competition and choice and to enable the myriad economic and communities benefits of a world-class infrastructure.

1.3.3.5 Retail Model: Municipal FTTP Deployment and Service Provision

In this model, SCL or the City builds FTTP infrastructure and offers retail services to businesses and residences. Financing of this network is secured through identified City funds or other non-SCL revenue source.

CTC advises caution with respect to a retail FTTP network operated by the City or SCL. Neither our market research nor the empirical data demonstrate that the City or SCL can expect to obtain and sustain the market penetration necessary to support a retail model.[20]

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[19]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.

1.3.4 SCL Assets May Facilitate Private FTTP Deployment, but Caution is Merited

SCL, like many municipal electric utilities, owns assets in key locations that could greatly reduce FTTP deployment costs for SCL or a private sector communications provider. Construction costs could be reduced through use of such assets as fiber optics, communications conduit, utility poles, and facilities.

In addition, projects such as the potential FTTP network may create opportunities for SCL to cost-effectively deploy new assets through realization of economies of scale in shared construction. New assets are built more cost-effectively if they are coordinated with other new projects such as distribution system replacement or upgrades.

All of these strategies, however, merit great caution and legal evaluation—to determine risks with respect to security, cost recovery, and regulatory compliance.

1.3.5 SCL Should Preserve its Options with Respect to Joint-Use Fiber

SCL currently meets some of its connectivity needs by partnering with the City, schools, and other institutions in a Joint-Use fiber-build that has demonstrated significant success and stands out among government fiber projects around the country. SCL owns a partial interest in the Joint-Use fiber, which is located in the power space on the utility poles co-owned by SCL and Qwest. In response to NERC requirements for greater security and control, SCL is in the process of building wholly-owned fiber and moving its fiber-based applications from the Joint-Use fiber to the wholly-owned fiber.

To our knowledge, if SCL relinquishes its ownership interest in the Joint-Use fiber, there may be a risk that the fiber could no long remain in the power space on the utility poles.[21] We recommend that SCL retain ownership and day-to-day maintenance of its share of the Joint-Use fiber, even as SCL shifts to use of wholly-owned fiber. In this way, the Joint-Use fiber can remain in the power space[22] on the poles and enable the other Joint-Users to continue to use the fiber in its current placement. In return, SCL would receive lease payments. In the event that the City and SCL do identify a private sector partner interested in the FTTP project, SCL's interest in the dark Joint-Use fiber can be leased to that private sector partner for a fee, thereby

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[20] It is important to note that the business case for FTTP is not limited to such easily-quantified matters as cash flow and capital investment—rather, the business case for such a network also includes the less quantifiable financial factors, including economic development, small business empowerment, job creation, livability, environment protection, education, increased sales tax and real estate tax revenues, increased property values and other factors that measure the overall benefit of a next generation communications infrastructure such as FTTP.

[21] As is discussed below, CTC recommends that SCL seek specialized legal counsel on any strategies contemplated.

[22] Assuming minimal required make-ready, moving the Joint-Use fiber from the power space to the communications space will cost approximately $4.5 million, just as much a building new fiber.

preserving SCL's options and also ensuring that the fiber can remain in its placement in the power space.

1.3.6 SCL and City Agencies Should Build Fiber Assets Now for Future Projects

Opportunities for cost-effective installation of fiber arise each day as City and SCL crews work in the right-of-way. At a minimum, the City and SCL should consider adopting a future-looking policy to add to existing fiber and conduit infrastructure at every opportunity to build up critical mass. Every SCL and other municipal project has the potential to provide long term cost savings on communications infrastructure.

Conduit and fiber are the keys for future-proofing the City's infrastructure. There is a low incremental cost to install fiber or conduit during any capital improvement project or repair. This expense is not just advisable for SCL but is also a worthwhile expenditure for all other public agencies working in the right-of way. We recommend the adoption of mutually-agreeable, detailed specifications for installation of conduit or fiber optics during any relevant capital improvement project or repair, including:

- Road construction or repair by SDOT
- Sewer or water line replacement or repair by SPU
- Electrical work by SCL
- Sidewalk repair and replacement
- Relocation to underground of aerial utilities by SCL or any other entity
- Other open trenching opportunities initiated by private companies
- Any other circumstance under which any City department is working in the right-of-way

Immediate adoption of a conduit-fiber-placement strategy would capture each of these opportunities.

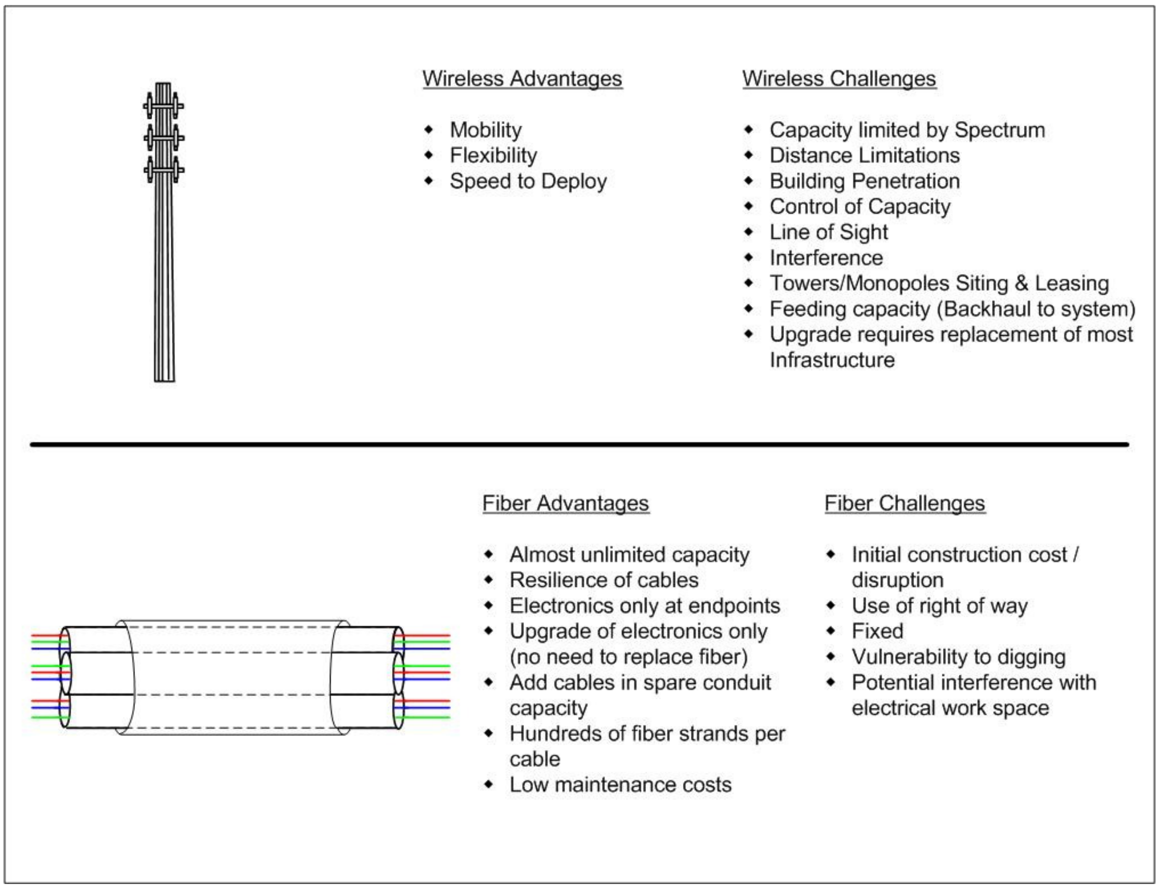
Similarly, the City and SCL should consider taking advantage of private sector work in the right-of-way. For example, in the event of commercial carrier construction, the City and SCL could simultaneously install fiber or conduit at far lower cost than if it undertook the installation itself. Alternatively the City and SCL could negotiate conduit or dark fiber during make-ready and permitting processes. Every private sector project in the right-of-way offers an opportunity for partnerships.

1.3.7 Fiber Holds Advantage over Wireless for Capacity, Security, and Long-Term Cost

Fiber and wireless are frequently posited as competing technologies, a common — but inaccurate — perception. Neither can supplant nor compete with the other; rather, ***these technologies inherently enhance and complement each other***. Wireless delivers mobility and fiber delivers capacity and speed. In addition, wireless needs fiber: for purposes of reliability and speed, a wireless network requires a robust fiber optic core backbone that connects it to core resources, to the Internet, and to other public networks. High wireless performance depends on backhaul over a core fiber network and, correspondingly, a wireless network will deliver poor performance if backhaul is inadequate, regardless of the quality of the wireless network itself.[23]

Each network technology has its own distinct advantages and challenges, but CTC finds that fiber is a more flexible, future-proof, and capable technology for purposes of the goals articulated by the Mayor and by the Task-Force.

Figure 2: Wireless and Fiber Advantages and Challenges



Wireless networks provide mobility and flexibility. Wireless PDAs, telephones, laptops and other devices are increasingly popular and becoming the dominant conduit for using data and voice services. However, wireless is limited in capacity and, as a result, these devices are not ideal for key applications such as high-quality video, imaging, enterprise IT functions, data and IT recovery and backup, remote presence, distance learning, telemedicine, and media production.

[23] In our analysis, the unsuccessful attempt to use (supposedly) lower-cost wireless backhaul was one of the key reasons for the technical failure of many of the high-profile municipal wireless initiatives of recent years.

Wireless holds a benefit with respect to speed to deployment and flexibility. Once a wireless service provider begins offering services, it can add capacity or coverage by adding base stations and antennas. As a result, the wireless service provider can typically act and respond more quickly than wired service providers newly entering an area.

However, there are significant challenges in providing effective wireless service. Design limitations such as power levels, spectrum availability, and required data capacity require that individual antennas or base stations serve limited areas, such as one mile or less. This requires the provider to expend resources and time in placing the base stations. The challenge of deploying and managing wireless is also complicated if unlicensed frequencies are used for such technologies as WiFi—operations must be at lower power, requiring significantly more hardware and powering in the field, and there is still risk of current and future interference from other unlicensed users.

Further, when a wireless provider needs to migrate to a more advanced technology platform, it may need to re-engineer and redesign its entire system. A thorough wireless upgrade, as may be required a few times per decade, may require the provider to replace a significant percentage of its capital investment.

Fiber networks hold the advantage in capacity, robustness, and security. Fiber provides almost unlimited capacity. Each single fiber optic strand is theoretically able to duplicate the entire electromagnetic spectrum available to all wireless users. In a practical sense, the capacity limit is imposed by the capability of the electronics connected to the fiber. Further, capacity is constantly increasing as technology improves. At the current time, each fiber strand is capable of operating at hundreds of Gbps (gigabits per second) with off-the-shelf technologies—more than 1,000 times the capacity of backbone wireless technologies and 100,000 times the capacity of the fastest, most sophisticated wireless services available to consumers on PDAs and laptops. These speeds will grow dramatically as new technologies become available.[24]

Fiber is resilient and reliable. It can be armored. It can tolerate falling from utility poles or being pulled laterally by out-of-control vehicles. Fiber electronics can be configured to operate in a fail-safe mode.

Fiber has a life of decades, assuming adequate maintenance, and it can cost-effectively and simply be scaled to dramatically higher speeds as new electronics become available. Capacity can be increased by upgrading the electronics at the endpoints, which may be hundreds or

[24] Wireless speeds will also grow, but cannot keep up. As a matter of physics, each individual strand of optical fiber offers the entire electromagnetic spectrum for use in communications—comparable to the entirety of wireless spectrum, most of which is not available for public use under Federal Communications Commission and military restrictions. Even if the entire electromagnetic spectrum did become available for commercial wireless, the laws of physics dictate that this theoretical wireless capacity would still be less than the terabits per second (Tbps) currently available in one fiber optic cable with existing off-the-shelf technology. Moreover, most of the wireless communication would be limited by range and by line-of-sight, unlike transmissions over fiber. In addition, substantial backbone fiber optic capacity would be necessary to connect the wireless communication system to its core and to other networks.

thousands of kilometers apart and kept in secure indoor locations. There is typically no need to "touch" the outside fiber optic cables to add customers or capacity, and maintenance of outside plant is relatively undemanding and, on average, inexpensive.

There are significant challenges in fiber optic network technology, especially in the high cost of initial construction—particularly for underground installation or where extensive make-ready is required for aerial installation.

There are also limitations in the type of services that fiber can provide. Fiber connects only to fixed locations. It may not be cost effective to extend fiber to a location that will only be served infrequently or temporarily.

1.3.8 SCL Should Seek Specialized Legal Counsel Regarding Any Strategies Considered

CTC recommends that SCL seek counsel regarding any strategies considered for transfer of assets to other entities (including the City of Seattle) and for any provision of communications services under any of the models discussed in this Report.

As CTC has discussed extensively with SCL, CTC is not a law-firm and does not give legal advice, and this Report does not purport to offer guidance or expertise on legal matters. CTC recommends that SCL seek specialized legal counsel on any strategies contemplated.

In the event that SCL contemplates transfer or lease of any of its assets to another entity in furtherance of the FTTP project, SCL should seek specialized counsel regarding legal restrictions and requirements associated with utility release of assets to a third party, including to the City. It is likely that such transfer is subject to State of Washington legislation, NERC requirements, and other applicable rules and regulations. SCL's risk management and legal counsel should evaluate how SCL could make those assets available both safely and legally. To our understanding, SCL may be restricted in its ability to grant free access to facilities, to allow co-location or access to facilities such as substations, to allow physical access to hand-holes or other fiber access points, and to finance or secure non-electric projects with electric revenues.

2. Fiber's Potential to Meet SCL Communications Needs

As part of this study, CTC met with designated SCL staff[25] to determine existing communications needs and to assess how fiber-optic based communication services meet these needs. This Section of the Report summarizes the key network connectivity needs identified during this process.

In summary, SCL has an increasing need for robust communications capabilities to distribution and transmission assets including substations, field devices, and customers. In our estimation, in the long-term SCL's key communications priorities would be well served by deployment of fiber deep into the neighborhoods of the City, for purposes of backhaul. We do not, however, see a business case for Fiber-to-the-Premises (FTTP) based on SCL's needs alone. Alternative, cheaper technologies are adequate for SCL's "last-mile" connectivity needs—so long as robust fiber in the core of the network and deep into the neighborhoods is available to adequately backhaul the transmissions from those alternative technologies.

2.1. SCADA

To address growing supervisory control and data acquisition and distribution automation needs, SCL began planning a fiber network that connects each of the distribution substations to the operations center. The planned fiber to the distribution substation eliminates the immediate need to use SCL's interest in the joint-use fiber—making that fiber potentially available for a new initiative.

2.2. "Smart Grid" and Other Automation Applications

SCL has explored the use of broadband over power line, power line carrier, fixed radio, and fiber-based alternatives to address its need for Smart Grid applications and other distribution and customer automation applications such as:

- advanced metering infrastructure (AMI)
- automatic meter reading (AMR)
- load management (LM)
- outage management (OM)
- demand side management (DSM)[26]

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[25] Discussions were held with Ms. Carol Butler, Mr. Eric Campbell, Mr. Rob Collins, Ms. Carol Dickinson, Mr. David Docter, Mr. Patrick Gallagher, Mr. Franklin Lu, and Mr. Roy Lum.

[26] Over the past few decades, the operation and management of the electrical grid in the United States remained relatively unchanged. The wide-spread August 2003 electrical outage in the Eastern U.S. highlights the devastating impact of an electrical service loss and the country's vulnerability in this area. In addition to the need to address the

In the examination of the applications requirements, SCL determined that a broadband connection (Broadband over Powerline or FTTP) is not required to support Smart Grid or other customer automation applications. In fact, vendor products that interface with FTTP or a consumer provider broadband connection are, at the current time, more expensive than Broadband over Powerline, Power-Line Carrier, or radio-based products.[27] Another factor militating against broadband products is that the effectiveness (performance and cost) of automated metering infrastructure requires connection of all customer meters in a given geographical area. Even the inability to connect to 10 percent of meters in a geographical area reduces automated metering infrastructure benefits.

Given these conditions, SCL staff determined that SCL should seek a radio communications automated metering infrastructure solution -- even if FTTP were available throughout the City of Seattle and available to SLC at no cost.

2.2.1. *Examples of Industry Smart Grid and AMI Deployments*

Many utilities—investor-owned, cooperative, and municipal—are in the early stages of planning and deploying Smart Grid technologies. For example, Pacific Gas and Electric is deploying a Power-Line Carrier network that enables a range of customer and distribution automation applications. The Pacific Gas and Electric strategy is to capture early benefits with existing technologies and vendor products.

A more far-reaching example is Xcel Energy's city-wide "Smart Grid City" effort in Boulder, Colorado. The pilot project provides "an international showcase of Smart Grid possibilities … [and] a comprehensive demonstration of an intelligent grid community."[28]

The city-wide pilot incorporates a range of customer and distribution automation applications. In particular, the pilot includes "Smart Homes" that offer:

- consumer-added green power sources (solar, wind)
- customer interaction with Xcel Energy
- smart thermostats, appliances, and in-home control devices
- real-time and green pricing signals

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nation's exposure, we are faced with sharply rising fuel prices and growing environmental sustainability issues. As a response to economic, reliability, safety, and environmental concerns, the electric industry is in the process of developing and implementing "Smart Grid" or "Modern Grid" strategies. For more information, see www.netl.doe.gov/moderngrid/. For further information.

[27] SCL operates a 26KV distribution system, unlike the typical 12.5 KV. Power-Line Carrier and Broadband over Powerline vendors indicate that their standard products require modifications to operate on a 26KV distribution system. This fact greatly reduces the cost -effectiveness and performance of Broadband over Powerline and Power-Line Carrier technologies for SCL.

[28] Michael Lamb, Xcel Energy, "Xcel Energy's Smart Grid City—Moving an Industry," presented at Wisconsin Public Utility Institute seminar, April 29, 2008.

- plug-in hybrid electric cars (charging and grid energy storage)

An integral part of the Xcel Energy pilot is the use of Broadband over Powerline for communications to participating households and businesses.

2.2.2. *The Need for Fiber to Backhaul Smart Grid/Automation*

Although in the examples above fiber is not specifically mentioned as an enabling technology, fiber drives robust and secure communication to distribution substations and is an essential need. Fiber is a critical, growing component of facilitating customer and distribution automation/Smart Grid technologies.

SCL is in the process of implementing a radio-based automated metering infrastructure pilot using Cellnet's 900 MHz radio network. The pilot is located in South Lake Union. If SCL pursues an implementation of a mesh radio automated metering infrastructure technology beyond the pilot, the future need increases for SCL to have fiber access to automated metering infrastructure data concentrators (radio nodes) in neighborhoods.

Table 1 demonstrates how the media required to enable Smart Grid applications require substantial backhaul connectivity—preferably fiber.

Table 1: Smart Grid Opportunities for Fiber

Smart Grid Communication Media	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 station) which covers a 2 to 7 mile radius
Meshed Radio	Silver Spring	Data collection nodes—2 to 4 per square mile (mesh nodes placed to form a grid with 500- to 2,000-foot spacing—one data collection node is required per four to eight mesh nodes)
Fiber-To-The-Premises (FTTP)	Tantalus Systems	Requires fiber drop to customer premises
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.

2.3. Security

SCL must follow North American Electric Reliability Corporation (NERC) and other security requirements. When compared to leasing options, the use of SCL-owned and maintained fiber increases the security and control SCL has over sensitive consumer and system data.

Although SCL indicates reluctance and concern over leasing services from a provider, so long as SCL controls the physical access to the fiber, it can position itself to offer dark fiber to other entities.

2.4. Potential Savings Available from Replacing Leased Circuits

SCL currently addresses its connectivity needs by partnering with the City, schools, and other institutions in a Joint-Use fiber-build, operating a mobile radio system, and leasing services from Qwest and other providers.

SCL is in the process of deploying new fiber to each of its substations. SCL has determined that the benefits of this strategy (cost avoidance by replacing leased circuits, increased security through elimination of telephone modems, and increased reliability) exceed the cost of constructing the fiber.

2.5. Other Considerations

Fiber not used to support core electric utility uses and applications will likely take a lower priority in terms of repair and maintenance. To balance priorities, additional staff dedicated to non-electric infrastructure is required.

3. Potential for Leveraging SCL Assets for FTTP

This Section of the Report documents SCL's existing infrastructure so as to evaluate whether existing assets can be leveraged for future fiber projects. Unless otherwise noted, all data in this Section are based on information provided by SCL staff in meetings with CTC.

CTC's experience demonstrates that municipal electric utilities frequently own assets in key locations that greatly reduce network deployment costs for the utility, City, or other communications provider.

SCL has invested in communications infrastructure and in skilled staff—for networking, outside plant, operations, and planning. In summary, SCL communication assets include:

- Fiber optic cable
- Communications conduit
- Utility poles and attachments
- Facilities such as distribution substations
- Communication towers[29]

Projects such as the potential FTTP network may create opportunities for cost-effective deployment of new assets through realization of economies of scale in shared construction. New assets are built more cost-effectively if they are coordinated with other new projects such as distribution system replacement or upgrades.

3.1. Infrastructure

Through master planning, project coordination, construction, and asset management, SCL has amassed a significant amount of communications infrastructure, some of which could potentially be leveraged for a private or public FTTP project. As SCL has noted, great caution is merited for purposes of security and regulatory compliance.

3.1.1 Fiber Optic Cable

SCL is considering vacating its portion of the Joint-Use fiber after completing construction of the fiber to connect SCL distribution substations. The Joint-Use fiber may offer some value to a potential FTTP provider, but it's important to note some of the limitations associated with this fiber:

[29] CTC recommends that SCL seek counsel regarding legal restrictions and requirements associated with utility release of assets to a third party, including to the City.

- Some segments have low fiber strand count--of the 47 fiber segments in the joint use fiber, 16 have 12 or under fiber strands; 15 have 14 to 28 strands; and 16 have 48 strands
- Some of the joint-use fiber is located in locations where SCL likely cannot sell or transfer ownership
- If SCL were to transfer ownership, it (or the new owner) may be required to vacate fiber entering a SCL substation and add a bypass

Another significant potential fiber asset is the planned fiber backbone connecting each of SCL's substations. For now, SCL plans to build fiber to meet its own needs. In the future SCL may need to expand the reach of the fiber to meet its own goals and operating requirements. Significant additional fiber can likely be added at relatively low incremental cost as necessary.

3.1.2 Conduit

SCL does not have spare conduit for fiber optic cable. To assist in fiber deployments, SCL may consider installing spare conduit in conjunction with distribution system upgrades and repairs. The long-term benefit of having spare conduit available is much greater than the incremental conduit costs in new construction or repair projects.

3.1.3 Facilities

The value of SCL facilities such as substations to a FTTP provider is limited. SCL security at substations appropriately precludes access at the substations by non-employees. NERC requirements may also preclude any non-SCL owned equipment from being located in the substations.

3.1.4 Communications Towers

Over 70 antenna sites have been constructed on SCL transmission assets, communication towers, and wood poles. Those sites primarily serve cell phones. Annual revenues to SCL from antenna sites exceed $900,000.

There has been an increase in requests for pole access over the past years, some of it as a result of the expanding broadband wireless network and increased interest in WiFi and other wireless projects. Maintaining aesthetics, minimizing neighborhood complaints, complying with zoning requirements, maintaining worker safety, and maintaining consistency in pole attachment charges are important considerations in SCL's antenna approval process.

For a private sector FTTP provider, access to communication towers is of relatively little interest and is unlikely to serve as an important incentive to investment.

3.2 Staff Resources/Expertise

SCL personnel are constructing, maintaining, and supporting a variety of communications infrastructure used to support electric utility networks[30] throughout the SCL service area. They represent an important form of value for SCL, which can leverage their expertise to plan and guide future fiber optic communications projects. SCL expertise includes:

- Construction Oversight and Inspection
- Communication Integration
- Fiber Monitoring
- Accounting
- Fiber Maintenance and Repair

SCL maintains significant internal expertise but, like most electric utilities, finds that technical and line worker staff availability is limited. Plans for future communications projects must recognize that SCL and all utilities face difficulty finding qualified employees just to fill open positions in SCL's existing business areas.

3.3 New Capital Improvement Projects

SCL is currently considering a range of capital intensive projects. Opportunities for cost-effective installation of fiber arise each day as SCL crews work in the right-of-way. Each new capital project offers the opportunity to add to existing fiber and conduit infrastructure to build up critical mass for a future FTTP project or for meeting SCL's own needs. There is a low incremental cost to install fiber or conduit during any capital improvement project or repair.[31]

SCL's potential upcoming capital improvement projects, in order of priority, include:

1. **Distribution system upgrades.** The electric distribution system is in need of considerable work, including pole and feeder replacement. During any pole or route changes consideration can be given to help ensure access in the communication space is available for a future FTTP provider.[32]

2. **Substation fiber.** SCL is building fiber between its substations. As is discussed above, increasing the strand count would entail small incremental cost and would enable leasing of strands without impacting SCL needs.

3. **Outage management.** SCL plans to upgrade its outage management software and links to automated metering infrastructure and Smart Grid applications.

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[30] SCL uses the term "network" to describe its electrical distribution system.
[31] This policy would be advisable for SCL but also for all other public agencies working in the right-of way. As is discussed in Section 1 above, we recommend the adoption of mutually-agreeable, detailed specifications for installation of fiber optics during any relevant capital improvement project or repair.
[32] SCL cannot reserve fiber in the communication space.

4. **Automated Metering Infrastructure (AMI) and Smart Grid**. Over time as automated metering infrastructure and Smart Grid technologies are deployed, SCL may benefit from having fiber access in selected neighborhoods. Working with a private sector FTTP provider to realize efficiency of scale may reduce implementation costs for both SCL and the FTTP provider.

5. **Energy Management System (EMS).** This upgrade has no impact in encouraging an FTTP deployment.

6. **Supervisory Control and Data Acquisition (SCADA).** This upgrade requires SCL to have fiber access to each substation.

7. **Automatic Generation Control (AGT).** This upgrade has no impact in encouraging an FTTP deployment.

4. Technology Models and Risk Assessments

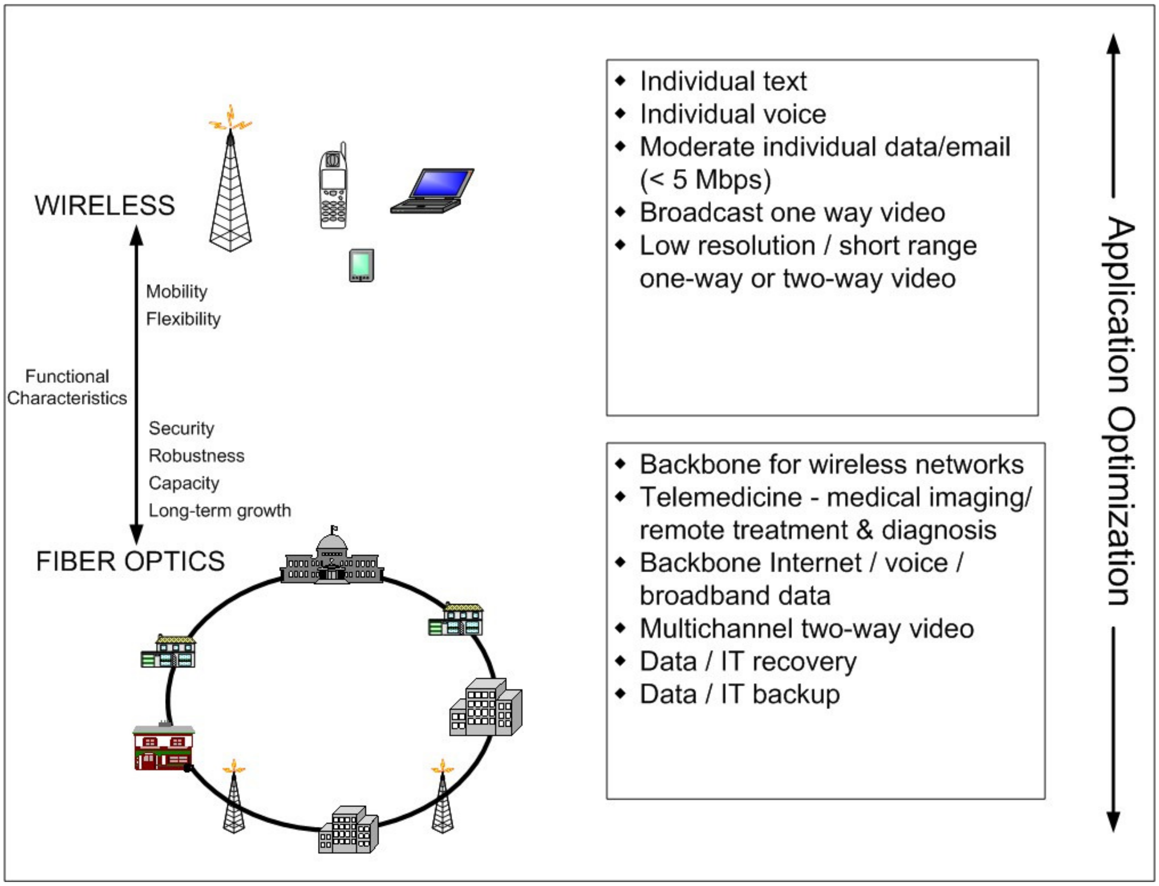
This Section of the Report describes and evaluates the significant differences between fiber and wireless technology. The Section attempts to describe each medium's advantages and disadvantages relative to the other, and makes the case that they do not supplant or compete with each other; rather, ***these technologies inherently enhance and complement each other***.

Wireless networks provide mobility and flexibility. A wireless network can be ubiquitous and available to any authorized user with a compatible device. User devices are varied and increasing in performance, popularity, and usefulness. A typical wireless personal digital assistant (PDA) device is simultaneously a telephone, an Internet access device, email client, camera, address book, location system, word processor, spreadsheet, audio player, and video player.

Wireless PDAs, telephones, laptops and other devices are increasingly popular and becoming the dominant conduit for using data and voice services. However, these devices are not ideal for some applications, such as high-quality video, imaging, enterprise IT functions, data and IT recovery and backup, remote presence, distance learning, telemedicine, and media production (Figure 3). This is because many of these applications require more processing power or larger interface devices than are available or practical in a small device. It is also because many of the applications are fixed in location and do not benefit from the mobility benefit provided by the PDA. Wired fiber optic networks provide functional advantages in capacity, robustness, and security.

Figure 3 illustrates the complementary, as opposed to competitive, aspects of wireless and fiber technologies.

Figure 3: The Complementary Natures of Wireless and Fiber Technologies



Further, a reliable high-speed wireless network requires a robust fiber optic core backbone to provide connectivity to core resources, to the Internet, and to other public networks. A fiber optic network can provide the wireless network with links to those resources at any speed and is scalable as the wireless network grows in capability and need. A well-designed network architecture links a robust, redundant fiber network with wireless networks at multiple points and over multiple paths and ensures that the wireless network is available and able to grow as more antennas are added.

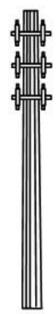
4.1. Relative Advantages and Challenges of Wireless and Fiber

4.1.1. *Advantages and Challenges of Wireless*

Each network technology has its own distinct advantages and challenges (Figure 4).

Speed to Deployment and Flexibility. Once a wireless service provider begins offering services, it can provide services to fixed mobile customers. It can add capacity or coverage by adding base stations and antennas, and it can typically provide significant value without directly causing a high impact on miles of public right of way. As a result, the wireless service provider can typically act and respond more quickly than wired service providers newly entering an area.

Figure 4: Wireless and Fiber Advantages and Challenges

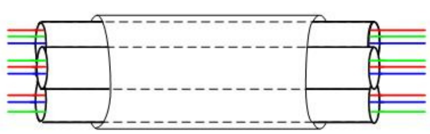


Wireless Advantages

- Mobility
- Flexibility
- Speed to Deploy

Wireless Challenges

- Capacity limited by Spectrum
- Distance Limitations
- Building Penetration
- Control of Capacity
- Line of Sight
- Interference
- Towers/Monopoles Siting & Leasing
- Feeding capacity (Backhaul to system)
- Upgrade requires replacement of most Infrastructure



Fiber Advantages

- Almost unlimited capacity
- Resilience of cables
- Electronics only at endpoints
- Upgrade of electronics only (no need to replace fiber)
- Add cables in spare conduit capacity
- Hundreds of fiber strands per cable
- Low maintenance costs

Fiber Challenges

- Initial construction cost / disruption
- Use of right of way
- Fixed
- Vulnerability to digging
- Potential interference with electrical work space

Design Limitations. However, there are significant challenges in providing effective wireless service. Design limitations such as power levels, spectrum availability, and required data capacity require that individual antennas or base stations serve limited areas, such as one mile or less. This requires the provider to expend resources and time in placing the base stations.

In order for the network to be effective, each base station requires power, backup power (such as generators and batteries), a tall structure for mounting the antennas, coordination with other wireless providers for interference, aesthetic compatibility with the surroundings, connections to the Internet and core network, and secure access to the facility. The provider must address the concerns of the community and the zoning authorities. The provider must typically pay significant rental fees. Every time the provider desires to improve coverage quality or add capacity, it must face these challenges in placing new facilities.

To serve customers who are indoors, providers must increase the density of their base stations and/or add facilities inside buildings, such as microcells or picocells.

The challenge of deploying and managing a wireless network may be greater if an unlicensed technology, such as WiFi, is used. While the provider does not need to obtain an FCC license, it must operate lower-power equipment in accord with FCC requirements. This requires the use of significantly greater densities of antennas, typically one for each street block. In addition to the challenge of placing and powering the devices, the service provider must accept and cope with all existing and potential future interference from other users of the unlicensed frequency band. It must have a technique to ensure that sufficient data bandwidth is available at the many antenna points and to address the unique capacity and interference problems at each antenna site.

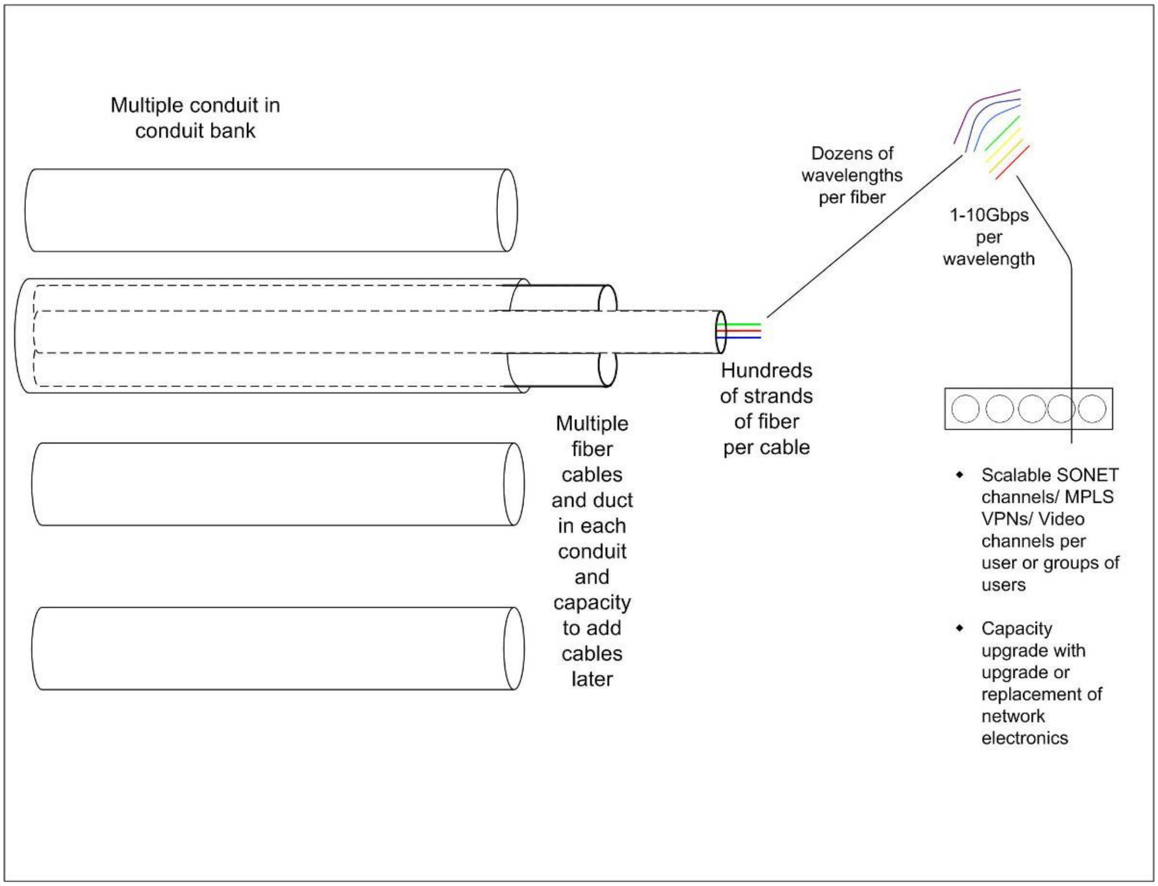
Costly Upgrades and Migrations to New Technologies. Finally, when a provider needs to migrate to a more advanced technology platform, it may need to re-engineer and redesign its entire system. Antennas, receivers, and transmitters may become obsolete, and spacing between base stations may need to be changed. Power and backbone connectivity may need to be upgraded. A thorough wireless upgrade, as may be required a few times per decade, may require the provider to replace a significant percentage of its capital investment.

4.1.2. *Advantages and Challenges of Fiber*

Capacity. Fiber optic technology provides almost unlimited capacity. One way to consider the potential of fiber optics is that each single fiber optic strand is theoretically able to duplicate the entire electromagnetic spectrum available to all wireless users. In a practical sense, the capacity limit is imposed by the capability of the electronics connected to the fiber.

Scalability. That capacity is constantly increasing as technology improves. At the current time, each fiber strand is capable of operating at hundreds of Gbps (gigabits per second) with off-the-shelf technologies (Figure 5). This is over 1,000 times the capacity of backbone wireless technologies and 100,000 times the capacity of the fastest, most sophisticated wireless services available to consumers on their PDAs and laptops.

Figure 5: Current Technologies Support over a Million Gbps in a Conduit Bank and Will Scale Further in the Future



Flexibility and Capability to Serve Multiple Providers. Each cable contains potentially hundreds of strands. Each underground cable conduit system has several cables, potentially dozens, located in separate conduits. As a result, many separate service providers can participate in a single conduit system. Even providers that do not own their own cables or fiber strands can lease discrete capacity from another service provider. Capacity is available in the form of separate wavelengths, channels, and virtual private networks (VPNs) and can therefore be secured from the other users and guaranteed at a particular quality of service.

Resilience and Reliability. Fiber optic cables can be armored and are resilient. They can tolerate falling from utility poles or being pulled laterally by out-of-control vehicles. Fiber electronics can be configured to operate in a fail-safe mode. If the fiber is installed in a ring or mesh topology, the communications can automatically and instantaneously fail over to another route.

Low-Cost Maintenance. Fiber optic capacity can be increased by upgrading the electronics at the endpoints. Depending on the technology and design need, electronic equipment may be dozens, hundreds, or thousands of kilometers apart and kept in secure indoor locations. There is typically no need to "touch" the outside fiber optic cables to add customers or capacity, and maintenance of outside plant is relatively undemanding and, on average, inexpensive.

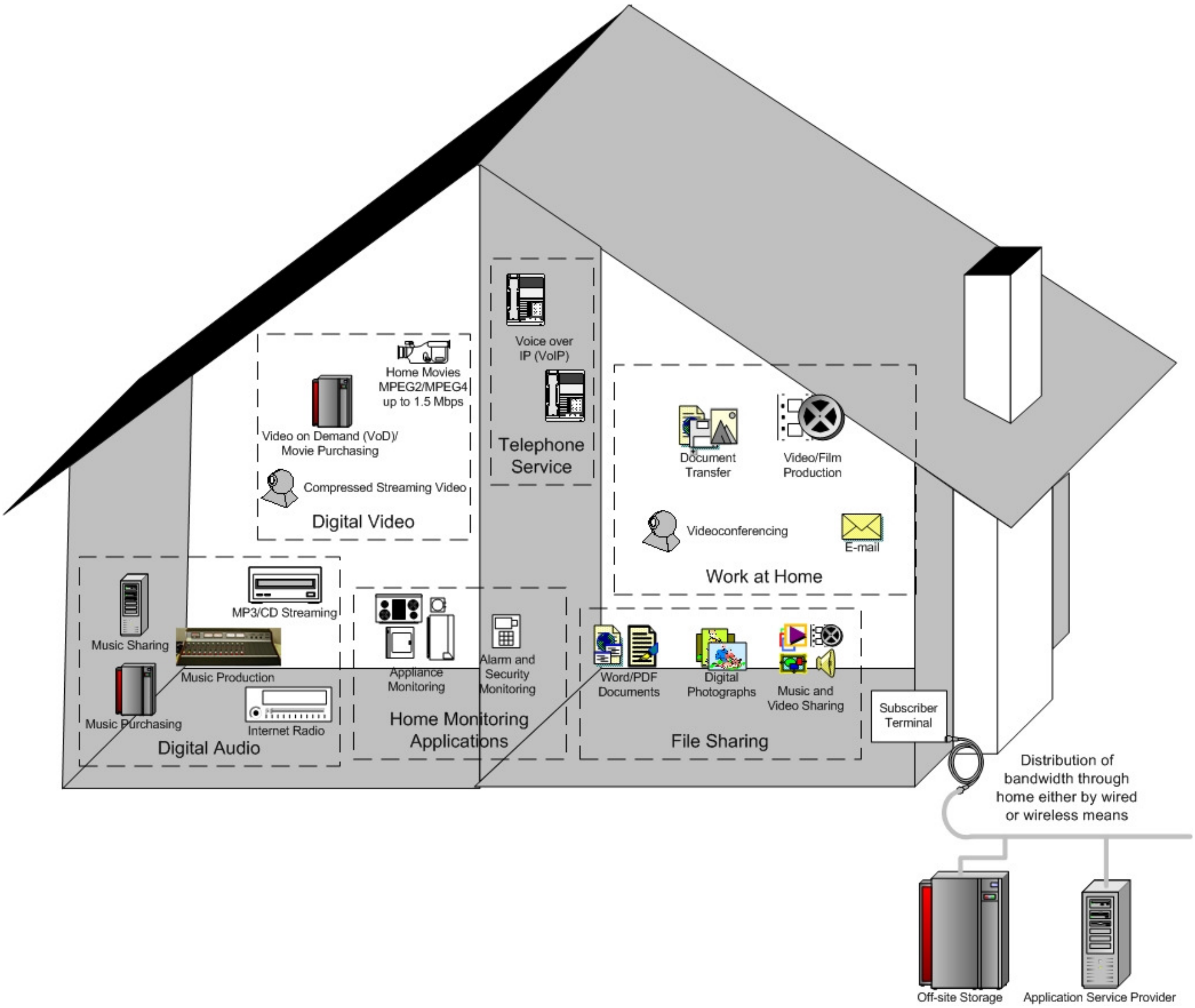
High Cost of Construction. There are significant challenges in fiber optic network technology, especially in the initial construction. Although lower impact construction techniques are emerging, there is still typically a need to perform boring or trenching to install fiber underground. Overhead installation requires space on utility poles. Fiber optic construction can be disruptive, especially if there is no underground conduit present and the area is served by underground communication utilities. Fiber networks must be permitted to be in the local right of way and use space in that right of way. In addition, fiber networks are vulnerable to underground digging, chewing by animals, fire, and damage in cable pathways, for example, in buildings or transit tunnels.

Service Limitations. There are limitations in the type of services that fiber can provide. Fiber connects only to fixed locations. It may not be cost effective to extend fiber to a location that will only be served infrequently or temporarily.

4.2. Capacity Needs are Constantly Expanding

The needs of communications users in residences and the workplace are constantly widening and increasing. A typical household has many more devices than were even conceived of in recent years (Figure 6). The diversity and needs of those devices will to grow as more people telecommute and require the capabilities of the workplace at home. This is true even as particular devices begin to use "compression" and other smart techniques to reduce the bandwidth needed for any particular use.

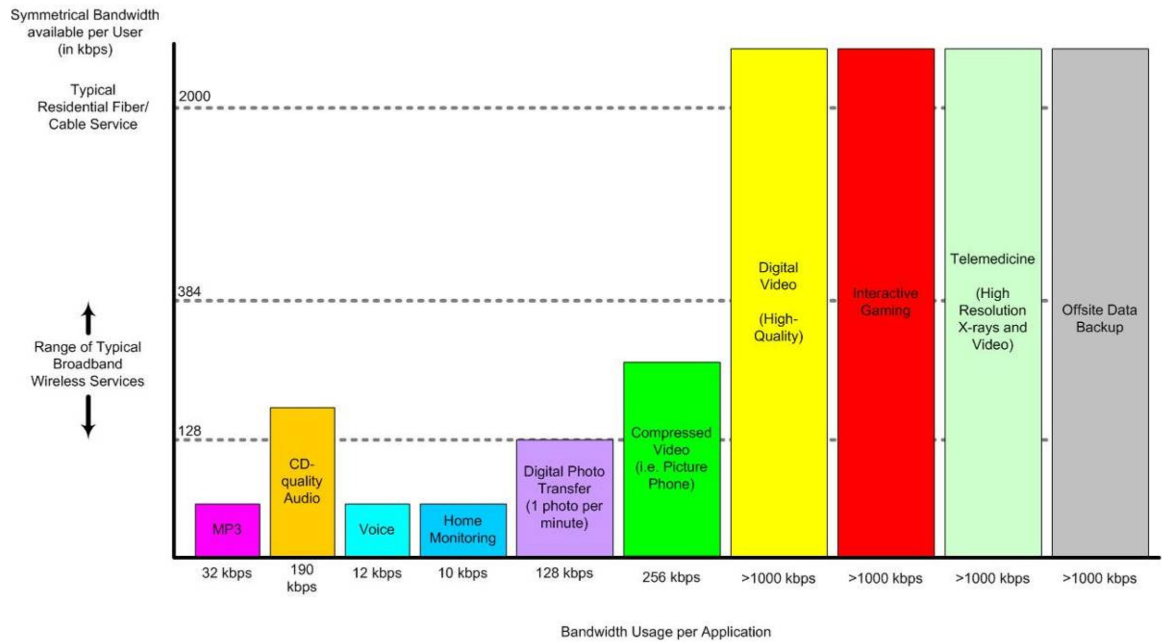
Figure 6: Current, Widely-Used, Home-Based Broadband Applications



Demand will grow as health care becomes more costly and people age, increasing the potential benefit of telemedicine to homes and remote clinics. It will grow as information and communications technologies become part of a strategy to save energy and reduce pollution.

Many of these applications require *symmetrical* (two-way) bandwidth of one or more million bits per second (Mbps). While some broadband wireless providers can provide this speed in the downstream direction (from the network to the user), broadband wireless technologies do not currently provide this stream in both upstream and downstream directions. As a result, interactive applications like telemedicine, digital video, gaming, and backup of files and data will perform poorly on most broadband wireless networks. In fact, some broadband wireless providers limit customers' ability to use these services on their networks.

Figure 7: Typical Symmetrical Bandwidth Requirements

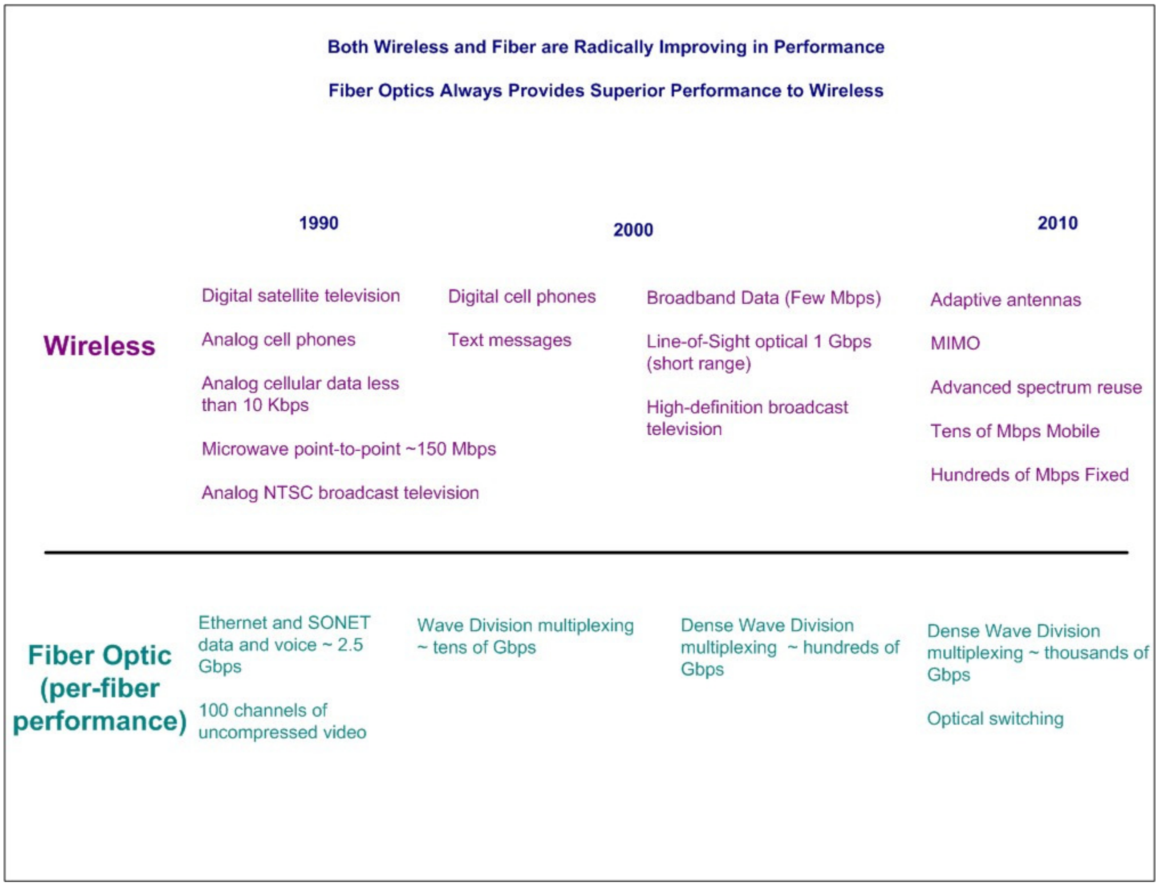


4.3. Both Wireless and Fiber Can Scale but Fiber Always Holds the Capacity Advantage

Communications equipment is big business, and researchers and manufacturers are constantly improving both wireless and fiber technologies. As a result, both can be expected to grow in their capability to offer more speed and capacity. In fact, it is likely that in future year's broadband wireless technology will provide sufficient bidirectional capacity for the applications in Figure 8.

However, fiber optic technology will also improve in performance in those years. A technology roadmap demonstrates the qualitative improvements in capabilities of off-the-shelf technologies since the early 1990s (Figure 8).

Figure 8: Wireless and Fiber Performance Roadmap

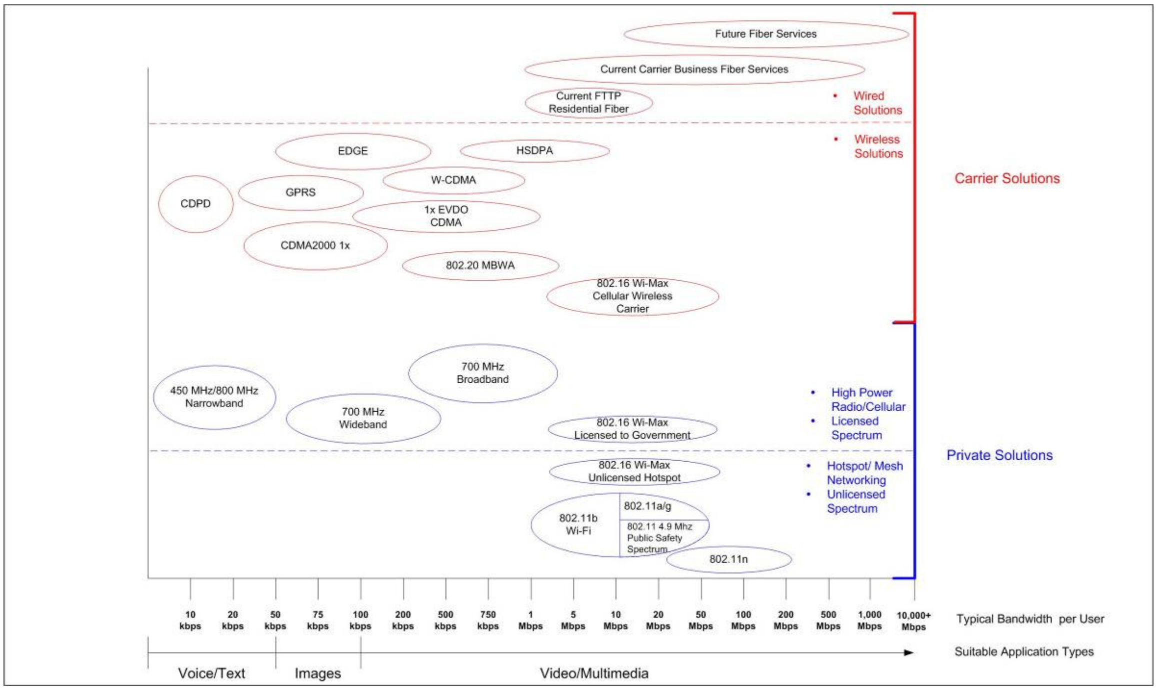


In all cases, the capacity of a service over a single pair of fiber optics was 50 or more times the capacity of comparable wireless links and services. This gap will likely remain. In coming years, we anticipate the development of advanced wireless technologies, including adaptive antennas[33], using multiple simultaneous wireless transmission routes, advance spectrum reuse techniques, and point-to-point laser optical technologies. At the same time, fiber optic advances will likely include faster electronics, a wider range of wavelengths, and optical switching.

The analysis is similar with respect to available wireless technologies. Figure 9 provides examples of broadband wireless and wireline technologies, including licensed, unlicensed, private, and carrier technologies. Because the actual capacity available to a user will vary according to specific circumstances, the capacity is shown as a range for each technology. Figure 9 also indicates the capacity required for typical applications, from text to advanced multimedia.

[33] Including multiple input multiple output (MIMO) antennas

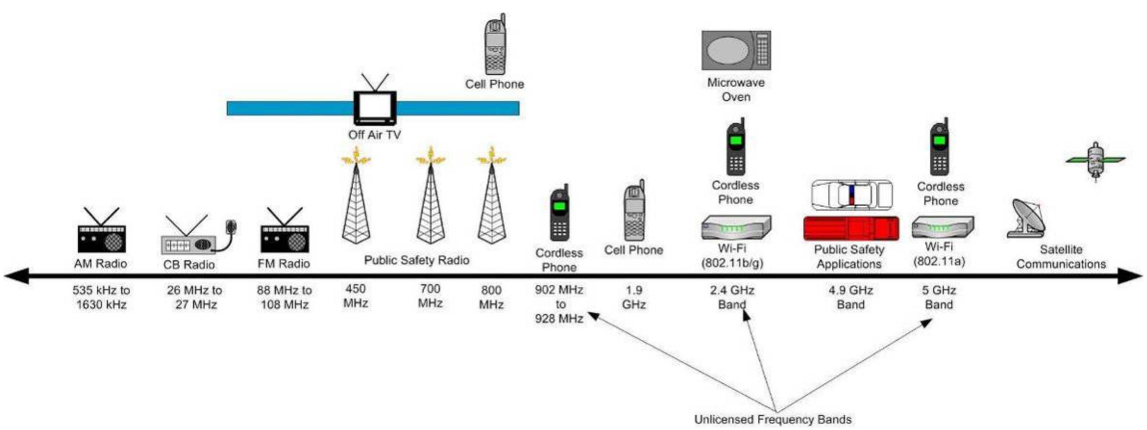
Figure 9: Wireless and Fiber Technology Roadmap



4.4. Wireless Performance is Physically Limited by Scarce and Costly Electromagnetic Spectrum

All wireless devices use the electromagnetic spectrum. The spectrum is shared by a wide range of users and devices. Most of the spectrum is assigned to particular uses by the Federal Communications Commission and by international agreement (Figure 10). Commercial licensed spectrum bands for voice and broadband services include 700 and 800 MHz, 1.7, 1.9, 2.1, 2.5, and 3.5 GHz. Popular unlicensed bands include 900 MHz, 2.4 GHz, and 5 GHz.

Figure 10: Spectrum Allocation



Higher speed services typically use the higher frequency spectrum. The higher frequency spectrum typically has broader channel widths and therefore is capable of providing more capacity. Lower frequency spectrum typically only has smaller channels available, but has the advantage of penetrating buildings and materials and not requiring as much of a direct line of sight.

Examples of wide channel widths are tens of MHz available in the Advanced Wireless Spectrum and former “Wireless Cable” spectrum. The actual capacity (speed) available will vary according to specific conditions and the technology used, but a reasonable estimate is that the maximum available speed from current technology is within an order of magnitude of the spectral width of a channel. Therefore, tens of MHz of spectrum in a particular large communications channel can conceivably, theoretically, provide the wireless users in particular area with hundreds of megabits per second of aggregate capacity.

The available speed can be increased by narrowing the wireless beam to smaller areas, and even particular users. Technologies can exploit multiple simultaneous paths between the two endpoints of communications. They can transmit in multiple senses of polarization. They can use sophisticated coding techniques to maximize spectral efficiency.

Depending on the outcome of a pending FCC proceeding, more spectrum may be opened up to unlicensed “secondary” broadband use through access to unused television channels (also known as “white spaces”). A new generation of ultrawideband wireless uses very large channels at high frequencies, but must operate a low power to not interfere with other users—which limits the technology to short range or point-to-point use.

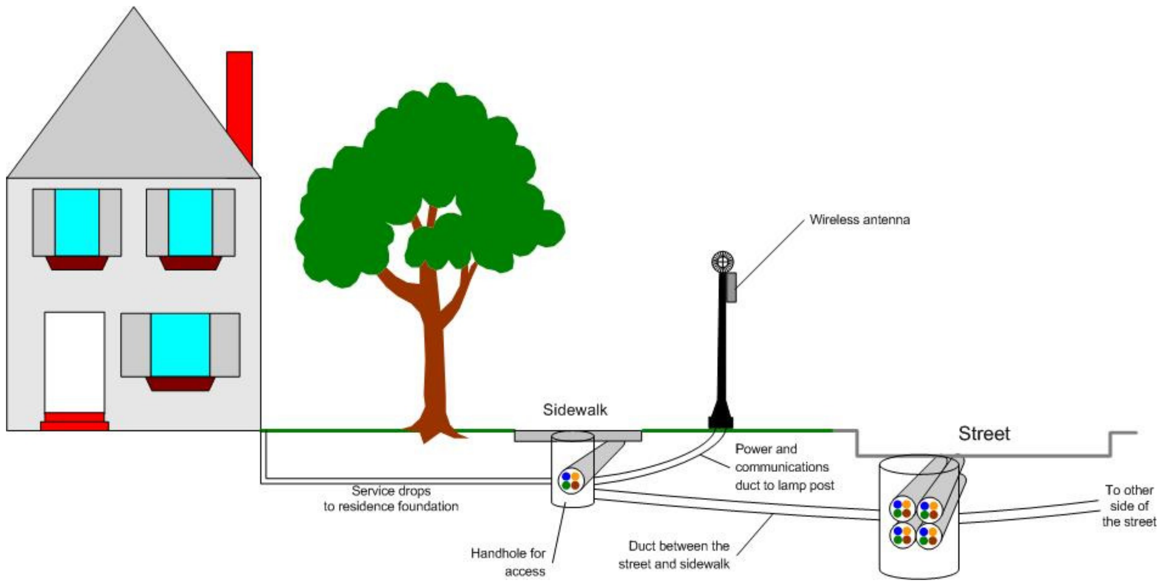
Nonetheless, even if the entire electromagnetic spectrum were to somehow simultaneously become available for particular wireless users, *the laws of physics dictate that this theoretical wireless capacity would still be less than the terabits per second (Tbps) currently available in one fiber optic cable with existing off-the-shelf technology*. Moreover, most of the wireless communication would be limited by range and by line-of-sight. In addition, substantial backbone fiber optic capacity would be necessary to connect the wireless communication system to its core and to other networks.

4.5. A Coordinated Fiber Optic Network Design Can Provide Capacity for Dozens of Separate Service Providers and Spare Capacity

There are many potential strategies for deploying a fiber optic network in the public right of way that maximize the long-term value and minimize the potential for future disruption. One is to construct a high-capacity conduit bank connected to manholes at regular intervals according to a standardized design (Figure 11). The primary manholes in turn connect to lower-capacity conduit connected to residential or business service drops or to wireless infrastructure. Small manholes or handholes can be managed by particular service providers for their proprietary access and service to particular customers.

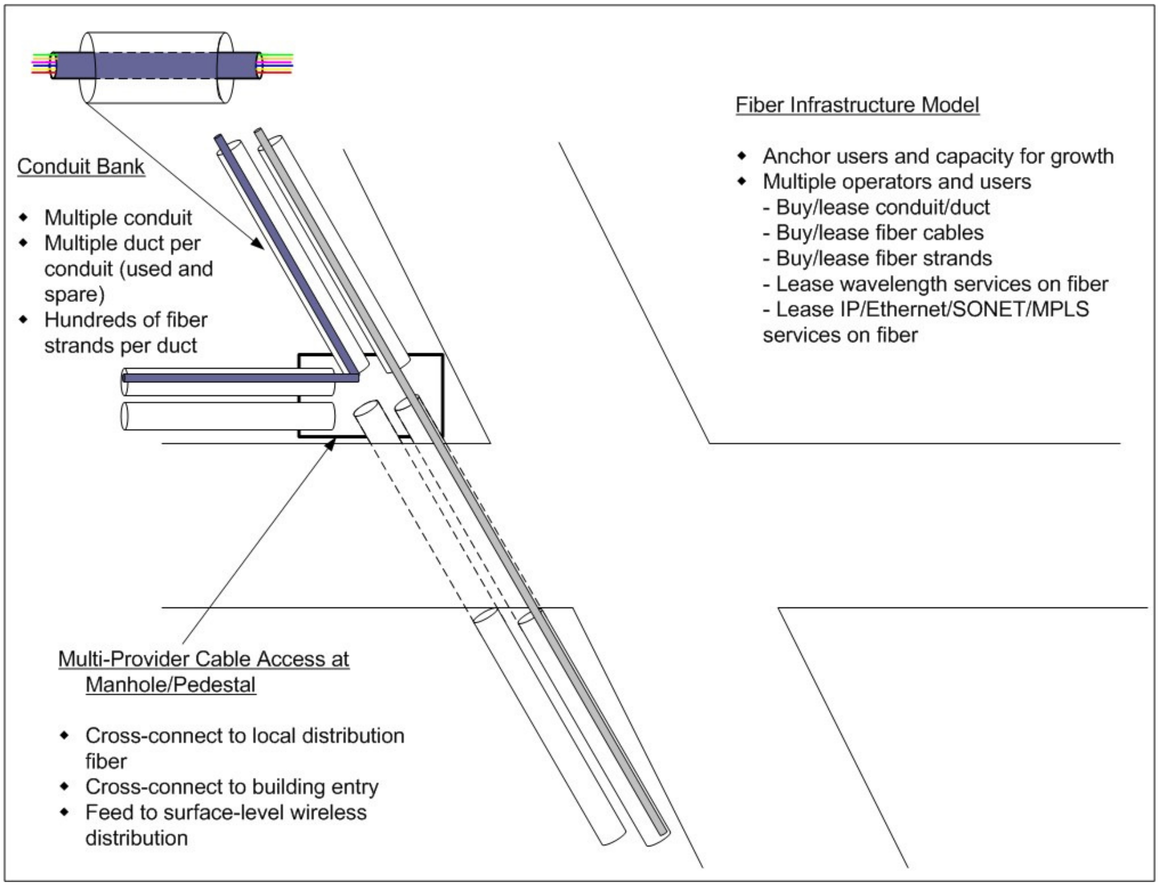
This type of strategy will enable several providers to leverage a single construction project. It will also provide capacity for other providers to enter at a later time at a relatively low cost and with minimal impact on the public right of way. To be effective, this strategy must be followed by all City departments, not just SCL.

Figure 11: Long Term Value Conduit Installation Strategy



A structured, standardized plan to install fiber optic infrastructure, either as part of a citywide strategy or as a required activity in coordination with road construction or maintenance, can create high value for residents and businesses. Each corridor could be reached by multiple wired or wireless service providers using a range of business models, from operation of conduit, to operation of fiber cables, to operation of fiber strands, to lease of services over the fibers (Figure 12). Government entities can obtain and provide value, using the fiber and conduit to connect traffic management infrastructure and manage utilities and mobile staff.

Figure 12: Structured Fiber and Conduit Design Provides Flexible Capacity Citywide



This type of strategy extends the level of raw communications capability in the most "wired" parts of the world to every served corridor. Wired and wireless service providers can serve a region without risk and difficulty of outside plant construction. There will not be a "last mile," because there will not be a physical bottleneck to extending communications services.

4.6. Wireless Network Performance

Ultimately, network performance is affected by a number of factors beyond simple RF coverage and the ability to connect at a particular data rate. Particularly for portable client devices or client devices installed in vehicles, perceived network reliability and performance is affected by the ability of the network to facilitate "hand-offs" as the device travels between the coverage areas of different base stations or wireless access points. The hardware must facilitate this on a rapid basis, even when network authentication or encryption is required.

Another critical factor for performance is the ability of the network to prioritize certain types of traffic, such as voice or video, to ensure a minimum level of Quality of Service for these sensitive services. In a mesh network, other key performance factors include: 1) the ability to minimize the number of mesh hops that add transmission latency and reduce effective throughput, or mitigate these effects through the use of multiple radios and channels for full-duplex transmission in the backhaul that is independent of client access; and 2) the ability of the mesh network to route traffic over the best “hops,” and ideally efficiently balance traffic loads over numerous paths through the mesh.

There are a wide range of factors that determine the performance and effective coverage area of a two-way digital radio system. Every wireless communications transmission starts with a certain level of signal power, which is boosted by antennas and reduced (attenuated) by cabling, connectors, transmission distance (free space loss), and obstructions (trees, walls, windows, etc.). At the receiver, a certain minimum level of signal must be received in order for the data to be received and decoded. For a given point-to-point link, all of these factors can be accounted for to approximate the possible range of a system.

Unfortunately, in a mobile wireless environment, certain factors are variable, including physical obstructions. To further complicate matters, ambient sources of radio energy (power lines, electronic appliances, etc.) and other radios using the same frequency bands can cause interference, reducing the “cleanliness” of the received signal and thereby reducing the signal-to-noise ratio of the received signal. Moreover, signals can scatter and bounce off nearby materials creating reflected signals that arrive at the receiver at different times, which can be another source of interference (multipath fading).

Of course, if cost were not issue, all of these problems can be overcome by significantly over-engineering a system. As that is not the case in any real-world deployment, there are a range of factors to consider during the initial design planning that have an influence over the system performance, coverage, and cost. These factors include:

- Frequency selection and availability
- Physical antenna mounting and support assets
- Maintenance requirements
- Security considerations

The following contains guidelines for design planning relating to these key factors. We note that these guidelines are not design specifications based on extensive field surveys and testing, as is necessary prior to finalizing a design, but rather are consistent with our experience and typical industry practices. Moreover, these guidelines are independent of any specific vendor solution.

4.6.1. *Frequency Selection*

The frequency of the transmission greatly determines the manner in which physical attributes of the desired coverage area, such as terrain elevation, trees, and building obstructions, impact system performance. Generally speaking, higher frequency signals are attenuated more than lower frequency signals over a given distance or through a particular physical obstruction. Thus, generally speaking, a lower frequency is preferable to higher frequencies for achieving more consistent coverage over a wide geographic area.

In addition to its physical properties, different frequency bands are subject to differing licensing requirements by the FCC. For one, most bands have specific requirements for channel divisions, meaning that we must consider the necessary capacity and applications the network must support. Larger channel widths allow for higher-speed transmission. Within any band, the FCC often limits the allowed users to certain classifications (government, commercial, etc.), or limits the type of communications (voice, data, broadcast, etc).

License exempt bands, such as the 2.4 GHz and 5 GHz channels used for WiFi, can be used by anyone with Federal Communications Commission-approved equipment, which necessarily must adhere to FCC-specified power limitations and other emission requirements. These bands are thus subject to extreme interference from other users, particularly if attempting to use these bands for longer-range communications than originally conceived by the FCC in determining the technical limitations of hardware. A band in which the FCC coordinates licensing to limit or prevent interference between users allows for more predictable and reliable coverage.

In selecting a frequency band for a City-wide deployment, the criticality of wireless services for public safety applications tends to suggest the need for an FCC-licensed band to minimize the chance of interference, thereby allowing the network to be engineered with fewer variables for more consistent performance and coverage. Moreover, the desire for high bandwidth connectivity to support video applications dictates the need for a wide band system facilitating simultaneous bi-directional transmission to each client at data rates exceeding several hundred kilobits per second.

Currently, the 4.9 GHz public safety band is the only licensed broadband spectrum available directly to local government and public safety entities. A total of 50 MHz of spectrum is available between 4940 MHz and 4990 MHz for fixed and mobile wireless services only for public safety-oriented services.[34] Moreover, FCC requirements for the hardware, including power levels and emissions requirements are similar to WiFi in the 2.4 GHz and 5 GHz bands. Thus, the capabilities and performance of networks in the 4.9 GHz band are similar to WiFi, with significantly reduced interference problems. Hardware for this band is widely available and relatively inexpensive relative to other high-speed wireless technologies designed for licensed bands, as the industry has largely adopted the same technologies underlying WiFi for use in the 4.9 GHz band.

In the future, there may be spectrum and/or services available in the 700 MHz public safety band, for which many of the details are subject to upcoming FCC decisions. This spectrum is

[34] Press Release, FCC Designates 4.9 GHz Band for use in Support of Public Safety and Proposes Licensing and Service Rules, Released February 14, 2002
http://www.fcc.gov/Bureaus/Wireless/News_Releases/2002/nrwl0202.html.

preferable from a purely technical perspective, though the timeline, cost, and operations requirements are still uncertain.

4.6.2. *Antenna Mounting and Support Assets*

Wireless communications near or above a frequency of 1 GHz typically require "line-of-sight" or near-line-of-sight between antennas, and thus proper placement of antennas and radios becomes a critical component of the system design. The higher the frequency, the more essential antenna placement becomes, since higher frequencies are less able to penetrate obstructions, as discussed. In addition to mounting height and positioning to achieve line-of-sight, access to electrical power and wired backhaul connectivity are significant factors relative to their affect on implementation and ongoing costs. Backhaul connectivity, bridging the individual radios in the network to the Internet or the City's internal networks, can be accomplished with wireless, fiber optics, or using leased data circuits from a commercial carrier.

Over the relatively short transmission distances of WiFi and 4.9 GHz technologies, terrain elevation changes are not likely to be a major concern in Seattle. When transmission distances are much longer, elevation gradients of the terrain can necessitate mounting antennas at high elevations relative to the ground, typically atop tall building or tower structures. However, the substantial tree foliage in Seattle does present a significant challenge, both for connectivity between a base station radio, or Wireless Access Point, and a client radio device, and between Wireless Access Points for a mesh network. Thus, Wireless Access Points should be mounted well above the surrounding tree line and nearby structure height wherever possible, such as on rooftops of City buildings or utility poles.

In a wireless mesh network, each Wireless Access Point establishes connectivity to one or more adjacent Wireless Access Points within range, allowing data traffic to traverse between the client devices and one or more wired "injection" points, "hopping" between Wireless Access Points along the path. Ideally, a mesh network has enough overlap between the coverage areas of each Wireless Access Point to provide redundant pathways through the network, thereby increasing backbone network reliability. Similarly, the injection points, which are typically Wireless Access Points with wired (or fiber) connectivity to the Internet or a private network, should also be redundant and sufficiently numerous to provide reliability and maintain consistent network performance. Mesh networks have the advantage of minimizing the requirement for wired connectivity to each Wireless Access Point, and thus presumably reducing implementation and ongoing costs where wired network connectivity access is limited.

4.6.3. *Security Considerations*

Security in a wireless network is always of significant concern, but the risks can be mitigated with advanced security technologies and good practices. In fact, a wireless network can be more secure than most wired networks in which security measures are often limited to the relatively weak controls in place to prevent physical site access.

In the case of a City-operated network offering services to the public, there are a few key areas of concern:

- Controlling access to prevent theft of service or unauthorized access, if services are provided at a cost or only to registered users;
- Preventing users from abusing access to the network for illegal or other unauthorized activities; and
- Preventing use of the network from impacting internal City network services or allowing the network to be used to compromise the City's internal network security.

Notice that none of these issues relate to protecting the data or keeping it private, as this is typically not a concern for most operators of public networks, nor is it a responsibility they want to undertake. These issues relate primarily to controlling access to the network (authorization, authentication, and accounting) and limiting its usage to appropriate purposes. Network access is usually controlled through the use of a server that stores user credentials (username and password) in conjunction with standards based support in the Wireless Access Point for the Institute of Electrical and Electronics Engineers[35] 802.1x framework for authentication messages and a wide range of authentication protocols, including Extensible Authentication Protocol – Transport Layer Security (EAP-TLS), Extensible Authentication Protocol- Tunneled Transport Layer Security (EAP-TTLS), and Protected Extensible Authentication Protocol (PEAP).

In some cases, public networks do not restrict access to a limited set of users (no authentication), but require acknowledgement of an acceptable use policy prior to gaining access beyond an internally hosted "splash" page. Users' web browsers are automatically directed to this page when first connected to the network, at which time they can be shown anything from acceptable use policies to sponsor advertisements. Access to the general Internet is usually granted after entering credentials or clicking "accept" to whatever policies are deemed appropriate or necessary by the operator. Moreover, often these management servers limit the amount of time a specific computer can be connected and/or filter certain types of known malicious or abusive traffic.

With respect to networks providing public access, we recommend that at a minimum, the wireless network not be connected directly to any internal portion of the City network, unless through an outside, or "un-trusted" interface on a firewall. While it is not necessary to provide separate Internet access for a public wireless network and the City's internal network, at a minimum, the capacity available to public usage should be limited, or prioritized below critical services or applications hosted or used by the City's internal systems and personnel.

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[35] The Institute of Electrical and Electronics Engineers (IEEE) is a standards development body that is responsible for a range of widely developed standards, including those relating to Ethernet (802.3), WiFi (802.11) and WiMAX (802.16).

In the case of a private network, particularly one used for public safety purposes and carrying sensitive data, it is necessary to both restrict physical access to the network and protect the transmitted data from interception or malicious modification. In other words, all connections should ensure data integrity through the use of strong encryption. Moreover, the encryption and authentication should leverage individual user credentials rather than a single pre-shared key for authentication and encryption key generation.

Unlike early versions of WiFi hardware that supported only the Wired Equivalency Privacy (WEP) for data encryption, which was later discovered to have serious security flaws, the current standard for wireless network security is based on IEEE 802.11i. The WiFi Alliances' interoperable version of 802.11i is referred to as WiFi Protected Access 2 (WPA2), which is considered secure and suitable for nearly all non-classified governmental applications. In fact, it leverages the Advanced Encryption Standard (AES) for encryption, which is approved for securing "Sensitive But Unclassified" information by the Federal Information Processing Standard (FIPS) Publication 140-2.

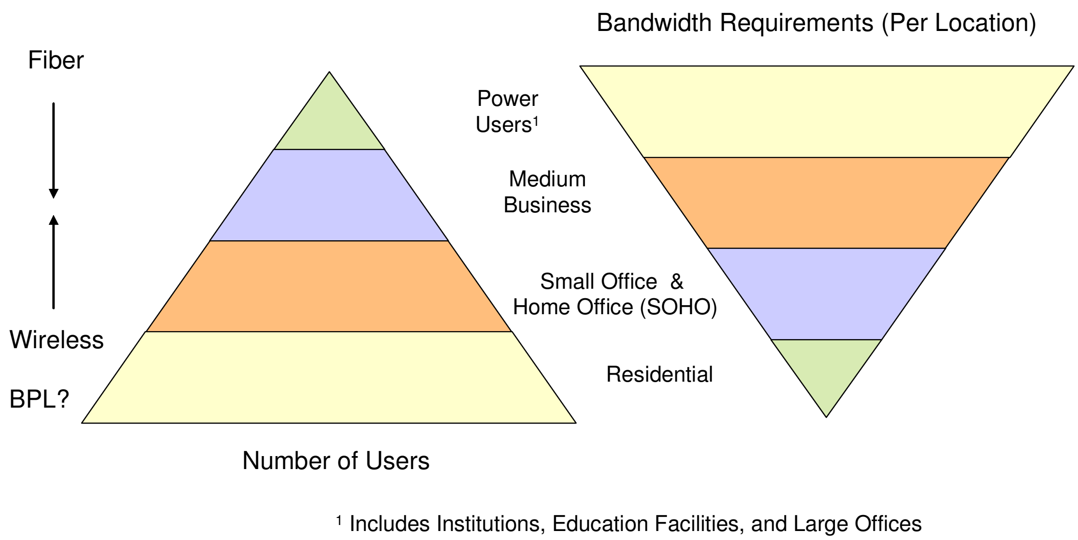
We recommend that WiFi Protected Access 2 is enforced for all connections to a public safety network or other internal WiFi network. Additionally, other security measures can be implemented depending on the specific requirements and network design, including Virtual Private Network (VPN) technologies that offer additional encryption, authentication, and in some cases, added functionality for roaming between multiple types of networks (private 4.9 GHz network, public WiFi, commercial EVDO, etc).

4.7. Fiber's Advantages Match the Need Articulated for this Project

In determining which technology solution will best meet the needs of the Mayor's initiative, another consideration is how the technology will offer required levels of service.

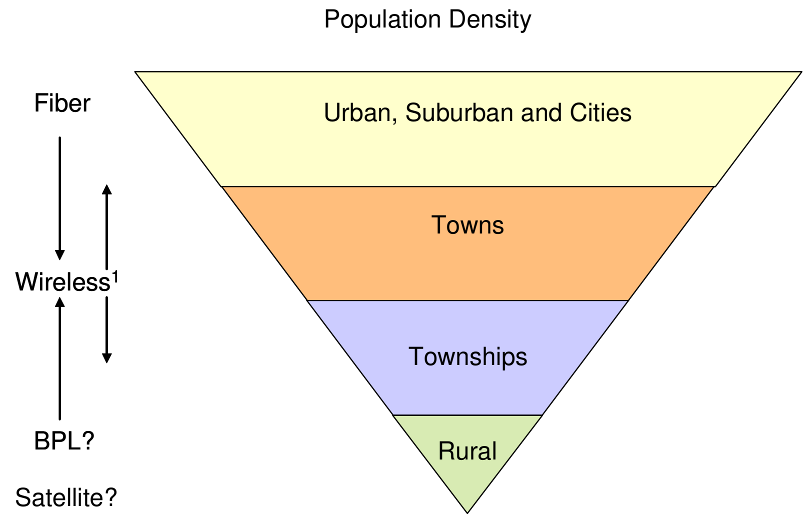
Figure 13 illustrates the relationship between bandwidth requirements and the type of consumer or user. The figure illustrates that, at the current time, bandwidth requirements at residential locations are substantially lower than in a medium business or a "power user" location such as a school. The bandwidth and capacity of fiber are essential for "Power Users," big institutions and businesses.

Figure 13: Relationship of Consumer Bandwidth Requirements and Technologies



Of course, both fiber and wireless are more cost effective in areas with higher population density than in rural areas. Wireless, however, will eventually run into capacity constraints, and require more and more transceiver sites to serve the number of users. Figure 14 illustrates the appropriateness of fiber for urban and suburban areas where population is dense.

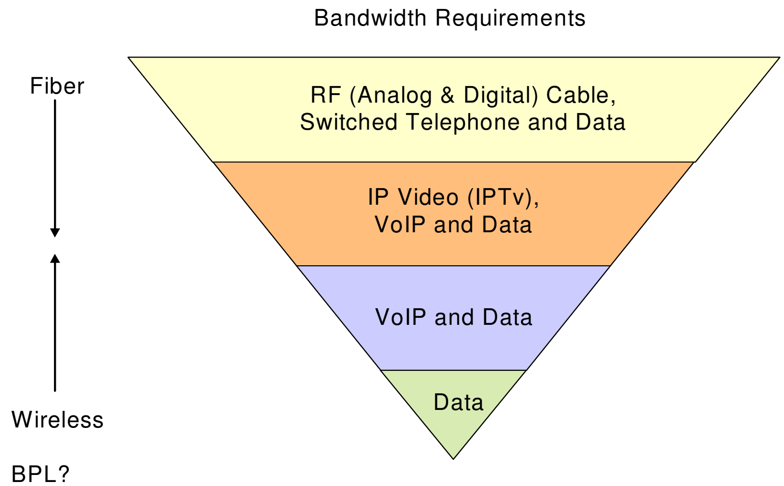
Figure 14: Relationship of Population Densities and Technologies



[1]Terrain, foliage and other objects impacts the viability of wireless.

Figure 15 illustrates the relationship between bandwidth needs and applications or services. High-speed data and voice services can likely be supported over wireless, assuming video is not transmitted over the data connection. However, video services require FTTP—both traditional "cable" video and Internet Protocol (IP) based video applications such as IPTV, telepresence, and video-conferencing.

Figure 15: Hierarchy of Services and Technologies



4.8. Fiber Offers Off-the-Balance-Sheet Benefits of Significance

It is important to note the ways in which fiber also offers benefits such economic development, small business empowerment, job creation, livability, environment protection, education, increased sales tax and real estate tax revenues, increased property values, and other factors. These "off-the-balance-sheet" benefits are difficult to quantify yet key to understanding the capability of fiber and how it differs from wireless technology.

Economic Development. According to a 2005 study by the Massachusetts Institute of Technology and Carnegie-Mellon University:

> *"We can say unequivocally that broadband access does matter to the economy, just as common sense suggests it should. We estimate that between 1998 and 2002, communities in which mass-market broadband was available by December 1999 experienced more rapid growth in employment, the number of businesses overall, and businesses in IT-intensive sectors."*[36]

Broadband communications is increasingly essential to the functioning of the United States' economy and democracy. High speed communications are not only an engine for commerce, but

[36] William Lehr, Carlos Osorio, Sharon Gillett, Marvin Sirbu, "Measuring Broadband's Economic Impact," Broadband Properties, December 2005 (reporting on MIT/Carnegie Mellon study), http://www.broadbandproperties.com/2005issues/dec05issues/Measuring%20Broadband%20Eco%20Impact,%20Lehr,%20Gilett,%20Sirbu.pdf.

also for integration of the many, diverse areas of the US into an increasingly-global economy. Concern is growing throughout the US that we are losing our competitive broadband advantage to competitor nations and cities in Europe and Asia, and that this disadvantage will grow with time. Even more troubling, the broadband deficit is likely to impact our competitive status with respect to education, economic development, standard of living, and quality of democratic discourse.

High-bandwidth broadband is widely-recognized a key driver of future economic competitiveness. The calls for greater broadband deployment come from organizations as diverse as the U.S. Chamber of Commerce, AARP, the National Association of Chief Information Officers, and major equipment manufacturers such as Intel, Nortel, and Cisco--all of whom recognize that the United States' position as a technological and economic leader require networks that enable growth applications such as teleconferencing, telecommuting, and distance learning.

Our competitor nations in Europe and Asia are increasingly recognizing FTTP as a key engine of economic growth and development. Significant fiber deployment projects are underway throughout Northern Europe, including in France, Ireland, Sweden, Holland, and Germany.

Developed Asian countries have also recognized fiber as the inevitable, essential broadband medium. FTTP connections increased nearly 10 percent in Japan in just the second quarter of 2007. FTTP now represents 36 percent of Japanese broadband connections, according to the World Broadband Information Services.[37] In fact, fiber is rapidly displacing DSL in Japan. Japan accounts for more than two-thirds of the global Fiber-to-the-Home market and 48 percent of the entire Fiber-to-the-Premises market, according to World Broadband Information Services.[38]

In Asia, South Korea and Taiwan also have significant FTTP markets, and China is rapidly deploying fiber.[39]

On the municipal side, our competitor cities in Europe and Asia have undertaken forward-thinking FTTP projects. Municipal FTTP projects are underway or under consideration in numerous major European and Asian cities including Paris, Vienna, Amsterdam, Stockholm, Zurich, Milan, Dublin, Singapore, and Hong Kong.[40]

The key driver in all of these projects is the need for economic development in the global economic environment of the 21st Century. These projects recognize that fiber networking:

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[37] http://www.wbisdata.com/newt/l/wbis/index.html.
[38] http://www.wbisdata.com/newt/l/wbis/index.html.
[39] "FTTH accounts for 36% of Japan broadband," Telecoms.com, http://www.telecoms.com/itmgcontent/tcoms/stats/articles/20017479743.html.
[40] These projects span a wide variety of models, ranging from municipal ownership to public/private partnership to municipal attempts to stimulate private fiber builds. A number of these projects and their associated models are presented as case studies below.

- Enables small business creation and growth
- Enables job creation and the enhanced, multiplied economic activity that accompanies it
- Supports businesses with very high bandwidth needs, such as digital media and software
- Attracts and retains businesses of all sizes
- Enables workforce education
- Enables telework and distributed work
- Enhances reputation for visionary and pioneering projects
- Promotes major development initiatives such as revitalization zones or event bids

Even as there is growing consensus nationally that broadband is a key driver of economic competitiveness, the United States is simultaneously falling behind our competitor nations in broadband infrastructure, competition, and availability in individual communities – and, more broadly, in large parts of the United States. Indeed, the US has slipped to 16th in the world in per capita penetration as of May 2007, compared to our ranking as 4th just six years ago.[41]

The economic consequences of falling behind in broadband could be profound. For example, small and medium businesses cannot compete without affordable, high-speed access—and large businesses increasingly refuse to locate in areas without very high speed access. Home-based businesses fail to emerge or grow because of slow Internet speeds. Lack of very high-speed broadband also precludes development of the collaborative, distributed work that is a hallmark of the emerging global economy.

Political Discourse. High-bandwidth broadband is widely-recognized as a facilitator of political discourse and activity – the most important medium for communication and expression of political ideas since the advent of television. This is the platform upon which Americans interact, the 21st Century equivalent of the town square, printing press, and backyard fence.

Fiber can facilitate democratic and free market values by providing a very high-bandwidth ecosystem in which the members can develop, share, and stimulate ideas.

The incumbents have publicly declared their intention to charge access tolls of third-party innovators and independent IP-based video providers.[42] They have also reserved to themselves the absolute discretion to refuse, block, or degrade communications of which they do not approve (or from which they do not profit). They have demonstrated this intent through actions such as Comcast's degradation of peer-to-peer file transfers,[43] Verizon's initial refusal to allow a

[41] The Honorable Sonja Reece "Cities and Towns Must Fill the Broadband Void," W2i Digital Cities, June 21, 2007, http://w2i.com/resource_center/the_w2i_report__weekly_newsletter/news/p/id_74.
[42] See Lawrence Lessig, "Congress Must Keep Broadband Competition Alive," Financial Times, October 18, 2006, http://www.feetcom/cms/s/a27bdb16-5ecd-11db-afac-0000779e2340.html.
[43] Peter Svensson, "Comcast Admits Delaying Some Traffic," Associated Press, Oct 23, 2007, http://ap.google.com/article/ALeqM5gxRiQSVfgK4sLbVRE_X4MOlM9q0A.

text-messaging program by a pro-choice organization,[44] and AT&T's censoring of an anti-war statement by a musician during a performance.[45]

The incumbents' networks do not mandate these practices—rather, it is the choices of the incumbents that results in these practices that undercut participatory democracy in communications. Municipal fiber offers a similar choice—one that can be resolved in favor of the public interest, rather than in favor of commercial or narrow interests.

Environmental Sustainability. Sustainability is one of the key benefits of fiber networking that is only now being recognized. A recent European Union-commissioned Report notes that communications technology's carbon reduction impact is 10 times more than its direct carbon dioxide reduction.[46]

According to the European Union study, the strategic use of communications technologies such as fiber:

> *can contribute significantly to energy efficiency, sustainable economic growth as well as job creation. ICT (Information and Communications Technology) can reduce the need of travel and transportation of goods by bridging distance problems. It can increase efficiency and innovation by allowing people to work in more flexible ways. It can also ensure a shift from products to services and allow for dematerialization of the economy.*[47]

In recognition of this connection between communications technology and environment protection, a number of projects are underway to demonstrate the importance of communications infrastructure to sustainability. The Clinton Global Initiative, for example, is working with Cisco's Connected Urban Development project to partner with local communities (member communities include San Francisco, Seoul, Amsterdam, Madrid, Hamburg, Lisbon, and Birmingham) to demonstrate through pilot projects the potential of Information and Communications Technology (ICT), including FTTP networking, to reduce carbon emissions.

Cisco's Connected Urban Development project has noted that, around the world, cities take up only one percent of the earth's land-mass, but hold 50 percent of the world's population, consume 75 percent of energy, and produce 80 percent of the world's carbon dioxide emissions. If city-based FTTP can enable remote work, telecommuting, distributed work, and satellite offices, the reduction in emissions can be dramatic.

Other private sector companies are also realizing the environmental benefits of high bandwidth. NEC's Broadband Solutions Center in Japan demonstrated a 41 percent reduction in CO_2 of a

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[44] Editorial "The Verizon Warning," the New York Times, October 3, 2007, http://www.nytimes.com/2007/10/03/opinion/03wed1.html?_r=1&oref=slogin.
[45] Manila Ryce "AT&T Censors Pearl Jam's Anti-Bush Lyrics," The Largest Minority, August 12, 2007, http://www.jwharrison.com/blog/2007/08/12/att-censors-pearl-jams-anti-bush-lyrics/.
[46] "Saving the Climate @ the Speed of Light: First Roadmap for Reduced CO_2 Emissions in the EU and Beyond," published by European Telecommunications Network Operators' Association and World Wildlife Foundation, 2007.
[47] Ibid.

broadband-based office relative to a conventional office. NEC employees at this office "changed their working style using broadband solutions, such as IP telephony, a wireless LAN, and systems for remote access, web conferencing, and document sharing." They also demonstrated a CO_2 reduction effect of 70 percent when documents were digitized and shared electronically to reduce paper use.[48]

This Report analyzes the potential carbon-reducing impact in Seattle of high-speed networking through telework in Section 6 below.

Consumer Choice and Price, Service Competition. Municipal fiber has the potential to create an open platform for all comers by enabling open access, competition, and non-discriminatory policies -- at the same time as the cable and phone companies are entrenching their closed network models that preclude competitive access to the networks.

Municipal fiber opens the door to dramatic innovation and competition of countless companies and individuals—all over the big pipe of fiber. In this way, the network replicates over big-bandwidth the creativity of the early Internet era that has been reduced by the closing of networks.

In the formative days of the commercial Internet, dial-up modems were used to access the Internet over copper telephone wires. Subscribers had open access to any Internet Service Provider simply by dialing their chosen Internet Service Provider over their computer's modem. Under common carrier rules, the telephone companies (who owned the access network--the telephone wires and equipment in their offices) could not legally control or limit their competitors' traffic, nor could they block or limit access to the phone lines of a particular Internet Service Provider. This dynamic enabled the Internet to grow into the indispensable information storehouse and innovation engine it is now, because both content creators and users were allowed unhindered connectivity.

Today, however, bandwidth requirements far exceed the capabilities of a dial-up modem connection. As a result, consumers use the higher capacity service offerings of a limited number of broadband networks. However, incumbent broadband networks are generally proprietary, or closed to competitive providers.

Under recent rulings, the owners of DSL, cable broadband, and commercial FTTP systems have been permitted to close their networks to competitors – a deviation from the common carrier rules under which the telephone networks have long operated and under which numerous Internet Service Provider s competed over dial-up modems. As a result, many of these Internet Service Providers have gone out of business—because they cannot access the distribution networks, at any price. The dynamic Internet Service Provider competition of the early commercial Internet era has ceased to exist.

[48] NEC "An Environmental Load Assessment Method for Broadband Solutions," http://www.nec.co.jp/rd/rel/english/topics/t36.html.

However, advanced networks can allow access to multiple providers of services -- in the same way that all companies have non-discriminatory access to roadways, over which they can compete commercially. Government can facilitate this process by laying the foundation for competition in the form of communications infrastructure, and allowing the free market to drive innovative service development and competitive pricing.

5. FTTP Financing Mechanisms

This Section describes the primary approaches for obtaining financing for communications infrastructure.

Financing is one of the largest challenges for publicly or privately financed Fiber-to-the-Premises (FTTP) infrastructure. To date, the mechanism to finance a vast majority of US municipal FTTP projects have been bonds either secured with established municipal electric or water revenues (revenue bonds), by the general obligation of the community (General Obligation bonds), or with sales tax revenue.

A common lingering question with any model for private or public FTTP is the type of financing guarantees required by the municipality. For example, none of the responses to the 2006 Seattle Request for Interest offered financing absent City financial guarantees. As of this writing, the City of Palo Alto, CA is in negotiations with a consortium of companies for FTTP financing, construction, and operations. Early speculation is that although Palo Alto may not be required to provide financing, the City will likely be asked to guarantee the private Consortium's investment.

Absent full private sector financing, a municipal electric utility or municipality has the choice of four base funding models. These are described below. The following Section applies these funding models to the business models considered for SCL.

5.1. Equity Model

Under the Equity model (also known as "co-op" or "customer ownership"), a combination of private, public, and consumer investment is used to build various parts of the FTTP network. Generally, subscribers pay an upfront subscriber fee of approximately $2,000 to $3,000 (or obtain a loan for that amount that entails smaller monthly payments over time, possibly rolled into a traditional mortgage). The build-out of the FTTP network is phased by neighborhood once a neighborhood reaches a predetermined subscriber level.

In order to initiate this model, the municipality or infrastructure provider constructs fiber to the neighborhood or to the node in a configuration designed to support FTTP. In the municipal example, the fiber to the neighborhood financing is accomplished through General Obligation or revenue bonding. Although municipal-backed financing is still required, the total amount of required financing is substantially less than it would be otherwise because consumers are bearing the cost of the attachments to their homes.

In the event that the provider is private sector, financing for the backbone network into the neighborhood is presumably private but the customer receives some kind of ownership interest in the connection to his or her home.

There are quite a few possible variations of this model, with some difference as to how far customer ownership reaches into the network and how the ownership is structured.

This model is both creative and potentially useful. It emerged first in Sweden, where it is referred to as the "coop" model. This model is currently under consideration by the Utah UTOPIA network as a strategy to improve the cash flow of the FTTP enterprise and reduce the financing exposure of each participating community; to our knowledge, this is the first use of this model for a residential FTTP network in the US.

Variations on this model of customer fiber purchase and ownership appears to have met with some success in Europe and it is currently being piloted by the CANARIE network in Ottawa, Canada. In just the last few months, this topic has received significant attention within the non-carrier communications community, and it is the subject of a forthcoming article by Professor Tim Wu of Columbia Law School, an influential intellectual in communications policy, and Derek Slater, a respected researcher at Google.

5.2. Access Fees

Under this model, service providers are charged an access fee per month to cover the required FTTP infrastructure investment, customer drops, and installation costs. As these costs would presumably be passed on to consumers, only subscribers that use the network are charged.

The determination of the rate charged of the provider is based upon estimated market shares. As a result, failure to meet projected market share results in cash flow shortages and, correspondingly, exceeding projected market share results in cash flow reserves

Significantly, under this model, general obligation of other secured bond financing is likely required. Historically, the investment community is leery of securing bonds based on anticipated new revenues.

5.3. Property Owner Assessment

Under this model, the City assesses all property owners for proportionate shares of the costs of the FTTP infrastructure (likely excluding consumer drops, customer premises equipment, and installation). Consumers pay for fiber drops, customer premises equipment, and installation when they subscribe to a voice video or data service (one-time charge, amortized fee, or combination), and consumers pay for services directly to the provider of their choice.

The assessment approach to financing FTTP infrastructure arises from the growing consensus that broadband constitutes essential infrastructure for the viability of the community. Roads, water supply, and wastewater are all considered essential infrastructure and are publicly financed through an assessment-type approach. In the case of water and waste water, the infrastructure is "bundled" with the service. In the case of the roads, infrastructure costs are "unbundled" from use in a mechanism comparable to that contemplated here for FTTP infrastructure.

It is prudent, however, to expect that assessment-based financing of an open access FTTP infrastructure is likely to receive regulatory, legal, and political challenges from incumbent providers.

5.4. Bonding Supported by Retail Subscriber Fees

The majority of municipal FTTP projects in the US are financed through General Obligation or revenue bonding. Bond payments (principal and interest) are covered by revenues from subscriber fees. Frequently, the municipality seeks a three to five year moratorium on principal payments to allow for system expansion and acquisition of a critical mass of paying consumers.

5.5. Comparison of Funding Alternatives

Table 2 presents the advantages and disadvantages of each the financing models.

Table 2: Funding Model Advantages and Disadvantages

Funding Model	Advantages	Disadvantages
Equity Model	• Fee applies only to consumers acquiring services	• Low income areas will require supplemental financing • Multiple dwelling unit owners and condominium association boards must agree to participate for apartments and condos to be included
Access Fees	• Fees apply only to consumers acquiring services • Some investment risk shifted to service provider	• For SCL, funding is likely to require revenue bonds backed by electric revenues • SCL absorbs majority of investment risk
Property Owner Assessment	• Treats fiber and broadband as essential infrastructure • Lowers investment risk of FTTP	• Potential for legal, political, and public relations challenges • Potentially requires referendum
Bonding Supported by Retail Subscriber Fees	• Fees apply only to consumers acquiring services	• For SCL, funding is likely to require revenue bonds backed by electric revenues • SCL absorbs all investment risk

Section 7 below applies these financing mechanisms to various business models.

6. Market Research Results

This Section of the Report describes the results of the market research conducted by CTC's market research team in August 2008.[49] In total, we completed and analyzed telephone surveys of 301 randomly-selected businesses and 381 randomly-selected homes in the City of Seattle. The surveys provide market information about Internet, telephone, and cable television services and gauge interest in a City-wide broadband network.

The market research has a number of key uses. First, it enables SCL and the City to determine the support among Seattle residents and businesses in the City playing a role to facilitate deployment of broadband networking resources. Second, it identifies the areas where the existing private market is failing to meet the needs of Seattle's businesses and residents.

Third, it provides data regarding the potential market in Seattle for a new entrant into the broadband space—with respect to voice, video, and a range of data services. To this end, Section 7 of this Report uses the survey results to provide inputs (particularly with respect to potential revenues) for each potential SCL business model's financial and feasibility analysis.

In addition, the survey results provide the background data to project how higher-speed broadband might increase telework and thereby realize efficiency benefits for the Seattle community with respect to time, gas costs, vehicle use costs, and carbon emission reductions.

Detailed findings of the market research effort are provided in Appendix A. Highlights and a summary of findings are presented in this Section.

6.1. Summary of Key Findings of Residential and Business Market Research

Key findings of the market research study include:

- The vast majority of residents and businesses have Internet access, with 87 percent of businesses and 81 percent of homes having high-speed Internet service. Older residents and low-income homes are less likely to have computers or Internet access.
- Seattle businesses and residents are somewhat satisfied with their Internet connection speed, but are less satisfied with the price paid. Price of service combined with speed appears to be a key to gaining market share.

[49] 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).

- Seattle businesses and residents are somewhat less likely to switch to Internet service provided by the City compared to the private market at most price levels. This finding suggests that any City network would need to build brand image as part of any service offering.
- One-half of businesses allow telecommuting today and 37 percent of residents telecommute at least part of the time. The lack of high-speed symmetrical offerings appears to be suppressing potential telework levels, as both residents and businesses express greater interest in telework than data services currently enable.
- The price of competing telephone or television service needs to be at least 20 percent below the current market price before a substantial portion of businesses or residents are willing to switch providers.
- Approximately 75 percent of businesses and residents believe the City should have some role in the development of a broadband network.
- Businesses and residents are largely unwilling to pay a hook-up fee to own their fiber-optic connection unless the monthly price reduction for services is substantial. This result is not unexpected, given the newness of the concept and the fact that the value proposition is not fully understood by consumers.
- There is widespread agreement among businesses and residents that the City should help students, parents, and teachers gain access to affordable high-speed Internet.
- Approximately 50 percent of businesses and residents would support a plan for the City to build, own, and operate a communications network if the network were supported only with subscriber revenue. Only 25 percent would support the plan if the network were operated with both subscriber and tax revenue.

6.2. Summary of Results of Business Market Research

This section provides a summary of results and key findings from the business survey. More detailed results and graphics are provided in the appendices to this Report.

A total of 301 business surveys were completed, providing a confidence range of ±5.6 percent at the 95 percent confidence level for aggregate responses, assuming 33,700 businesses in Seattle. That is, one can be 95 percent confident that aggregate responses lie within 5.6 percent of the actual for the entire population of businesses.

6.2.1. *Business Internet Service*

- 90 percent of businesses have Internet service, with 87 percent having high-speed Internet. DSL has the largest market share at 51 percent, followed by cable modem at 25 percent.

- 70 percent of business respondents indicate that their Internet was "fast enough" and 72 percent indicate that they were somewhat satisfied or very satisfied with their connection speed.
- The average monthly price for Internet service is $132. Leased line or other custom services represent the most expensive and dial-up service represents the cheapest.
- Businesses in Seattle value choice of providers and are widely dissatisfied with their lack of choice. The research demonstrates a large gap between the importance respondents place on the ability to choose among competing providers—and their lack of satisfaction with the choices available. Price, billing & customer service, and connection speed also show significant gaps between the importance of the factors and current levels of satisfaction.
- More than 80 percent of businesses indicate that Internet access is important to achieving their strategic goals and maintaining their competitiveness. 64 percent indicate that Internet is somewhat or very important in facility location decisions.
- Two-thirds of businesses are somewhat or very willing to switch to 100 Mbps Internet service for the same monthly price as they currently pay, while nearly 80 percent are willing to switch for a 20 percent price discount. The percentage willing to switch to a City-sponsored Internet service is slightly less at most price levels.
- One-half of Seattle businesses allow telecommuting, and 23 percent report that more than 30 percent of their employees telecommute at least part of the time. More than one-third of businesses indicate that they would encourage more telecommuting if employees had faster home Internet service.

6.2.2. *Business Telephone and Television Service*

- Qwest has the highest share of local telephone service in the business segment, with a 64 percent market share, followed by Integra with a 17 percent share.
- 10 percent of businesses use Voice over Internet Protocol (VoIP) for a portion of their business calls, and another 5 percent are considering VoIP. 20 percent of business respondents were unfamiliar with the technology.
- Businesses pay an average of $250 per month for telephone service. One-half of businesses pay less than $150 per month, while 12 percent pay more than $500 per month.
- 32 percent of businesses are somewhat or very willing to switch phone providers for a 10 percent price reduction and 54 percent are willing to switch for a 20 percent price reduction.

- 15 percent of businesses have cable television service and five percent have satellite[50] television. Satellite subscribers pay an average of $83 per month, while cable subscribers pay an average of $79 per month.

6.2.3. *Business General Information and Opinions*

- Two-thirds of businesses agree that the City should help students, parents, and teachers have affordable high-speed Internet. Slightly less than one-half agree that the City should help non-profits obtain high-speed Internet, help all residents have high-speed Internet, or build a publicly-financed communications network.
- Nearly 70 percent of businesses agree that high-speed Internet is an essential service and believe that businesses can only function efficiently if they and their customers have high-speed Internet. More than one-half agree that businesses consider affordable high-speed Internet access when making location decisions.
- 52 percent of business respondents would support a City communications network that was operated only with subscriber revenue. Only 22 percent would support a City network that was operated with both subscriber and tax revenues.
- More than 80 percent of businesses state that it is important to have a choice of multiple providers for Internet, phone, and television service. Less than one-third of respondents indicate that same billing for all services was important.
- Approximately three-fourths of businesses believe the City should have a role regarding broadband access. Fifty-five percent believe the City should install a network and 18 percent believe the City should encourage a private firm to build a network.
- Businesses are largely unwilling to pay a hook-up fee for a fiber-optic connection. Only 11 percent were somewhat or very willing to pay a $1,000 hook-up fee and only 4 percent were willing to pay a $2,000 hook-up fee. 27 percent were willing to pay a $2,000 hook-up fee in exchange for a 30 percent monthly price reduction.

6.3. Summary of Results of Residential Market Research

A summary of results and key findings from the residential survey is included in this section. More detailed results and graphics are provided in the appendices to this Report.

A total of 381 residential surveys were completed, providing a confidence interval of ±5.0 percent at the 95 percent confidence level for aggregate responses, assuming 267,250 households

[50] Competing with satellite television in the business market is unlikely because entertainment venues used by businesses to attract customers are only available over satellite.

in Seattle. That is, one can be 95 percent confident that aggregate responses lie within 5.0 percent of the actual for the entire population.

All residential data summaries represent weighted responses, weighted by the age of respondent. As younger residents are much less likely to respond to surveys, the data is weighted by age of the respondent to better represent the population as a whole. The 2000 Census data is used as the appropriate population breakdown by age cohort. The weights used are summarized in Table 3.

Table 3: Residential Weighting Factors

Age Cohort	Survey Responses	2000 Census	Weight
18 to 34	10.3%	39.3%	3.806
35 to 44	20.4%	20.2%	0.990
45 to 54	24.9%	17.3%	0.695
55 to 64	22.8%	8.9%	0.391
65 and older	21.7%	14.4%	0.663
Total	100.0%	100.0%	1.000

6.3.1. *Residential Computers and Internet Service*

- 89 percent of Seattle homes have a computer, with 38 percent having both laptop and desktop computers.
- 86 percent of Seattle homes have Internet access and 81 percent have high-speed Internet service. 44 percent of homes have cable modem service while 25 percent of homes have a DSL connection.
- Computer ownership and Internet access are correlated with age and household income. Of respondents 65 and older, only 69 percent own a computer and 53 percent have high-speed Internet service in their home. Of respondents with annual household income less than $20,000, only 62 percent own a computer and 52 percent have high-speed Internet access.
- Seattle residents are generally satisfied with their Internet connection speed, with 69 percent indicating that their speed is fast or very fast. 65 percent are somewhat or very satisfied with their connection speed.
- The largest gap between consumer satisfaction and level of importance is price. 83 percent of respondents indicate that price is important while only 41 percent are satisfied with the price they are currently paying for Internet service.
- More than 70 percent of respondents were willing to switch to 100 Mbps Internet service for the same price and 87 percent were willing to switch for a $20 per month price reduction. Residents were somewhat less willing to switch to City-sponsored Internet service at most price levels.

- Approximately one-third of respondents were willing to switch to 1 Mbps service for a monthly price of $25 or less, while only 5 percent were willing to switch for a monthly price greater than $40.

6.3.2. *Residential Television and Telephone Service*

- Approximately 67 percent of homes subscribe to cable television service and another 7 percent have Satellite television. Cable subscribers pay an average of $54 per month while Satellite subscribers pay $64 per month.
- 53 percent of cable or satellite subscribers are somewhat or very likely to switch service for a $10 per month price reduction, while 71 percent are likely to switch for a $20 per month price reduction.
- 77 percent of respondents[51] use a Qwest landline for their home phone service, while 18 percent have telephone service through a cable company and 3 percent have Internet-based phone service.
- 47 percent of respondents were somewhat or very likely to switch phone providers for a $10 per month price discount, while 70 percent were willing to switch for a $20 per month price discount.

6.3.3. *Enhanced Services*

- Of the 73 percent of respondents that work full-time or part-time, 37 percent telecommute at least part of the time and 12 percent telecommute full time.
- 57 percent of respondents indicate that their primary method of commuting to work was driving alone in a car, while 19 percent use public transportation. On average, carpoolers drive the furthest difference (16.5 miles each way) while public transit users have the longest time commute (34.9 minutes each way).
- There appears to be the opportunity to increase telecommuting. 44 percent of respondents indicate that their employer allows telecommuting while 57 percent indicate an interest in telecommuting. 54 percent of respondents indicate that they would need high (10 to 100 Mbps) or very high (100 Mbps and over) Internet speed to telecommute.
- 85 percent of residents believe the City should have some role in the development of a broadband communications network. Sixty percent believe that the City should install a

[51] We conducted the surveys over the telephone. As wireless telephone numbers are often not included in available databases, the percentage of survey respondents with a landline telephone is higher than the percentage of Seattle households with a landline telephone.

network while 25 percent believe the City should encourage a private firm to build a network.

- More than one-half of residents agree that high-speed Internet is important for efficient business operations and that high-speed Internet is an essential service, similar to electricity and water. Only 14 percent believe that high-speed Internet is affordable for low-income households.
- 75 percent of respondents agree that the City should ensure that students, parents, and teachers have affordable high-speed Internet. One-half agree that the City should build a publicly-financed communications network.
- 49 percent of residents would support a plan for the City to build, own, and operate a communications network if it were supported solely by subscriber revenue, while 28 percent would support a plan if it were funded by both subscriber and tax rev

6.3.4. Estimate of New Entrant Market Shares Under a Retail Model

Consumer propensity to switch to new providers is a balance of (1) their satisfaction and (2) the importance they assign to various service attributes such as price, user features, customer service, and availability of alternatives. For example, residential survey respondents indicated significant gaps between satisfaction and importance with respect to price, speed, and customer service (in order of the size of the gap) with their Internet service.

This data is important in determining the feasibility of a communications venture because new market entrants can capture market share by focusing on identified gaps to develop appropriate marketing strategies and product development

To help quantify the influence the gaps between satisfaction and importance have on consumers, we asked a series of questions regarding their willingness to acquire services with varying performance attributes and prices. The responses had a 5 point scale ranging from very willing/likely to very unwilling/unlikely to switch services, with the mid-point being neutral.

It is important to recognize that actual actions taken by consumers (residential and business) will differ from survey responses. Survey responses tend to overstate actions consumers will actually take. Further, survey data is temporal, consumer preferences and choices are influenced by advertising, product enhancements by existing providers, special offers, and other factors of influence. To compensate for these influences, we use a multiplier for each response category – which indicates the percentage of responses that will actually respond as indicated. The factors used are as follows:

- Very likely/Likely: .75
- Somewhat willing /Likely: .50
- Neutral: .25

- Somewhat unwilling /Unlikely: .00
- Very unwilling /Unlikely: .00

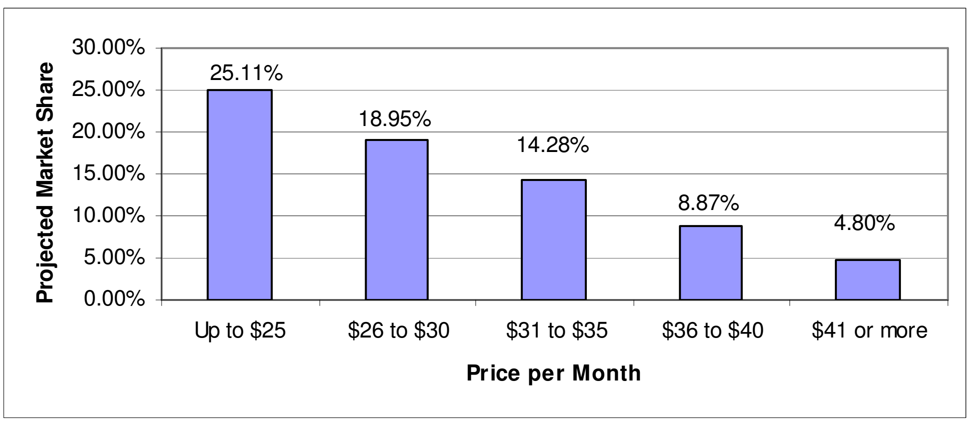
The following are the results of this analysis.

6.3.4.1. Residential Internet

The first Internet product presented in the surveys was a 1 Mbps symmetrical service, with prices ranging from under $25 per month to $41 or more per month.

As seen in Figure 16, if a 1 Mbps service is priced at under $25 per month, we might expect to capture up to 25 percent of residential Internet users[52]. The percentage drops as the price is increased above $25 per month. This was one of the difficulties with some city-wide WiFi projects – getting substantial (over 25 percent) market shares with product pricing in the $25 to $30 per month range.

Figure 16: Residential Internet (1 Mbps) Market Share Estimate



Next we asked a series of questions regarding the respondent's interest in obtaining a 100 Mbps service. As seen in Figure 17, over half of Internet users are willing to acquire a 100 Mbps service at either the same or reduced prices when compared to their existing price levels. The results indicated in Figure 17, dropping prices below existing levels does not result in a substantial gain in projected market share.

[52] The survey results indicate that approximately 88 percent of households have Internet access.

Figure 17: Residential Internet (100 Mbps) Market Share Estimate

Using the average monthly cost of $40 [53] for Internet access as the base price, we project a new provider would see up to a 54 percent market share with a 100 Mbps service priced at $40 per month. Dropping the price to $30 per month only increases the anticipated market share by 6 points.

6.3.4.2. Residential Telephone

Telephone is more of a commodity product than Internet. Telephone consumers have a wide-range of alternatives from Internet based voice over Internet protocol (VoIP) products to wireless cell phones. Just a few years ago, 98 plus percent of all households had a land- line telephone from incumbent telephone providers (Qwest in Seattle). By the end of 2008 it is estimated that 20 percent[54] of households will no longer have a land-line telephone and only use a wireless service. Further the survey indicated that 23 percent of respondents (land-line users) acquire service from their cable television provider or use an Internet-based alternative. For Qwest – this indicates they have gone from serving virtually every resident in Seattle to approximately 62 percent of households. We anticipate the size of the land-line telephone market share will continue to decline.

The average monthly price indicated by survey respondents is $35 – including long distance. As seen in Figure 18, we anticipate seeing up to a 14.5 percent market share with a similar priced service. Decreasing the price by $10 per month will increase the anticipated market share by over 21 percent – to 36 percent. With number portability and expanding alternatives, continued price pressure and high customer churn rates can be expected. Again, the market size for residential land-line telephone service is shrinking – wireless and Internet based alternatives and use is the rise.

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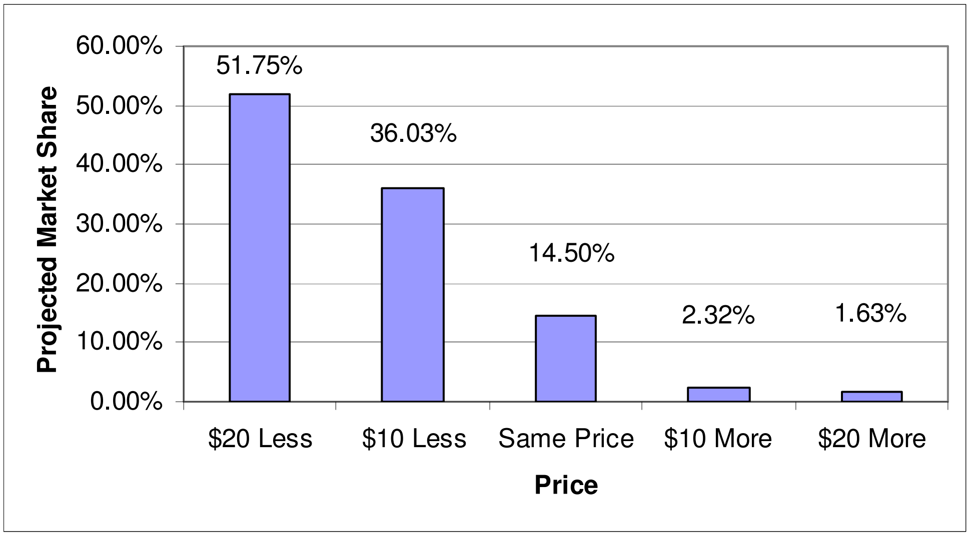
[53] Cable modem average is $45 per month, DSL average is $37 per month and dial up average is $23 per month.
[54] "Call My Cell: Wireless Substitution in the United States" September 2008, The Nielson Company.

Figure 18: Residential Telephone Market Share Estimate



6.3.4.3. Residential Cable Television

As in the case of the telephone, cable television has seen a declining market size due to adoption of satellite and other options. Although the market has declined in size, the drop is not as dramatic as the land-line telephone market. Today in Seattle, 67 percent of households are estimated to purchase cable television services, seven percent use satellite, 16 percent use over-the-air, and nine percent do not watch television.

An increasing alternative to cable television is over the Internet television viewing. Today in Seattle, one-half a percent of respondents indicted that they use the Internet as their source of television programming. As higher speed and more reliable Internet connections are made available we anticipate the use of the Internet for television to increase dramatically. In addition, the conversion to off-the-air broadcast to high definition will greatly increase the numbers of "free" channels available to Seattle residences – without the picture "snow" frequently experienced with analog broadcasts. Given these factors we anticipate the size of the cable television market will continue to decline.

Today Seattle residences pay an average of $53 per month for cable television service. A new entrant in the market may expect up to a 21 percent market share for a similar offering at the same price. Decreasing prices by $10 per month, we expect to see the anticipated market share to increase to over 38 percent.

Figure 19: Residential Cable Television Market Share Estimate

A major challenge for new entrants into the cable television market is maintaining contribution margins[55]. Program fees paid by cable television operators continue to rise and customer willingness to pay more is in the decline. Cable operators are no longer able to shift all programming cost increases to consumers and thus have seen lower contribution margins resulting in lower profitability for the cable television distributors.

6.3.4.4. Business Internet

The range of needs and range of satisfaction levels of Internet use for business is much greater than in the residential market. Large organizations tend to have fewer issues and complaints with Internet access and related costs. Smaller businesses are frustrated with cost and connection speed.

Approximately 90 percent of Seattle businesses use an Internet connection, with over half being DSL and ¼ cable modem customers. Larger businesses will use leased lines and at times Gbps based fiber connections.

Significant satisfaction and importance gaps exist with choice of providers, customer service, price, and speed. As in the case of residential services – a new market entrant must view these gaps as opportunities.

First we looked at the likelihood of businesses obtaining a 1 Mbps service at different price levels. As seen in Figure 20, a 1 Mbps service is only attractive to only 24 percent of businesses with Internet access – even at under $25 per month.

[55] Differences between gross revenues and cost-of-goods sold.

Figure 20: Business Internet (1 Mbps) Market Share Estimate

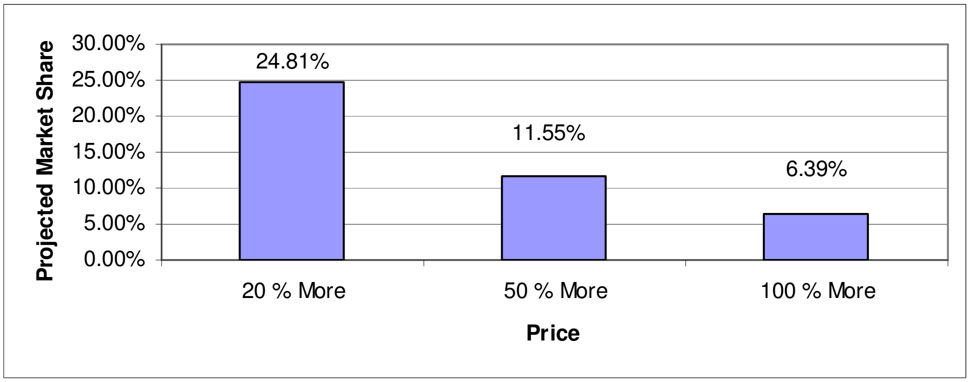
Increasing the speed of the Internet allows the provider to charge a higher price. The survey results indicate we can expect that up to 47 percent of businesses may acquire a 100 Mbps service priced at the same rate as they pay for DSL or cable modem service[56] (average of $90 per month). As illustrated in Figure 21 there is sensitivity of projected market share by increasing or decreasing the price by 10 percent.

Figure 21: Business Internet (100 Mbps) Market Share Estimate

For some businesses, there is an interest in obtaining a 1,000 Mbps service (1 Gbps). Six percent of businesses indicate a willingness to pay double their current price for a 1 Gbps service[57]. The interest in obtaining a 1 Gbps service is shown in Figure 22.

[56] Businesses using a cable modem or DSL (76 percent of businesses) pay an average of $90 per month. The survey results indicate that up to 47 percent of these users may be willing to pay $90 per month for a 100 Mbps service.
[57] Businesses using a leased line (13 percent) pay an average of $500 per month. The survey results indicate that up to 6 percent of these users may be willing to pay $1,000 per month for a 1 Gbps service.

Figure 22: Business Internet (1000 Mbps) Market Share Estimate



6.3.4.5. Business Telephone

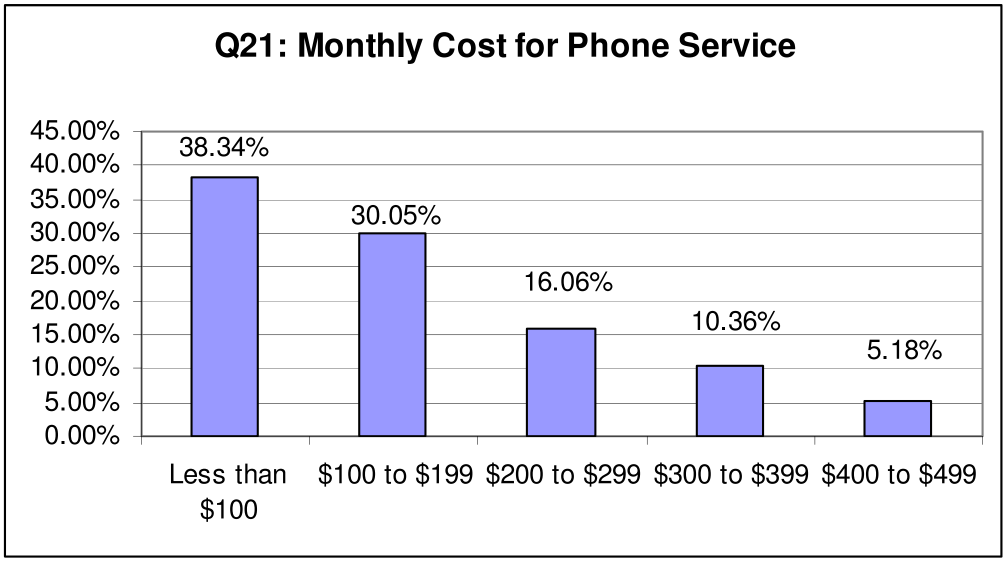
As in the case of residential, business telephone has become a commodity. Businesses however still primarily use a land line connection since wireless is not a direct substitute product today. This is not to say, however, that it will not change in the future.

As seen in Figure 23, in order to capture a 26 percent market share, discounts of at least 10 percent must be offered.

Figure 23: Business Telephone Market Share Estimate

The average monthly telephone fees paid per month is $250. There is however, a large range of prices paid by businesses. For example 38 percent of the businesses see an average monthly phone cost of less than $100, while over 15 percent pay over $300 per month. The ranges of costs are shown in Figure 24.

Figure 24: Business Telephone Market Share Estimate



6.3.4.6. Business Cable Television

The cable television market size by businesses is low. Only 15 percent of businesses acquire cable television services at an average cost of $79 per month and five percent acquire satellite services at an average cost of $83 per month.

Given the low use of cable television by businesses and the need to keep the survey as short as possible we did not ask propensity to switch questions in the survey.

In the financial model we assume the business market will respond similarly to price changes as in the residential market. Further we assume the market size for cable television is 15 percent (existing cable television users) since business satellite users are interested in sports and entertainment programming only available via satellite (example: NFL Game Day).

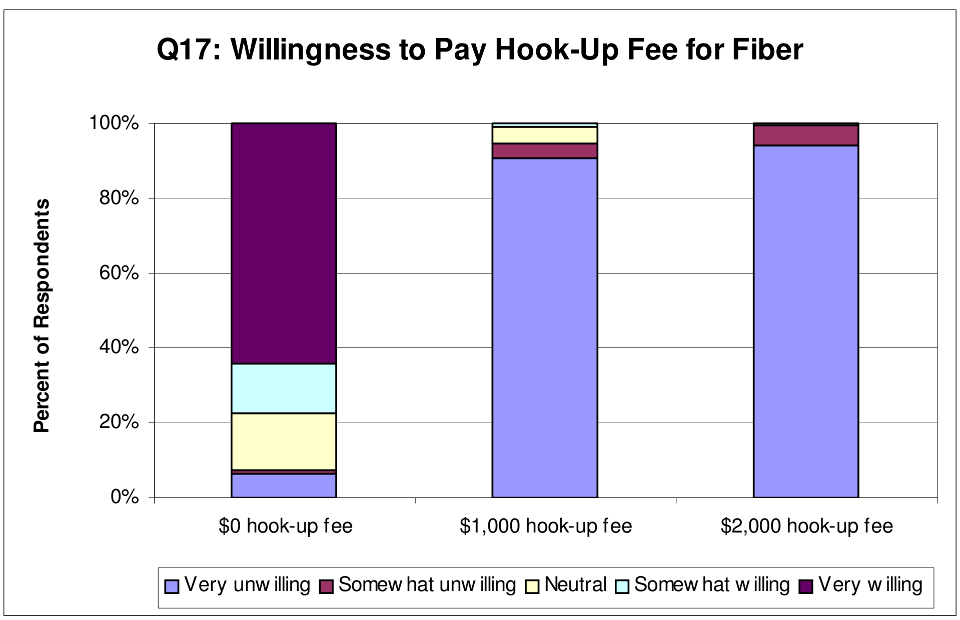
6.3.5. Consumer Interest in Owning Fiber: the Equity Model

One emerging business model is having consumers pay a $1,500 to $3,000 hook-up fee for the ability to receive a FTTP connection which provides a portal to a large selection of voice, video and data providers. This model has shown some success in Europe and in earlier stages of consideration in a handful of US cities. In theory this model addresses many of the concerns identified by Seattle residents and business owners. In particular, this model addresses the desire to have the ability to choose from a large selection of providers, not just a select few.

The survey results do not necessarily suggest an Equity model would be unsuccessful; however, it does show that a considerable education effort is required to demonstrate the value proposition that the Equity model may offer. Convincing residences and business to participate in the Equity model will not be done successfully through the use of door hangers and 12 month price promotions. A grass-roots personal contact campaign that educates consumers on the model and its value proposition[58] is required.

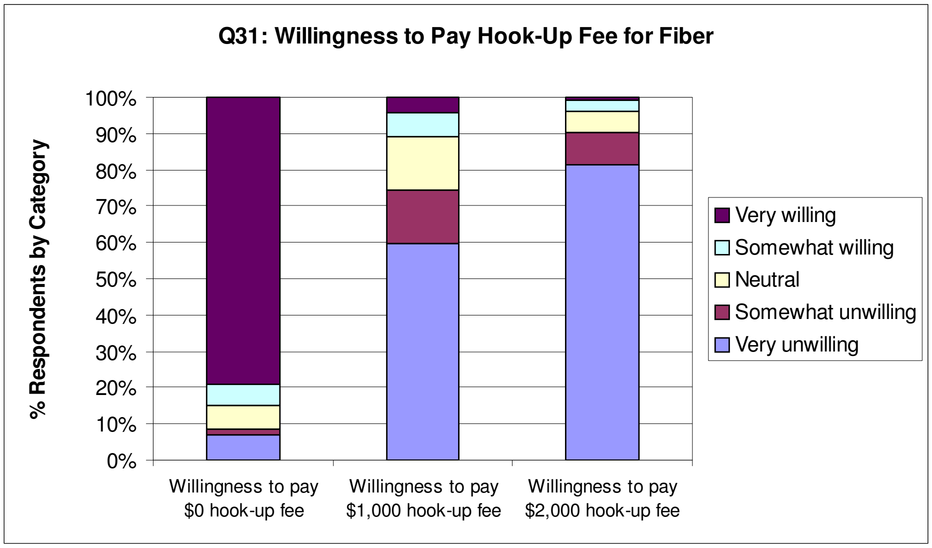
Where residences and businesses were asked about their willingness to pay a hook-up-fee, the interest is quite low. No residences and 4 percent of businesses were willing to pay a $2,000 one-time fee. The responses are shown in Figure 25 and Figure 26.

Figure 25: Residential Willingness to Pay Hook-up Fee



[58] Includes but not limited to consumer choice of providers, reduced access fees, and increased property value.

Figure 26: Business Willingness to Pay Hook-up Fee



The willingness to pay a hook-up fee does increase with the promise of service price discounts. If a 30 percent discount is possible; 27 percent of businesses and 10 percent of residences are willing to consider payment of a $2,000 hook-up fee. In addition the "neutral" response increased significantly than the case with no service price discounts. The responses with various price discounts are shown in Figure 27 and Figure 28.

Figure 27: Residential Willingness to Pay a $2,000 Hook-up Fee

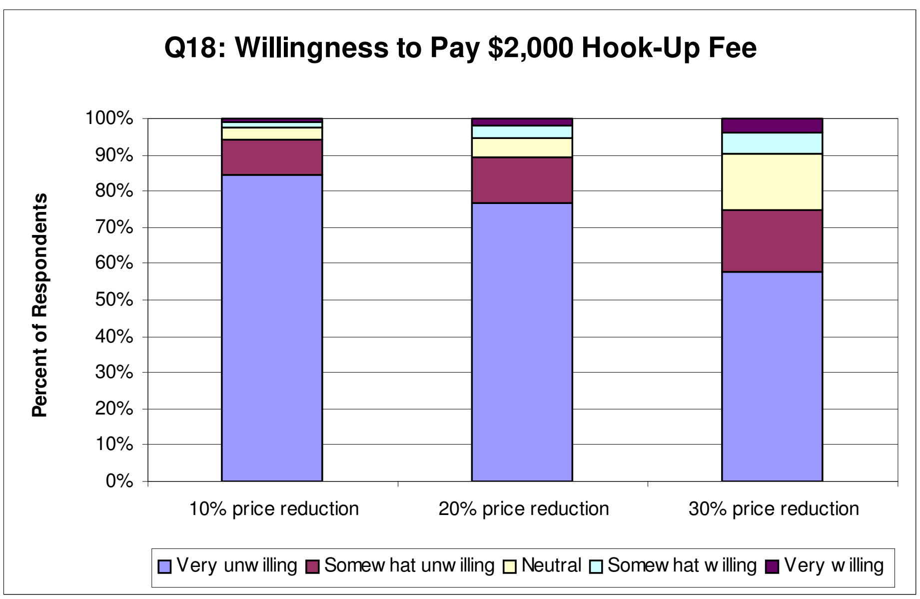
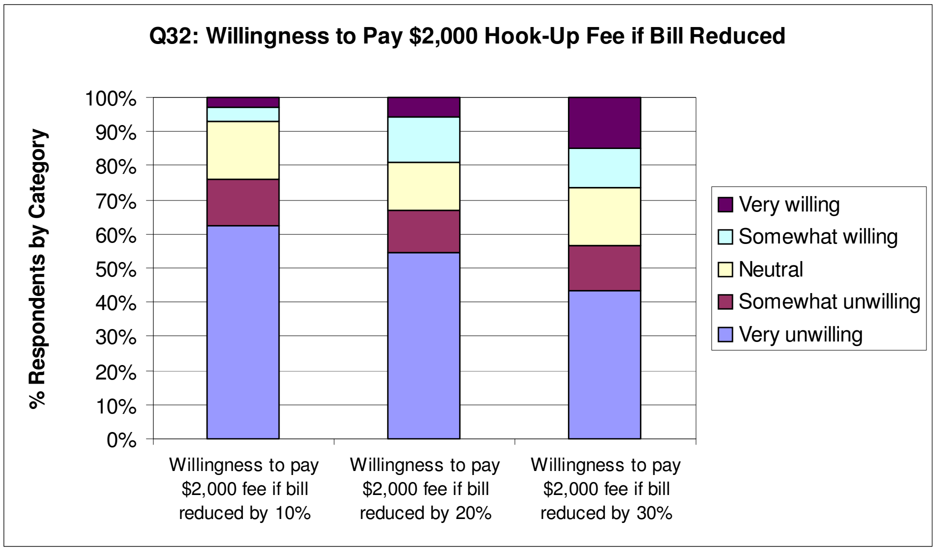


Figure 28: Business Willingness to Pay a $2,000 Hook-up Fee



6.4. Environmental Savings Through Telecommuting

As part of market research, CTC included questions regarding interest Seattle residents have in telecommuting, whether existing cable modem and DSL connections are sufficient to support telecommuting, and if higher speed Internet connections were available would workers increase their frequency of telecommuting. This section summarizes the potential cost savings to Seattle commuters as well as the potential emission reductions due to increased telecommuting with improvement of the speed of Internet access

Over time, a successful telecommuting program will show significant cost savings to the City of Seattle and their residents by reducing vehicle operating expenses, the amount of time spent traveling, reduced road repairs, reduced congestion on roads, and other factors. In addition with the decrease of mileage driven and gasoline burned, telecommuting serves its part in benefiting the environment and reducing greenhouse gases by lowering the amount of auto emissions.

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 reduction in such indirect factors as:

- Cost of roadway repair and maintenance
- Maintenance and expansion of public transportation
- Overhead costs
- Traffic volume and congestion and associated commute time

- Office space congestion
- Parking congestion
- Other soft benefits including quality of life and employee morale

These benefits are beyond the scope of this Report.

6.4.1 Savings Analysis: Vehicle Use for Commuting to Work

A number of questions were asked in order to establish the current working environment of Seattle's residents. These questions included determining working status, primary mode of transportation, distance traveled to work, and ability or willingness to telecommute on a daily or weekly basis.

Out of the households surveyed in Seattle;

- 73 percent work on a full or part time basis,
- 57 percent of respondents that work travel to work by car alone when they commute- of which over 70 percent drive alone at least 5 days per week,
- The average one commute miles to work is 8.9, taking on average 21.3 minutes to commute

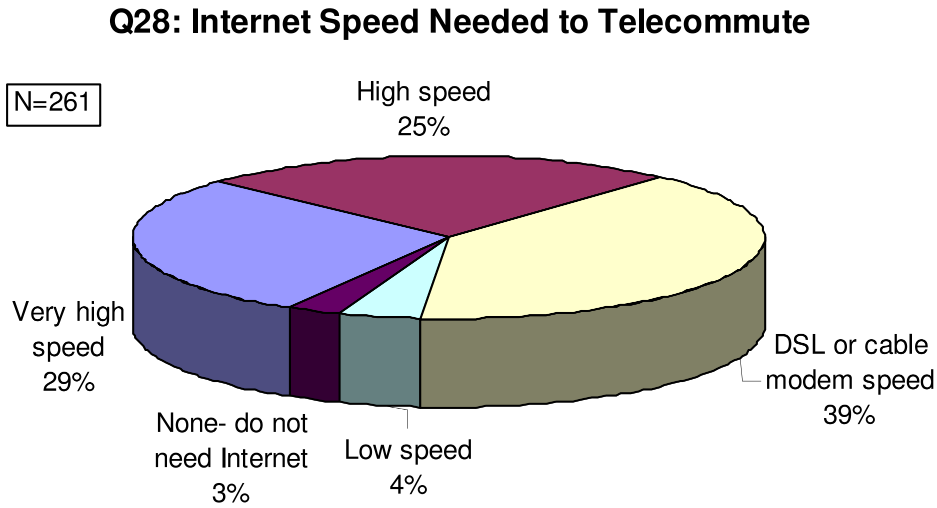
Given approximately 267,254 households are located in Seattle area, 129,401[59] vehicles drive alone sometime during the work week.

6.4.2 Increase in Telecommuting

One major factor allowing an employee to telecommute is the speed of high speed Internet comparable to what is supported by DSL or cable modem speeds. As seen in Figure 29, over 54 percent of respondents indicated that speeds beyond cable modem/DSL is required for telecommuting (25 percent indicated speeds of 10 Mbps to 100 Mbps are required, 29 percent indicating speeds of 100 Mbps or over are required).

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

Figure 29: Connection Required for Telecommuting



The survey indicated that 57 percent of respondents would be willing to telecommute at least one day per week- if connection speed was not an issue. This is an increase of 20 percent of workers who telecommute today (37 percent or workers telecommute at least occasionally today). We also asked if interested in telecommuting how many days per would they telecommute. We then compared the results of frequency of telecommuting today versus what residents might given the availability of an improved Internet connection. Table 4 shows the projected increase of telecommuting. The increase is for only workers that primarily drive alone when physically commuting for work. Similar calculations can be done for individuals' car pooling or using public transportation.

Table 4: 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%

6.4.3 Miles and Time Saved by Telecommuting

Given the estimate of 129,401 residents use a vehicle to travel to work an average of 10.2 miles taking 21.1 minutes- even telecommuting one day per week provides tremendous time and cost savings. Table 5 shows the projected reduction in miles driven through increased telecommuting. Table 6 shows the reduction in time commuting due to increased telecommuting. The projected reduction is almost 84 million miles driven per year with an annual time savings of over 3.3 million hours.

Table 5: 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 6: 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

6.4.4 Cost Savings to Residents

Based on the increase in telecommuting, CTC calculated the cost savings in gasoline and vehicle expenses to residents telecommuting at least one day per week. If residents are traveling tens of millions of miles less per year, they are consequently consuming less gas and less vehicle operating costs.

If a vehicle obtains an average twenty miles per gallon and the average cost of gasoline per gallon is $3.75, through increased telecommuting Seattle residents could save 4.8 million gallons per year or $18 million per year.

Gas savings however do not represent the total cost of driving. The Internal Revenue Service mileage rate was created to determine the permanent and changeable costs for operating a vehicle – including gasoline. The 2008 standard mileage rate for businesses is 58.5 cents per mile[60]. Based on the average miles saved per week and the gallons of gasoline saved per week, residents would save over $60.9 million on their vehicle expenses per year. At a six percent discount rate over 15 years, this represents a net present value of the vehicle savings at $591.3 million.

Table 7: Annual Cost Savings to Residents

Average Miles Saved per Week w/Telecommuting	IRS Mileage Rate	Vehicle Operating Cost Savings per Year (48 Weeks)
2,001,483	$ 0.585	$ 60,885,113

Most of the time spent commuting has limited or no productivity. It reduces the amount of time available to spend with family, working on household projects, or learning new skills to increase one's value in the workplace. If we place a value of $10 per hour on commuting time-telecommuting would save an additional $33.1 million per year. At a six percent discount rate over 15 years, this represents a net present value of the time savings at $321.7 million. This combined with vehicle savings yields a potential discounted 15 year savings to commuters of $913 million.

6.4.5 Auto Emission Reduction

Telecommuting/telework has been documented to reduce carbon and toxic emissions.[61] Emissions are substances and gases released into the air as byproducts[62] including exhaust and evaporation of fuel. One of the largest sources of air pollution is from cars and trucks. Emissions from an individual car are typically low, but as the number of cars on the roadways

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[60] Data obtained from, http://www.panache-yes.com/mileagerate.html, accessed September 23, 2008.

[61] The US 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 had 79 employees from five companies enrolled in the program by early 2002. The estimated emissions reduction was 52kg/day VOC, and 6kg/day NOx. 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 NOx. The Washington Metropolitan area project was designed to assist employers to 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 NOx.

[62] Data obtained from, http://www.merriam-webster.com/dictionary/Emissions, accessed September 15, 2008.

increase the amount of emissions also increases.[63] The types of pollutants emitted from gasoline powered vehicles are:

- ROG or Reactive Organic Gases,
- NOx or Nitrogen Oxide,
- PM10 or fine particulates,
- CO or carbon monoxide, and
- CO_2 or carbon dioxide.

Table 8 shows the projected emission reduction in Seattle based on the increase in telework as a result of implementation of high-speed networking. The total reduction was calculated by taking the amount of miles saved per year by increased telecommuting multiplied by the reduction factor.

Table 8: Emission Reduction Factors

Types of Emissions	Reduction Factor (gram/mile)[64]	Total Reduction (kilogram/year)
ROG	0.34	32,665
NOx	0.47	45,154
PM10	0.52	49,958
CO	2.91	279,568

Carbon dioxide emissions are dependant upon the gallons of gasoline burned, not miles driven. Based upon the EPA's factors a reduction almost 42.3 million kilograms of CO_2 is possible in Seattle through increased telecommuting enabled by improving the performance of available Internet connections.

[63] Data obtained from, http://www.epa.gov/OMS/consumer/05-autos.pdf, accessed September 15, 2008 and http://www.dot.ca.gov/hq/transprog/reports/CMAQCAL.pdf , accessed September 23, 2008.
[64] Ibid.

7. Business Models and Risk/Benefit Analysis

This Section of the Report is intended to provide SCL with financial data by which to evaluate the feasibility and relative merits of alternative business models for a fiber network.[65]

This Section of the Report concludes that the least risky approach is a "Key Account" model because it offers a low-risk that meets SCL's regulatory and safety requirements while modestly facilitating the Mayor's FTTP goals by lowering the market entry barrier of a stand alone fiber deployment. Further, the Key Account model provides the first step towards an evolving Customer Ownership or "Equity" model, which has shown early success in Sweden.

To reach this recommendation, we examined the primary models for a municipally-owned or facilitated fiber network, ranging from simple leasing of infrastructure to full-blown offering of communications services as an additional utility.

Where appropriate, CTC's methodology in evaluating these models was to determine what level of market share would make the various models cash flow (i.e., to generate enough revenue annually to cover its own operating and financing expenses).[66] In the financing community, the key measurement for a municipal communications network is cash flow -- the capability to maintain sufficient cash flow to cover debt service (principal and interest), operating expenses, and ongoing network enhancements.

For each model, we also make brief mention of American or European jurisdictions where the business models have been implemented or are under consideration.[67]

[65] It is important to note that this Section details only the quantifiable financial factors that are relevant to the business case for the network. Many of the additional benefits of the network include such key items as economic development, small business empowerment, job creation, livability, education, increased property values, and other factors that measure the overall benefit of a next generation communications infrastructure such as FTTP. Given the parameters of the tasks assigned by SCL to CTC for this Report, however, this Section and the overall Report address only the direct cost and revenue aspects of the business case for the alternative business models.

[66] For each FTTP model, we estimated costs assuming use of Home Run Ethernet technology because it is the preferred technical model for Seattle's requirements (flexibility, openness, and competition). Use of Passive Optical Network (PON) technology would slightly impact the financial projections, but will not impact the comparison between the FTTP models or the recommendations made in this Section.

[67] These descriptions are intended to demonstrate where such models are evolving, but should not be read as endorsements of the models or as authoritative data regarding the likelihood of success or failure. The municipal FTTP movement is still in its infancy, especially in larger communities, and there is limited empirical data on which to rely for purposes of understanding how processes and business plans have worked. In addition, there are dramatic differences in circumstances between Seattle and each of the existing municipal FTTP networks in the United States and elsewhere. We caution against simple comparisons and note instead that these municipalities face major differences in financing, topography, technology evolution, market, customer base, competitive situation, and other factors.

7.1. Infrastructure Participation Model

In this model, SCL makes available to a private sector entity, for lease, selected SCL assets that will enable the private entity to more efficiently and expeditiously build and operate a network. This is the model that is under consideration in Portland, OR and Palo Alto, CA, though neither is directly analogous to Seattle because neither has a municipal utility with such infrastructure capabilities as SCL.

Interest in this model is currently running high--even without the benefit of a municipal electric utility, Palo Alto is in negotiations with a private consortium for city-wide FTTP —apparently at no cost to the city.

7.1.1. *Technical Considerations*

A common assumption is that SCL can assist in encouraging a private party installing FTTP by facilitating pole attachments and reducing make-ready costs. Although SCL can assist with pole attachments, it does have certain limitations as a result of regulatory considerations, safety requirements, and Qwest's ownership interest in the poles.

According to SCL,[68] Qwest has no authority regarding how pole make-ready work estimates are made for pole attachments where the make-ready work does not impact Qwest lines. SCL has the right to change racks, raise primary or secondary conductors, and adjust its own facilities first to make room for new communication lines. However, if proper clearance cannot be attained through adjustments to City facilities, and in the event that changes are necessary to Qwest's communication lines, prior approval must be granted by Qwest in accordance with the Joint Use Agreement. Qwest does have a say in how pole make-ready work estimates are made if the make-ready work impacts Qwest lines. Qwest can slow and/or prevent a pole attachment by refusing to move its lines to accommodate new City or private lines installations.

An all dielectric[69] fiber cable can be installed in the power space to avoid any potential slow down of approvals or make-ready by Qwest. This alternative requires SCL to own and maintain the fiber cable constructed in the power space. Construction of fiber in the power space on the poles does not mean that SCL has to be the retail provider. Another municipal electric utility in a major US city has successfully leased dark fiber in the power space to retail providers since 1995. The availability of dark fiber has enabled and encouraged alternative providers to enter the market place--eliminating the control the incumbent telephone company in that city has over access to communication infrastructure.

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[68] August 6, 2008 memo to Mr. Gary Maehara from Mr. Josh Walter, provided to CTC in August 2008 by SCL staff.
[69] Fiber cable that has no electric conductor is referred to as an All Dielectric Self Supporting (ADSS) fiber cable.

7.1.2. *Risks and Benefit*

Pursuit of the Infrastructure Participation Model is a relatively lower risk approach to facilitate the availability of FTTP. We see relatively little financial risk in this model. However, there is some limited risk associated with regulatory and security concerns—risk that can be alleviated through appropriate legal and engineering planning. Another risk arises from potential public perception. If this model is pursued but does not prove successful, both SCL and the City face the potential perception that they did not do enough.

7.1.3. *Financial Analysis*

The potential assets discussed in Section 2 do not require a substantial investment by SCL to make certain assets available.

At minimum, this model would require SCL maintaining an ownership position in the joint-use fiber and then leasing the fiber to the City. The City in return has the option of offering low or no-cost access to a FTTP provider, which may help encourage build-out.

7.1.4. *Existing Project in Another Community*

In Palo Alto,[70] a consortium of three companies (PacketFront, 180 Connect, and Axia NetMedia) have proposed to fund, build, own, and operate an open-access, network-neutral system throughout the city. It appears that the city incentivized the private investment in part by 1) agreeing to purchase services itself, thus serving as a key, large customer of the network, 2) leasing selected assets to the consortium, and 3) offering use of 36 of the City's dark fiber strands. Based on the preliminary information currently available, no up-front investment by the City is required, but it is not clear whether the city will be asked to guarantee financing. To our knowledge, this offer is the first of its kind for FTTP in the United States, and we will continue to monitor the negotiations and update SCL as data about the negotiations become public.

7.2. Retail Delivery Model

In this model, the City or SCL builds, owns, operates, and offers exclusive services over the network. The City or SCL becomes a competitive provider of voice, video, and data services. This is the model used most frequently by small municipal utilities in rural parts of the U.S. Case studies of two such networks are presented below. Given our understanding of SCL's and the City's parameters and financing considerations, we are frankly skeptical of this model.

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[70] Katrina Peterson, "Investors Pitch Broadband Concept," Palo Alto Daily News, July 8, 2008, http://www.paloaltodailynews.com/article/2008-7-8-pa-fiber-session.

This model requires the City or SCL to directly compete with Comcast and Qwest. It requires the City or SCL to finance the buildout of the network—and potentially of operations in the event that network revenues do not cover expenses. It also requires the City or SCL to define and update services on an ongoing basis, establish consumer-level sales and marketing efforts, and establish consumer-level help desk and other support mechanisms.

The retail model requires the broadest range of staff additions, training, marketing, and other activities to run and maintain the business venture. This section provides an overview of the estimated requirements and the projected financial results.

The retail model presented in this section provides a magnitude[71] projection and includes a wide-range of estimates of staffing, operating, maintenance, and other costs. In the event that SCL or the City consider adopting this model, we recommend that these projections be refined in a more detailed business plan. In addition, the estimated market shares were chosen to drive a positive cash flow—they are not necessarily obtainable or sustainable.

7.2.1. *Technical Considerations*

For this model we have assumed the use of “Home Run” fiber as described above. This model will require additional staff and facilities to support the new business. We estimate that over 300 additional employees are required to operate the proposed business.

7.2.2. *Risks and Benefits*

The success of the retail model greatly depends on the government’s capability to compete in a consumer market with established and experienced providers. Other municipal FTTP systems[72] have obtained such shares, but they are located in rural or small town communities where competition is limited (or nonexistent) and the local government possesses a strong branding or trust image with its citizens. In addition, most of these municipal networks were first to market with a high-speed Internet offering and the incumbent cable television network was in a state of disrepair.

[71] A “magnitude” projection provides projected data sufficient for initial planning purposes. Refinement of the analysis is planned after results of the residential and business market research is completed.
[72] For example, see the Reedsburg, WI and Jackson, TN case studies presented in this report.

7.2.3 Financial Analysis

7.2.3.1 Financing Costs

Our analysis estimates total financing requirements to be $530 million for the retail model. For financing, we assume two bonds[73] and an operating loan.

1. A $230 million bond[74] 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 $250 million bond in year 1 to cover the remaining implementation costs, including headend equipment, operating equipment, customer premises 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[75] at an interest rate of 5.00 percent. Further principal payments do not start until year 4.

3. We assume a $50 million loan in year 3 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 5.

We assume that the bond issuance costs are equal to 1.0 percent of the principal borrowed. For each bond, 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.

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 9.

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[73] The scope of work for this Report does not include a review of the City's or SCL's bonding capability or review of local or state bonding restrictions. A more detailed review and opinion from the City's and SCL's accountants of bonding capability and restrictions is recommended in the business planning phase.
[74] 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 existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required.
[75] 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 thereafter, we have included expenses for equipment replenishment paid from incoming revenues.

Table 9: Retail Model Income Statement

Year		1	10	20
a. Revenues				
Video		$ 9,393,684	$ 24,333,012	$ 24,333,012
Internet		20,922,835	77,974,012	77,974,012
Voice		2,611,287	7,942,045	7,942,045
Provider Fee		-	-	-
Ancillary Revenues		9,117,469	45,447	45,447
	Total	$ 42,045,275	$ 110,294,516	$ 110,294,516
b. Content Fees				
Video		$ 5,040,060	$ 14,452,762	$ 15,964,841
	Total	$ 5,040,060	$ 14,452,762	$ 15,964,841
c. Operating Costs				
Labor Expense		$ 7,593,750	$ 21,087,000	$ 21,087,000
Operation and Maintenance Expenses		11,285,876	27,889,657	27,889,657
Pole Attachment Expense		-	-	-
Depreciation		30,553,147	25,886,262	25,869,334
	Total	$ 49,432,773	$ 74,862,919	$ 74,845,991
d. Operating Income		$ (12,427,558)	$ 20,978,835	$ 19,483,684
e. Non-Operating Income				
Interest Income		$ -	$ -	$ -
Interest Expense (Headend and CPE Bond)		(12,500,000)	(9,209,648)	(1,055,942)
Interest Expense (Fiber Bond)		(10,350,000)	(7,540,177)	(846,002)
	Total	$ (22,850,000)	$ (19,202,634)	$ (2,642,554)
f. Net Income		$ (35,277,558)	$ 1,776,201	$ 16,841,130
g. Taxes (Franchise Fees & In Lieu Tax)		$ 469,684	$ 1,216,651	$ 1,216,651
h. Net Income After Fees & In Lieu Taxes		$ (35,747,242)	$ 559,550	$ 15,624,479

7.2.3.2 Operating and Maintenance Expenses

Years 1, 10, and 20 operating and maintenance expenses are presented in Table 10. These expenses are in addition to the cable television (video) programming (content) fees, pole attachment expenses, and labor expenses shown in the Income Statement (Table 9).

Table 10: Summary of 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	400,000	400,000	400,000
Contingency	400,000	400,000	400,000
Billing Maintenance Contract	50,000	50,000	50,000
Fiber Maintenance	1,321,875	1,321,875	1,321,875
Legal Fees	300,000	150,000	150,000
Content Aquisition	250,000	50,000	50,000
Marketing	1,000,000	750,000	750,000
Annual Variable Operating Expense			
Education and Training	303,750	843,480	843,480
Customer Handholding	51,414	181,790	181,790
Customer Billing (Unit)	25,707	90,895	90,895
Allowance for Bad Debts	630,679	1,654,418	1,654,418
Internet Connection Fee	5,832,450	21,157,200	21,157,200
PSTN Connection Fee	120,000	240,000	240,000
Total	$ 11,285,876	$ 27,889,657	$ 27,889,657

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
- Expand retail "storefront" to facilitate customer contact and their experience with doing business with the City or SCL.
- 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 or SCL staff is important to fully realize the economies of adding a business unit. This training is especially important for electric customer service representatives, account managers, and other staff that deal directly with the taxpayers or electric ratepayers - even if they will not be directly assigned to the new enterprise.

Cable Programming: To provide retail cable television service, the City or SCL will need to obtain programming through independent negotiations with content providers, including Comcast. In the past small cable operators have joined the National Cable Television Cooperative to acquire a substantial portion of programming via National Cable Television Cooperative negotiated contracts. The National Cable Television Cooperative however has a moratorium on adding new members which is unlikely to be lifted in the near future. Given this, the City and SCL are on their own in negotiating programming contracts with each programming content owner. We anticipate the City or SCL will spend $250,000 in year 1, $100,000 in year 2, and $50,000 each following year to negotiate and maintain programming (content) contracts.

These expenses are in addition to on-going programming fees. On-going cable programming fees are the highest expense[76] as a percentage of revenue in the retail model. This makes reduction of cable television pricing difficult unless the provider is willing to use cable television as a loss-leader[77] product.

Billing and Collections: The City or SCL already has billing software and capabilities. The estimated incremental cost of billing for the new broadband utility is five cents per bill. In addition, we have included $400,000 for upgrade or purchase of a billing module. Incremental maintenance of billing software is estimated to be $50,000 annually.

Marketing and Sales: It is important to be proactive in setting customer expectations, addressing security concerns, and educating the customers on how to initiate services.

Staffing Levels: Skills in the following disciplines are required:

- Sales/Promotion
- Internet and related technologies
- Staff Management
- Strategic Planning
- Finance
- Vendor Negotiations
- Networking (addressing, segmentation)
- Marketing

Based upon our experience, the recommended support staffing levels for the technical employees are shown in Table 11.

Table 11: Recommended Support Staffing Levels

Position	Metric
Plant Service Technician	1 per 100 miles of plant
Customer Service Technicians (CST)	1 per 2,500 subscribers (per shift)
Customer Service Representative (CSR)	1 per 2,500 subscribers (per shift)

The expanded business and increased responsibilities will require the addition of new staff. The initial additional positions, staffing levels and base salaries are shown in Table 12. These numbers are based upon the levels indicated in Table 12, and assume that 24x7 customer service representative support is provided (three shifts) and two shifts of customer technicians are

[76] See line b of the Income Statement in Table 9.

[77] Attracting customers to purchase a base product which encourages them to buy other services. The provider expects that the typical customer will purchase Internet and/or telephone services at the same time as the loss leader (cable television) and that the margins made on these items will be such that positive cash flow (profits for private sector less cash flow for the public sector) is generated for the provider.

available. Changing the support to 7am to 8pm (or other reduced hours) will decrease the required number of staff.

Table 12 Estimated Staffing Requirements

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

For purposes of this analysis, benefits in the amount of 35 percent of base salary are assumed.

7.2.3.3 Summary of Assumptions

Key annual operating and maintenance assumptions include:

1. With the exception of cable television programming (content) fees, annual increases in subscriber fees will offset annual increases in expenses. Cable television fee increases will exceed increases of cable television subscriber fees by one percent per year.
2. Content fees are estimated based on adding a slight premium on current fees paid to content owners by cable television providers. The premium is due to the fact that the City or SCL will not be able to join the National Cable Television Cooperative.
3. Salaries and benefits are based on estimated market wages. See Table 12 for the list of staffing requirements. Benefits are estimated at 35 percent of base salary.
4. Insurance is estimated to be $400,000 in years 1 through 20.
5. Utilities are estimated to be $200,000 in years 1 through 20.
6. Office expenses are estimated to be $400,000 in years 1 through 20.
7. Contingency is estimated to be $400,000 in years 1 through 20.
8. Maintenance of billing software is estimated to be $50,000 in year 1 through 20.
9. Fiber maintenance fees are assumed to be $5,000 plus 0.5 percent of total fiber implementation cost annually.
10. Legal fees are estimated to be $300,000 in year 1 and in year 2, and then are reduced to $150,000 in years 3 through 20.
11. Negotiation of able television programming fees is assumed to be $250,000 in year 1, $300,000 in year 2, and $150,000 in years 3 through 20.
12. Marketing and promotional expenses are estimated to be $1,000,000 in year 1 and $750,000 in years 2 through 20.

13. Education and training are calculated as four percent of direct payroll expense.
14. Customer handholding is estimated to be 10¢ per subscriber per month.
15. Customer billing (incremental) is estimated to be 5¢ per bill per month.
16. Allowance for bad debts is computed as 1.5 percent of revenues.
17. Internet connection fees are estimated at an average of 25 Mbps per user at a 40 oversubscription ratio. Cost of Internet backhaul is estimated at $20 per Mbps per month.
18. Public Switched Telephone Network connection fees are estimated at $120,000 in year 1 and $240,000 in year 2 and thereafter.
19. No pole attachment fees are included since fiber cable is located on SCL poles.
20. Customers will pay the costs of one set-top box and fifty percent internal wiring. These payments are shown as ancillary revenue in the income statement.
21. Franchise fees are estimated to total five percent of cable television revenue annually.
22. 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.
23. 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.
24. The market size for residential cable and satellite television will decline to 66 percent of households by year 9. The market size for the cable television business will remain at 15 percent.

Inflation and salary cost increases were not used in this analysis as it is assumed that cost increases will be passed on to customers in the form of increased prices.[78]

7.2.3.4 Pricing

Pricing is a critical part of the retail model for obvious reasons, because it impacts the consumer's cost/benefit analysis and its willingness to purchase the product -- and thereby impacts the provider's market share. It is important to keep in mind that maximizing market share is not necessarily the same as maximizing revenue--a very inexpensive product can drive market share but the revenue generated could not maintain operations and make financing payments.

Our model leverages the results of the market research and selects pricing at a level that balances revenue generation and obtaining market share. Specifically:

- The model prices cable television packages slightly below Comcast's current package pricing.

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[78] Models that add the same escalation factor on revenues and expenses will overstate the anticipated gross margins (revenues less expenses) in the out years. For example: in year 1, $2 in revenues and $1 in expenses results in a gross margin of $1. Increasing each by 10 percent results in $2.20 in revenues and $1.10 in expenses, yielding a gross margin of $1.10. In other words, gross margins will also increase by the escalation factor.

  - The mix of cable television packages and options nets an average of $53 per month per subscriber.
  - Package prices (without premium channels) range from $12 per month to $51.50 per month.
  - Premium packages (incremental) ranges from $10 per month to $40 per month.
- Internet packages are priced to be competitive with existing area Internet service providers while offering higher capacity connections. Specifically residents are offered a 100 Mbps connection at the current price of Comcast cable modems.
  - $39.95 per month for a residential 100 Mbps connection.
  - $89.95 per month for a business 100 Mbps connection.
  - $1,000 per month for a business 1 Gbps connection
- The model prices telephone packages to be competitive with Comcast and Qwest.
  - $34.95 per month for residential unlimited local and long-distance.
  - $89.95 per month average for business unlimited local and long-distance.

7.2.3.5 Cash Flow Results

Examining a stand-alone Income Statement is not a sufficient analysis. This analysis also examines the cash flow after principal[79] payments are made, accumulated unrestricted cash balances, and restricted[80] cash balances.

Year-end net income and cash flow results are compared in Table 13. Although net income is positive, it is insufficient to cover debt service. The results demonstrate a net cash shortage projection of almost $150 million[81] at the end of year 20.

Table 13: Base Case (Retail) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (35,747,242)	$ (28,971,779)	$ 559,550	$ 7,133,781	$ 15,624,479
Cash Flow	$ 35,775,101	$ (3,989,736)	$ (4,669,762)	$ (52,917,570)	$ (8,346,858)
Unrestricted Cash Balance	$ 35,775,101	$ 12,358,655	$ (51,127,608)	$ (132,624,685)	$ (172,793,870)
Restricted Cash Balance (Debt Service Reserve)	$ 24,000,000	$ 24,000,000	$ 24,000,000	$ 24,000,000	$ 24,000,000

The cash flow balances are quite sensitive to the pricing and projected market shares. In order to cash flow, the retail business market share and/or pricing has to be increased. For example, we evaluate the sensitivity of residential Internet (service with largest revenues) by maintaining all assumptions except for residential Internet pricing and market share. If residential Internet pricing is increased by $5 to $45 per month while leaving market share at 54 percent, positive cash flow is maintained. However, as indicated in the surveys, market share is highly sensitive to price. The survey results suggest that if the residential Internet price is increased by $5 per

[79] The Income Statement accounts for interest expense but not principal payments on debt. The cash flow statement adds in non-cash expense such as depreciation and includes principal payments.
[80] The restricted cash balance is the debt service reserve fund, and is held in escrow until the last bond payment is made.
[81] Unrestricted cash balance plus the restricted cash balance.

month, market share declines by 14 percent. This combination nets a cash shortage of $98 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 14.

Table 14: Reduced Market Share (Retail) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (35,468,915)	$ (30,363,620)	$ (10,080,607)	$ (3,506,375)	$ 4,984,323
Cash Flow	$ 37,723,391	$ (13,543,574)	$ (15,518,664)	$ (62,305,254)	$ (19,195,760)
Unrestricted Cash Balance	$ 37,723,391	$ 35,181,424	$ (79,557,616)	$ (213,837,987)	$ (308,251,682)
Restricted Cash Balance (Debt Service Reserve)	$ 24,000,000	$ 24,000,000	$ 24,000,000	$ 24,000,000	$ 24,000,000

Cable television and telephone market shares have an impact on results, though in a less dramatic fashion. If residential cable television market share is dropped in half, net cash shortage drops to $184 million (a $34 million reduction). If residential telephone market share is dropped in half, net cash shortage drops to $192 million (a $42 million reduction).

The sensitivity of and the ability to obtain the required market share while maintaining contribution margins is one of the key challenges with the retail model.

Another consideration is the debt service coverage ratio. The debt service coverage ratio does not go above 1 in the base model. In the example of raising Internet prices, the debt service ratio is below 1 for the first three years and is 1.15 or below in years 4 through 20.

7.2.3.6 Market Share

The measure of success for a municipal venture is the ability to maintain a positive cash flow throughout the life of the proposed model. To maintain a positive cash flow, a substantial market share is required- without offering substantial discounts from existing subscriber fees.

At the price levels discussed above, the market research indicates a new provider may expect to attain up to the following market shares:

- 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

This level of market share at these prices will not maintain cash flow. To sustain the retail model cash flow, a new provider will need to obtain higher market shares or increase pricing without substantially lowering market shares. For a retail overbuild model, there exist no empirical data that demonstrate that a new market entrant can expect to obtain and sustain the market share numbers required to maintain cash flow. Frankly, we do not believe that there is any relevant empirical data at all—the existing FTTP networks in the United States are not analogous to a potential network in Seattle because they are frequently in rural areas or small towns and they therefore face dramatically different circumstances than a large, urban area.

In contrast to some of these smaller communities, a new market entrant in Seattle is likely to face difficulty obtaining such market penetration because it will compete with existing facilities-based cable and Internet providers and a phone company that has signaled intention to initiate video programming. Each of these providers currently offers (or plans to offer) a suite of voice, video, and data services. The City and SCL face the additional difficulty of potential branding-negativity—consumer perceptions that the City or SCL would not ably offer these services, perceptions that are likely to be highlighted by incumbents.

7.2.4 Existing Project in Another Community

Many municipal electric utilities, such as Reedsburg, WI and Jackson, TN operate successful FTTP networks that use the retail service model. One key difference in each of these cases the municipal electric was first to market with a high-speed Internet product and the incumbent providers had ignored network upgrades in the community for a number of years. Given the market status in Seattle, SCL would be challenged to maintain sufficient market share to maintain cash flow under this model.

7.3 Open Access Model

In this model, the City or SCL builds FTTP and wholly controls that asset. Private sector service provider(s) are selected to offer data, voice, and video services over it, respectively. In this model, the City's or SCL's role is limited to building and maintaining the FTTP network.

Variations on this model are emerging in parts of Europe, most notably Amsterdam, where the City (and a number of private investors) own the fiber infrastructure; a TelecomItalia subsidiary operates the lit network; and four competing Internet Service Providers provide services over the network. The City of San Francisco is also considering this model.

The passive layer model (also referred to as the "wholesale" or "open access" model) separates the infrastructure from the retail service. In this model, the City or SCL is in the business of infrastructure, not communications service provision. In the open access model, the City's or SCL's customer is not the retail consumer—rather, it is the service provider.

By building an open infrastructure on which capacity is leased to private sector providers, the City or SCL would address the key barrier to market entry for potential retail providers -- the cost of the FTTP infrastructure. The result is the potential for new competition-delivering, enhanced services.

7.3.1 Technical Considerations

We recommend consideration of a Ethernet over a "Home Run" fiber topology for planning purposes. This technology enables the standard mass-produced Ethernet equipment used in homes and businesses to be used in a City-wide network. Home Run Ethernet is being deployed by the Amsterdam FTTP network and other municipal service providers. It is particularly attractive for a wholesale deployment, because it enables individual retail service providers to directly reach customers over dedicated fiber optic strands from FTTP hub facilities in each neighborhood.

Ethernet technology has increased in speed by a factor of more than 100 over the past ten years and remained approximately constant in cost. It has been widely-deployed in home networks, business networks of all sizes, and carrier networks. Its wide adoption at all levels of the industry and well-matured standards have resulted in low hardware costs, widespread availability of related expertise, and continued development of faster and more functional versions. It is likely to continue to improve in quality, decline in price, and be eminently upgradeable as bandwidth needs increase in the coming years. Ethernet supports a wide range of deployment architectures, including the Home Run fiber topology, which offers the greatest flexibility for technology selection, models for open access, and overall greater capacity. It also minimizes the practical and aesthetic impact on the public right-of-way relative to other communications technologies.

The open access model requires fewer staff additions than does the retail model because it does not require consumer level support, sales, and marketing. The staff additions are geared towards operating and maintaining the FTTP network, promoting the network to potential service providers, and managing those providers leasing network access.

The open access model presented in this section provides a magnitude projection and includes a wide-range of estimates for staffing, operating, maintenance, and other costs. Prior to a decision, we recommend that these projections be refined in a more detailed business plan.

For comparison purposes, this analysis maintains the same market shares used in the retail model. However, we are not projecting these market shares are obtainable or sustainable.

Our wholesale model assumes that the City or SCL operates and maintains the fiber, the transport electronics, consumer drops, and the customer premises equipment. Contracting these activities to a management partner is a variation that reduces the required number of staff, while still allowing the City or SCL to maintain control of network availability and encouragement of new services and competition. In this variation, the City or SCL owns the fiber network and transport electronics, a management partner is contracted to provide network maintenance and operations, and the retail services supplier is chosen by the consumer. Further exploring this and other variations is an important step in business plan development.

7.3.2 Risks and Benefits

The theory behind open access is that given that multiple providers will seek market share, the probability of capturing sufficient market share is increased. In other words, the FTTP network has a greater chance of achieving higher aggregate market share if many providers are actively competing for customers than if only the City or SCL is marketing (as in the retail model). We believe there is some merit to this point in desirable, sophisticated markets such as those in Seattle and San Francisco.

Early results of the open access model have proved to be different, possibly because the model has been implemented primarily in rural, less dynamic markets. Without the open access infrastructure provider facilitating customer communications, potential consumers have not understood the breadth of options available. Further, the retail providers do not have a high capital investment, and therefore require a relatively low market share to remain profitable—reducing their incentive to market aggressively. As a result, in many of the open access deployments to-date, retail providers have been satisfied at a much lower market share than the infrastructure provider require to maintain cash flow.

7.3.3 Financial Analysis

Critical assumptions in the open access model include the access fees charged to the retail providers. In our analysis we used the following access fee structure.

- $23 per month for per residential Internet customer.
- $50 per month for per business Internet customer.
- $15 per month for per residential telephone customer.
- $30 per month for per business telephone customer.
- $15 per month for per residential cable television customer.
- $15 per month for per business cable television customer.

Assuming the retail pricing remains as indicated in the retail model, the above fees results in net per subscriber revenue to the retail provider of:

- $17 per month for per residential Internet customer.
- $40 per month for per business Internet customer.
- $25 per month for per residential telephone customer.
- $60 per month for per business telephone customer.
- $38 per month for per residential cable television customer.
- $38 per month for per business cable television customer.

The net revenue must cover all of the retail providers' investment, operating, and maintenance expenses plus their profit margins.

Using the same market share and market size assumptions used in the retail model, and charging each provider the above connection fees, the City or SCL will have an unrestricted cash balance of approximately $17.7 million by the end of year 20. A decrease of $1 per month of the residential Internet fee decreases the year 20 cash balance by $37.9 million to a shortage of $20.2 million. In other words, this model will cash flow under the assumptions stated here, but is exceptionally sensitive to minor revenue decreases and therefore entails significant risk.

7.3.3.1 Financing Costs

Our analysis estimates total financing requirements to be $475 million for the passive layer (wholesale) model. For financing, we assume two bonds[82] and an operating loan.

1. A $200 million bond[83] 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 $250 million bond in year 1 to cover the remaining implementation[84] costs, including headend equipment, operating equipment, customer premises 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[85] at an interest rate of 5.00 percent. Further principal payments do not start until year 4.

3. We assume a $25 million loan in year 3 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 5.

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

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

[83] 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 existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required.

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

[85] 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.

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 15.

Table 15: Open Access Model Income Statement

Year		1	10	20
a. Revenues				
Video		$ -	$ -	$ -
Internet		-	-	-
Voice		-	-	-
Provider Fee		16,074,684	54,501,864	54,501,864
Ancillary Revenues		9,117,469	45,447	45,447
	Total	$ 25,192,153	$ 54,547,311	$ 54,547,311
b. Content Fees				
Video		$ -	$ -	$ -
	Total	$ -	$ -	$ -
c. Operating Costs				
Labor Expense		$ 1,687,500	$ 2,153,250	$ 2,153,250
Operation and Maintenance Expenses		2,914,375	2,833,005	2,833,005
Pole Attachment Expense		-	-	-
Depreciation		27,794,305	23,817,131	23,805,702
	Total	$ 32,396,180	$ 28,803,386	$ 28,791,957
d. Operating Income		$ (7,204,027)	$ 25,743,926	$ 25,755,354
e. Non-Operating Income				
Interest Income		$ -	$ 649,916	$ 598,383
Interest Expense (Headend and CPE Bond)		(10,000,000)	(7,367,718)	(844,754)
Interest Expense (Fiber Bond)		(11,250,000)	(8,195,844)	(919,567)
	Total	$ (21,250,000)	$ (16,140,051)	$ (1,536,243)
f. Net Income		$ (28,454,027)	$ 9,603,875	$ 24,219,111
g. Taxes (Franchise Fees & In Lieu Tax)		$ -	$ -	$ -
h. Net Income After Fees & In Lieu Taxes		$ (28,454,027)	$ 9,603,875	$ 24,219,111

7.3.3.2 Operating and Maintenance Expenses

Years 1, 10, and 20 operating and maintenance expenses are presented in Table 16.

Table 16: 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	200,000	200,000	200,000
Contingency	400,000	400,000	400,000
Billing Maintenance Contract	25,000	25,000	25,000
Fiber Maintenance	1,321,875	1,321,875	1,321,875
Legal Fees	150,000	150,000	150,000
Content Aquisition	-	-	-
Marketing	150,000	50,000	50,000
Annual Variable Operating Expense			
Education and Training	67,500	86,130	86,130
Customer Handholding	-	-	-
Customer Billing (Unit)	-	-	-
Allowance for Bad Debts	-	-	-
Internet Connection Fee	-	-	-
PSTN Connection Fee	-	-	-
Total	$ 2,914,375	$ 2,833,005	$ 2,833,005

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 or SCL 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 17 shows the estimated staffing levels.

Table 17: 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		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

We assume benefits equal to 35 percent of base salary.

7.3.3.3 Summary of Assumptions

Key annual operation and maintenance assumptions include:

1. Salaries and benefits are based on estimated market wages. See Table 11 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 $200,000 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.

7.3.3.4 Cash Flow Results

These assumptions lead to the year-end net income and cash flow results summarized in Table 18.

Table 18: Base Case (Open Access) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (28,454,027)	$ (20,659,542)	$ 9,603,875	$ 16,740,503	$ 24,219,111
Cash Flow	$ 33,021,370	$ 3,559,550	$ 3,845,775	$ (27,482,819)	$ 2,711,733
Unrestricted Cash Balance	$ 33,021,370	$ 7,109,521	$ (2,406,317)	$ (17,383,736)	$ (4,828,699)
Restricted Cash Balance (Debt Service Reserve)	$ 22,500,000	$ 22,500,000	$ 22,500,000	$ 22,500,000	$ 22,500,000

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 $5 to $17 per month while leaving market share at 54 percent, the system nets, at end of year 20, a cash shortage of $143.5 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 19.

Table 19: Reduced Market Share (Open Access) Net Income and Cash Flow

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	$ (28,876,306)	$ (25,900,199)	$ (5,771,237)	$ 711,344	$ 8,895,532
Cash Flow	$ 35,274,937	$ (10,305,004)	$ (11,654,585)	$ (42,760,495)	$ (12,737,093)
Unrestricted Cash Balance	$ 35,274,937	$ 17,892,205	$ (66,612,837)	$ (160,212,001)	$ (223,897,468)
Restricted Cash Balance (Debt Service Reserve)	$ 22,500,000	$ 22,500,000	$ 22,500,000	$ 22,500,000	$ 22,500,000

The sensitivity to market shares is again a concern, but—unlike in the retail model—the City or SCL is serving multiple providers that are selling to consumers. In theory, with more retail providers, the probability of obtaining the required market shares increases. This however has proved to be difficult in practice- since the providers can cash flow at a lower penetration rate than the infrastructure provider- since the retail provider does not have a capital intensive market entry.

The sensitivity to market shares is again a concern, but—unlike in the retail model—the City or SCL is serving multiple providers that are selling to consumers. In theory, with more retail

providers, the probability of obtaining the required market shares increases. This however has proved to be difficult in practice because the providers can cash flow at a lower penetration rate than the infrastructure provider--the retail provider does not have a capital intensive market entry and may not be motivated to work and invest to increase market share.

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 $176.6 million.

7.3.3.5 Market Share

For this analysis, we used the same market share assumptions, based on our market research in Seattle, as in the retail model:

- 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

The balance of market share and access fees is critical to maintain cash flow. Simply put, this model can pay for itself under the conservative assumptions stated here, but even a small reduction in revenues or market share will result in net operating losses. As a result, even at these levels of market share, this model entails risk with respect to cash flow.

7.3.4 Case Study

San Francisco is currently considering the passive layer or open access model. San Francisco is still in the analysis stage and shifting or migrating to a different model is quite possible. This model has shown early success in Amsterdam. In the Amsterdam model, the City is one of the investors in the infrastructure. To operate the network, the infrastructure owners have contracted with a network operator. Although the network operator is able to provide retail services, it offers open access to any qualified provider. Four service providers currently compete for consumers on the network.

7.4 Fiber-to-the-Neighborhood/Lease Model

In a more modest variation on the open access model, this model entails SCL deploying a network that delivers fiber deep into neighborhoods. This SCL 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 SCL fiber. Possibly, the private sector invests in last mile fiber and leases the SCL backbone fiber as part of that network. Alternatively, the private sector investment is for wireless service backhauled over SCL fiber.

In another emerging model, fiber is built to customers who pay one-time connection fees to own the fiber that connects their business or home to the network. As in the passive layer model, SCL 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 is under consideration for the UTOPIA network of 16 communities in Utah. These case studies are discussed below

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, there is no existing municipal FTTP network in the United States that uses this model; as a result, there exist no empirical data in the US 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.

7.4.1 Technical Considerations

To facilitate the Fiber-to-the-Neighborhood model SCL would extend fiber to a node that services up to 500 homes. Given the home-run architecture, the cable extended from the hub is required to contain 500 fiber strands.

7.4.2 Risks and Benefits

Table 20 presents a snapshot of the strengths and weaknesses of the Equity model. It shows several challenges (risks) that need to be addressed.

Table 20: 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 US 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, SCL, and private providers	
• Has potential to increase home values	

7.4.3 Financial Analysis

Using the same market share assumptions (based on CTC's market research) used in the retail model, and charging each provider a connection fee of $6 per month per service per customer, the City or SCL will have an unrestricted cash balance of approximately $4.1 million by the end of year 20. An increase of $1 per month of this fee increases the year 20 cash balance to $74.1 million.

7.4.3.1 Financing Costs

Our analysis estimates total financing requirements to be $150 million for the model. For financing, we assume two bonds[86] and an operating loan.

1. A $100 million bond[87] 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[88] costs, including headend equipment, operating equipment, customer premises 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[89] at an interest rate of 5.00 percent. Further principal payments do not start until year 4.

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 21.

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[86] The scope of work for this Report does not include a review of the City's or SCL's bonding capability or review of local or state bonding restrictions. A more detailed review and opinion from the City's and SCL's accountants of bonding capability and restrictions is recommended in the business planning phase.
[87] 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 existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required.
[88] The outlined open access model allocates the customer premises equipment costs to SCL. Development of CPE ownership and other policy issues is an important task in preparation of a business plan.
[89] 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.

Table 21: Equity 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

7.4.3.2 Operating and Maintenance Expenses

Years 1, 10, and 20 operating and maintenance expenses are presented in Table 22.

Table 22: 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 23 shows the estimated staffing levels.

Table 23: 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.

7.4.3.3 Summary of Assumptions

Key annual operation and maintenance assumptions include:

1. Salaries and benefits are based on estimated market wages. See Table 17 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.

7.4.3.4 Cash Flow Results

These assumptions lead to the year-end net income and cash flow results summarized in Table 24.

Table 24: 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 a 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 25.

Table 25: 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.

7.4.3.5 Market Share

We used the same market share assumptions as in the retail model:

- 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

As indicated in the financial analysis the balance of market share and access fees are critical to maintain case flow.

7.4.4 Case Study

As of the latest public information, the Utah UTOPIA network is considering implementing the Equity model. As in the case of Palo Alto, we will continue to closely follow UTOPIA's results.

7.5 Key Account Model

In this model, SCL deploys a robust fiber network to meet its own internal needs for communications and smart grid technologies and potentially those of the City. The network is not marketed to residents, but businesses and large institutions have opportunity to lease spare capacity. This model is successfully used by anther large city municipal electric utility.

7.5.1 Technical Considerations

SCL recognizes that expanded connectivity is a requirement for effective operation and maintenance of the electric utility. SCL is willing to consider constructing backhaul fiber into the neighborhoods of the City and seeking commercial means by which to pay for that fiber. SCL is unlikely to consider an anchor tenant[90] arrangement with a provider because of security and other operating considerations. However, in the event that a private sector provider builds FTTP in Seattle, SCL could consider an incremental investment in increasing the number of fiber strands in planned routes and adding additional routes that position SCL to offer dark fiber or other connectivity services.

7.5.2 Risks and Benefits

The financial analysis is dependent upon what strategy SCL might take in seeking dark fiber customers.

In one approach, SCL might make the incremental investment to increase the strand count by at least 48. For SCL's ring connecting the substations this incremental investment is approaching

[90] Agreement in which the municipal electric or municipal agrees to acquire connectivity services from a private provider in return for the provider making an infrastructure investment in the community.

$136,000.[91] Then, as dark fiber customers are added, the cost to connect to the backbone is paid for by the customer.

Another approach is to extend dark fiber to neighborhoods or business parks that are likely to have an interest acquiring dark fiber. In their case SCL could build fiber into the neighborhoods or business parks. This approach has a higher financial risk - but greater potential.

7.5.3 Financial Analysis

Initial risks in the Key Account model are limited to the incremental cost of increasing the fiber strand count. Increasing the fiber count by 48 strands where the fiber cable is located in the power space adds a cost of only $4,000 per mile - less than 10 percent of the total cost.

7.5.4 Case Study

The following is a case study of a major American city's public power utility, which provides dark and lit fiber optic services to various industrial, commercial, and enterprise customers. This case study is used by permission of the city's municipal electric utility.

Governance: Since 1995, the municipal electric has been providing dark and lit optical fiber communications services to various industrial, commercial, and enterprise customers. The fiber unit within utility manages this program. The fiber unit's primary reason for service is to provide connectivity services to the electric utility, including Supervisory Control and Data Acquisition (SCADA). In addition, the fiber unit provides services (for a fee) to a range of City departments and agencies.

Initiation Dates: The program was introduced in 1995 with a dark fiber offering. In 2000 the fiber unit expanded its services to include point-to-point video circuits for the entertainment industry and Ethernet service to large data users.

Business Model: The primary business of the fiber unit is to provide fiber connectivity to support SCADA, a critical aspect of the electric distribution system. SCADA applications protect mission-critical utility systems, enhance the reliability of the utility services, and protect the safety of electric utility work crews.

The fiber unit's physical infrastructure has capacity beyond that which is required for electric utility and City needs; it can therefore offer its products and services to other customers, thus generating revenue for the electric utility. The fiber unit seeks to maximize the amount of net revenue it can bring in without compromising its primary mission of serving the electric utility. The fiber unit has several advantages relative to other carriers, all of which arise from the unit's position as a key part of the electric utility. The advantages are:

[91] Assumes total of 34 route miles to connect the ring.

Access to electric entrances of buildings, which provides a diverse and separate path from other carriers
Reach into most buildings in the City via electric ROWs
Financing of fiber infrastructure from a long-term perspective
Leveraging of the electric utility fiber connectivity needs (SCADA) provides a core service footprint in the City

The electric utility plans to connect all of its larger distribution stations with fiber. Fiber connectivity is attractive because it is reliable, can support future applications such as video monitoring, and does not experience ground potential issues the way copper does. The electric utility anticipates that the need for fiber connectivity beyond the substations will continue to increase. Future customer automation efforts may require the reliability and capacity of fiber for backhaul from data concentration devices.

RTUs are getting smaller and less expensive. Eventually, the electric utility will place RTUs on pole tops and other field devices, which will require expansion of the fiber footprint.

Financing: The fiber unit generates substantial annual revenues; the majority is derived from dark fiber leases. The revenue from the fiber unit provides an incremental revenue stream from an asset that is required to support the electric utility applications, directly benefiting rate payers.

Additional Benefits: The fiber unit also seeks to enhance the range of connectivity services it offers to external customers in the City by leveraging fiber and other connectivity assets used to support the electric utility functions. Specifically, its goals include:

- Generate revenue from fiber optic capacity currently unused for the primary mission by making it available city agencies, businesses, and educational users.
- Assist in economic development by providing alternative connectivity services to certain industry segments.
- Provide connectivity services to support city agency and nonprofit efforts to bridge the digital divide.
- Provide connectivity alternatives and help increase competition for connectivity services in the City.
- Encourage new uses of fiber connectivity by offering fiber as a wholesaler to any organization that meets the fiber unit’s financial requirements.

Benefits from the services offered to external customers do not directly show in the fiber unit’s revenue streams, but the unit support reduces expenditures in connectivity for each entity and the unit’s fiber enables applications that are not possible with traditional leased services.

7.6 Summary Comparison of Potential Business Models

Table 26 summarizes the comparison among the various models.

Table 26: Comparison of Potential Business Models

1. Assist the City by allowing access to selected assets (Infrastructure Participation Model)

Description	SCL makes assets already in place and included in the current capital program available for lease to the City or other entity. SCL sets lease rates that are verifiable and cover all incremental costs for fiber or conduit additions.		
SCL and City Risks Overall	Limited incentives to attract providers to build fiber to the premises. Limited influence over providers services. Limitations due to regulatory concerns and safety requirements.		
Approach	a. When SCL vacates joint-use fiber, SCL retains ownership and leases fiber strands to the City to allow the fiber to stay in the power space.	b. SCL adds empty communications conduit at time of underground construction.	c. When connecting SCL substations as planned in the capital program, increase the fiber count.
SCL Risks (specific approach)	Potential litigation due to Qwest ownership interests with SCL poles.	Potential for stranded capital investment.	Potential litigation due to Qwest ownership interests with SCL poles.
SCL Opportunities	Provides cash flow through dark fiber lease and maintenance fees.	Avoids digging near SCL underground electric assets in the future.	Provides cash flow through dark fiber lease and maintenance fees. Provides a foundation for SCL consideration of leasing dark fiber to key businesses in Seattle.
Minimum Additional Capital Investment	None	Under $50,000. Incremental $2.00 per foot for placing conduit in a trench.	$136,000 to add a minimum 48 additional fiber strands in planned cable to be located in the power space[92] as SCL connects substations.
O&M (Year 1 $)	No change	Minimal, incremental cost for GIS updates and maintenance of spare conduit map layer.	Incremental staff time to manage dark fiber leases. Staff requirement estimates 10 percent of a full time equivalent employee.
What is Needed to Meet Objectives	Accelerate the plans to connect SCL substations with fiber. SCL maintains physical control and ownership of fiber and access to substations.	Other City departments must follow SCL lead in order for strategy to have any potential measurable impact.	SCL maintains physical control and ownership of fiber and access to substations.
Benefits to Consumer and City	Avoids cost of relocating fiber to the communication space (avoidance of a minimum of $4.5 million).	Reduces future street digs and road repair.	Provides a fiber ring throughout the City of Seattle that is available at incremental costs. Fiber ring could support needs of wireless providers if efforts to attract a fiber to the premises provider are not successful.

[92] SCL has funding included in its capital improvement program to build out fiber for communications incrementally and has submitted a Budget Issue Paper to include $5 million in the 2009-2010 budget to accelerate this deployment.

2. Pursue key account dark fiber leases (Key Account Model)

Description	SCL markets dark fiber to large businesses, Internet service providers, and institutions. When appropriate, leverage available fiber to support commercial and industrial customer demand side management and service quality efforts.
SCL and City Risks Overall	Expanded fiber footprint is attractive to potential providers – but anticipated time frame unlikely to meet City objectives. Limited influence over providers services. Limitations due to regulatory concerns and safety requirements.
Approach	When SCL expands fiber elsewhere in the system for support of electric applications, Include at minimum of 48 additional fiber strands. Build out fiber extensions from fiber connecting SCL substations as dark fiber leases are obtained.
SCL Risks (specific approach)	Expansion of services beyond core business. Target user base likely under 20 organizations with limited direct revenue growth potential.
SCL Opportunities	SCL could earn additional revenue from selling dark fiber to businesses or large institutions (A major municipal electric utility in the US recovers its investment in dark fiber extensions through an 18 month contract and charges customers for O&M and lease of fiber strands). Dark fiber customers “pay” for fiber extensions- which are available at no cost for SCL electric applications as they emerge.
Minimum Additional Capital Investment	Incremental fiber cable cost of $4,000 per mile for incremental fiber strands, fiber extensions paid for by lease. Up to $136,000 to add additional fiber strands in planned cable to be located in the power space as SCL connects substations (in addition to 1 c).
O&M (Year 1 $)	Assign SCL staff person to lead marketing efforts plus 25 percent full time equivalent employee for technical resource. Staff needs grow as fiber leases are added. Development of a business plan, estimate of $100,000.
What is Needed to Meet Objectives	SCL increases fiber count in planned cable connecting substations (see option 1c). Agreement of businesses and large institutions through contract to lease spare capacity as incremental fiber extensions are built.
Benefits to Consumer and City	Provides a foundation for economic development initiatives requiring enhanced connectivity to key business segments

3. Deploy a fiber-to-the-neighborhood network, potentially with the "last mile" financed by the private sector or through subscriber equity (Fiber-to-the-Neighborhood/Lease Model)

Description	The City or SCL builds and controls a fiber to the neighborhood 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 a hookup fee to finance the fiber extensions to their homes and businesses. Private sector entities are selected to operate the network and offer services to residences and businesses. These entities pay SCL an access fee for use of the SCL network.
SCL and City Risks Overall	Impact to SCL electric rates. Perceptions of the relationship between electric utility need and fiber to the premises availability. In the Equity, customer ownership model, potential perception of the City or SCL "redlining" high income households since investment of fiber to the premises is made in areas of those willing to pay. In the Equity, customer ownership model, unproven model in the US. Value proposition basis not well understood by consumers. The City or SCL 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
SCL Risks (specific approach)	Potential for stranded capital investment. Potential litigation due to Qwest ownership interests with SCL poles. Competes with financial resources for investments required to operate and maintain the electric system. Potential impact to SCL electric rates. Does not address an immediate SCL need
SCL Opportunities	Equity model success in Europe (Sweden) has increased interest with this approach in the US.
Minimum Additional Capital Investment	$150 M ($100 M for fiber,[93] $40 M to cover implementation costs,[94] $10 M loan for initial operating expenses[95])
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. The subscribers to services pay an equity or hook-up fee. 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. Emission reductions and cost savings (vehicles, roads, public transportation) due to increased telecommuting. Initial emission reduction estimated at in 42.3 million kilograms of CO_2 per year. Initial consumer vehicle savings estimated at $60.9 M per year and time savings of $33.1 M per year. Provides a foundation for economic development initiatives requiring enhanced connectivity.

[93] 4.5 percent interest, 20 year repayment, principal repayment begins in year 1, 1 percent issuance cost on borrowed amount.
[94] 5.0 percent interest, 20 year repayment, principal repayment begins in year 1, 1 percent issuance cost on borrowed amount
[95] 6.0 percent interest, 20 year repayment, issued in year 1, principal repayment begins in year 3

4. Deploy a fiber to the premises network and allow any retail provider access (Open Access/Wholesale Model).

Description	The City or SCL builds and finances fiber to the premises throughout the City of Seattle. A private sector operator is selected to maintain and operate the network. Network access is available to any retail provider.
SCL and City Risks Overall	Unproven model in the US. Retail providers do not have high capital investment and therefore may not market aggressively, thus increasing potential for low market shares that will not provide sufficient SCL cash flow. Limitations due to regulatory and legal concerns.
Approach	The City or SCL obtains bonding for fiber build out and initial operating capital.
SCL Risks (specific approach)	Ability to attract and retain required staff. Impact to SCL debt to service ratio guidelines set by City Council. Competes with financial resources for investments required to operate and maintain the electric system. Potential for stranded capital investment. Potential impact to SCL electric rates SCL or City cash flow
SCL Opportunities	Success in Europe (Amsterdam) has increased interest with this approach in the US.
Minimum Additional Capital Investment	$450 M ($250 M for new fiber,[96] $200 M for equipment and miscellaneous implementation,[97] $25 M loan for initial operating expenses[98])
O&M (Year 1 $)	$4.6 M (employees, office facilities, warehousing for storage and maintenance, 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 providers that are willing to pay access fees at required levels while obtaining required penetration rates.
Benefits to Consumer and City	Provides consumers a choice of retail providers. Emission reductions and cost savings (vehicles, roads, public transportation) due to increased telecommuting. Initial emission reduction estimated at in 42.3 million kilograms of CO_2 per year. Initial consumer vehicle savings estimated at $60.9 M per year and time savings of $33.1 M per year. Provides a foundation for economic development initiatives requiring enhanced connectivity.

[96] 4.5 percent interest, 20 year repayment, principal repayment begins in year 4, 1 percent issuance cost on borrowed amount
[97] 5.0 percent interest, 20 year repayment, principal repayment begins in year 4, 1 percent issuance cost of borrowed amount
[98] 6.0 percent interest, 20 year repayment, issued in year 3, principal repayment begins in year 5

5. Become retail provider of voice, video, and data services (Retail Model)

Description	The City or SCL builds and finances fiber to the premises throughout the City of Seattle. The City or SCL becomes the retail provider of voice, video, and data services in the City of Seattle.
SCL and City Risks Overall	Requires the City or SCL to aggressively market voice, video, and data products. Competes directly with Qwest and Comcast. Potential for litigation- consumer watch dog groups and providers. Limitations due to regulatory and legal concerns.
Approach	The City or SCL obtains bonding for fiber build out and initial operating capital.
SCL Risks (specific approach)	High market penetration required to meet cash flow objectives. Does not give consumers the potential to choose from a wide range of providers. Infrastructure based providers already based in Seattle with stable market shares. Ability to attract and retain required staff. Impact to SCL debt to service ratio guidelines set by City Council. Competes with financial resources for investments required to operate and maintain the electric system. Potential for stranded capital investment. Potential impact to SCL electric rates.
SCL Opportunities	Some success with many small municipal electric utilities in the US. Control over service quality, availability, and pricing.
Minimum Additional Capital Investment	$530 M ($250 M for new fiber,[99] $230 M for remaining implementation costs,[100] $50 M loan for initial operating expenses[101])
O&M (Year 1 $)	$18.9 M (employees, office space, retail storefront, warehousing for storage and maintenance, 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. Cable television and telephone priced similar to existing services. Internet priced similar- but with greater performance.
Benefits to Consumer and City	Provides consumers an alternative provider of voice, video, and data services. Emission reductions and cost savings (vehicles, roads, public transportation) due to increased telecommuting. Initial emission reduction estimated at in 42.3 million kilograms of CO_2 per year. Initial consumer vehicle savings estimated at $60.9 M per year and time savings of $33.1 M per year. Provides a foundation for economic development initiatives requiring enhanced connectivity.

[99] 4.5 percent interest, 20 year repayment, principal repayment begins in year 4, 1 percent issuance cost on borrowed amount
[100] 5.0 percent interest, 20 year repayment, principal repayment begins in year 4, 1 percent issuance cost on borrowed amount
[101] 6.0 percent interest, 20 year repayment, issued in year 3, principal repayment begins in year 5

8 The Existing Broadband Landscape in Seattle

This Section of the Report provides a brief overview of the existing broadband landscape in the City, including announced future projects and deployments, and evaluates the reach and capability of existing and planned private-sector broadband infrastructure and services. In summary, this Section concludes that Seattle's residents and businesses have a relatively broad range of services available, as compared to other urban areas where there has been little or no Fiber-to-the-Premises (FTTP) deployment. However, as compared to FTTP areas (such as Verizon FiOS build areas and the FTTP networks in major cities in Europe and the Pacific Rim); Seattle is at a great disadvantage with respect to access, speed, capacity, and ubiquity of broadband.

8.1 Background

Seattle is not alone in this disadvantage among American cities. It is increasingly apparent that the current American market has not delivered true broadband competition or ubiquitous very high-speed broadband. While there may be significant competition in provision of programming and services such as telephone, email, and video—there is not significant competition in provision of "pipe" -- the infrastructure over which all of those services operate.

Moreover, to the extent that service competition exists, the market is distorted if the infrastructure provider can manipulate the quality of competing services over the connections the provider controls to the end customer. In a context in which network owners have been permitted by the Federal Communications Commission (FCC) and the courts to "close" their networks to competition, competitors can reach customers only by building their own facilities—at prohibitive cost that precludes the emergence of multiple competitors.

This situation is akin to a scenario in which the national road network is owned by UPS and closed to competitors--in order to provide service, FedEx, DHL and other package deliverers would be forced to build their own network of roads and highways--a prohibitive bar to competition. The result in the communications context is comparable: a broadband monopoly or duopoly of incumbent cable and telephone companies.[102]

Even using this closed model, the incumbents do not plan to build FTTP throughout Seattle's neighborhoods, with the exception of small scale trials in new developments. In fact, to our knowledge, neither of Seattle's existing wired providers plans significant FTTP rollouts in Seattle.

[102] Even less service exists in much of the country. Amazingly, significant areas of rural America have no broadband options other than satellite service, which is costly and cumbersome. Satellite technology has proven itself a competitor for delivery of one-way video and radio, but it is significantly inferior to fiber optics -- and even to cable modem or DSL service -- for Internet and interactive services. Satellite broadband cannot match cable and DSL for bandwidth, it is far more costly, and satellite transmission entails a latency and delay issue that makes widespread Internet use unlikely using existing technologies.

8.1.1 Existing Providers Do Not Have Incentive to Offer Very High-Speed Broadband

Seattle's incumbent providers are taking incremental steps to deploy some new technologies, but they are constrained in their investment choices by a number of key factors:

- The capital markets
- The high cost of infrastructure investment
- The advent of competitive services over data connections that threaten "triple play" service revenues

First, the capital markets reward short-term profits and punish long-term expense for investments like FTTP. As was noted in a 2006 Strategy Analytics study:

Unlike local governments, which can justify investing in expensive FTTH technology on the grounds that it may benefit the public or stimulate economic growth, telcos and other shareholder-owned companies face intense pressure to limit costs and show near-term returns on investment. This financial pressure will continue to make FTTH difficult to rationalize in the near term.[103]

Second, the existing broadband market precludes true broadband competition because of the impracticability of construction of numerous broadband physical networks.

The cost of building fiber all the way to the home or business constrains incumbent investment choices—and, under current law, building their own network is the only way competitive providers can reach consumers. With the "overbuild" model, each provider must build out competing networks in each neighborhood they want to serve. The required infrastructure and investment to serve one consumer is quite similar to the investment to pass all potential customers in the community. In other words, the required investment must be repeated for each provider, double the providers, double the network costs, double the investment.[104] As a result, each incumbent can justify major investments only by increasing revenues per household by selling many services, rather than just one or two.

[103] Jim Penhune and Martin Olausson, "Fiber To The Home in Europe: Will Municipalities or Markets Drive Growth?," Strategy Analytics, November 10, 2006.

[104] The alternative, "open access" model separates the network itself (provided by a "wholesaler") from the services (provided by "retailers" who compete over the single network). A single infrastructure provider (either private or public) sells wholesale access on a non-discriminatory basis to any private service provider. This model eliminates duplicate network infrastructure investment and reduces market-entry barriers to new and innovative service providers. This model enables the same creativity, innovation, and competition over new networks as existed over open dial-up networks in the 1990s.

To increase revenues, incumbents attempt to sell consumers "triple play" services--bundled voice, video, and data. Their goal by offering “triple play” is to increase both the market size and the net contribution margins.

Finally, the incumbents are even more constrained by the fact that very high-bandwidth threatens their business models of selling multiple services over their networks. Incumbents are not incentivized to build big pipes because, where high bandwidth is available, consumers are likely not to purchase incumbent services, but rather to use Internet-based voice and video services.

Current incumbent business models call for selling voice, video, and data services, the famous “triple play” or “bundle” that represents significant revenues. This business model is threatened by very high-bandwidth because, in a “big pipe” world, consumers may purchase only the high-bandwidth data connection and then get voice and video services from a web-based provider—a significant loss of revenue for incumbents, but a great savings for consumers and a great incentive for web-based innovation by thousands of competing companies.

The incumbents are likely concerned that competitive Internet-based applications over a big pipe will erode the market power they enjoy today. The structure of the market incentivizes them to mitigate this risk and retain market power by controlling and limiting data connections and thereby the ability of consumers to buy (or get for free) competitive voice and video services over data connections. Such services have the potential to turn their business models upside down.

For example, Internet-based Voice over Internet Protocol (VoIP) is a threat to incumbent voice revenues. VoIP, combined with high-speed Internet access, transforms voice communication from a service to an application.[105] Consumers can get VoIP as a free service (from companies such as Skype) or as a paid service (from companies such as Vonage).

Similarly, video multicasting and video streaming is a threat to incumbent video revenues. Current incumbent networks limit the functionality of video over the Internet. But very high-bandwidth will enable quality video multicasting and streaming. Consumers will not have to purchase a package, or “tier” of video channels, many of which they never watch. Rather, consumers will simply acquire programming over their data connections from Internet-based distributors (such as Akimbo or CinemaNow) or directly from the content producer (such as Comedy Central or a production studio).

Some incumbents are therefore well-served by limited-bandwidth—scarcity protects their business model and revenues and does not adequately enable Internet-based applications that compete with their own service offerings. So long as data capacity is a scarce resource, consumers will continue to purchase services from incumbents rather than accessing them as applications over the Internet.

[105] Services are bundled with the connectivity infrastructure. The voice telephone service acquired from AT&T is an example of a service. Applications separate the traditional service from the infrastructure. For example a VoIP telephone application can follow the user, and is not tied to a particular infrastructure.

But scarcity does not serve the goals identified by the Seattle Task Force because it fails to deliver the big pipe for innovation and creativity; new capabilities; opportunities for competitive and innovative service providers; enhanced customer alternatives; or consumer choice.

8.1.2 Existing Networks are Not Technically Capable of Speeds Enabled by Fiber

The incumbent communications carriers offer many products in Seattle that they describe as "broadband." Perhaps these products are broadband under the low standards for speed accepted by the FCC. But the FCC's new, much anticipated definition of broadband is only 768 Kbps (higher than the previous definition of 200 Kbps but still laughably low). "Basic broadband" is now defined as download (not symmetrical) speeds between 768Kbps and 1.5Mbps. As one observer has noted,

> For comparison's sake, an average movie download is 700 MB (5872025600 bits), and would take 8.16 hours to download under the old broadband definition at 200 Kbps. However, at the new faster rate of 768 Kbps, an American with basic broadband will be able to download a movie in just 2.12 hours.[106]

These speeds are insignificant fractions of the speed that fiber can deliver using current technologies.[107]

The networks operated by cable and telephone companies are limited in their technological capabilities and do not offer the kinds of speeds and capacity possible with FTTP.[108] Both industries are further limited in their reach: cable serving primarily the residential market and Qwest serving some business and residential areas but limited by its technology.

8.1.2.1 Comcast Hybrid Fiber/Coaxial Cable

Seattle's cable television operator is Comcast Cable, whose "footprint" includes all residences and some business areas of the City. Comcast offers broadband at typical cable modem

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

[107] In Europe and Asia, significant fiber projects are underway to offer worst-case symmetrical speeds of 100 Mbps—500 times the speed the Federal Communications Commission considers satisfactory. In some areas of Asia, such as Tokyo, a gigbit of connectivity is not unusual—5,000 times the speed the FCC currently approves.

[108] Even advertised speeds may be illusory or inconsistent. The New York Times noted that some "customers do not get the maximum promised speed, or anywhere near it, from their cable and digital subscriber line connections. Instead, the phrase 'up to' refers to speeds attainable under ideal conditions, like when a DSL user is near the phone company's central switching office." Matt Richtel and Ken Belson, "Not Always Full Speed Ahead," The New York Times, November 18, 2006.

speeds.[109] It operates a high-quality, reliable hybrid fiber/coaxial systems that can compete against other offerings in today's marketplace. Its system however is limited by its lack of fiber—even with advanced electronics and software, hybrid fiber/coaxial systems cannot keep pace with the potential speeds of fully-fiber networks such as those being deployed by Verizon in exclusive areas of the country, including the communities surrounding Seattle. The cable system is limited by the inherent shortcomings of the coaxial cable that runs from the nodes into the home. An additional limitation arises from the shared nature of cable modem service—bandwidth within a neighborhood is shared rather than dedicated. As a result, speeds may be significantly decreased by one's neighbors' simultaneous use of their cable modems.

Cable companies traditionally have serviced the residential market and they have very limited footprints in business areas of most communities – this is generally true throughout the United States. The limited availability of cable modem services in business areas has not made an appreciable competitive impact on the price of higher quality and speed broadband products for business.

8.1.2.2 Qwest Hybrid Fiber/Copper

Qwest is the incumbent local exchange carrier in Seattle, where it offers Digital Subscriber Line (DSL) services to most of the City and leases enhanced circuits to government and businesses at higher prices. Small and medium sized businesses may have difficulty affording these circuits.

DSL represents a relatively low-bandwidth form of broadband -- a network of roads, not superhighways. DSL does not even have the capabilities of a cable modem network because it is based on lower-bandwidth infrastructure. DSL runs on telephone network copper wires, which simply cannot handle the same capacity as fiber or even as Comcast's hybrid fiber/coaxial (HFC) network.[110] As capacity requirements increase, DSL is likely to fall further behind cable.[111] Qwest does not plan to build FTTP, other than perhaps in new "greenfield" developments.

Qwest has announced a strategy for upgrading some of its existing copper systems to fiber-to-the node, a technology that brings fiber deeper into the neighborhoods, but still attempts to use aging copper plant to cover "the last mile" to the home or business. This technology is widely regarded among communications engineers as extremely limited in capacity – even for today's existing applications.

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[109] Speed comparisons are dependent on Comcast High-Speed Internet service tier selected (6 Mbps, 8 Mbps or 16 Mbps) and are based on download speeds vs. standard 1.5 Mbps DSL service. Not all service tiers are available in all areas. Many factors affect speed. Actual speeds vary and are not guaranteed. Maximum upload speeds range between 384 Kbps and 2 Mbps depending on the service tier selected and can be even faster with PowerBoost®, Data obtained from www.comcast.com.

[110] Even in the best of circumstances, DSL coverage is difficult to project for a given location. A residence or business could be in an area where DSL is offered but is not available at their location due to the quality of the existing circuit or the fact that the system is tapped out--all DSL equipped circuits are already in use.

[111] The limitations of DSL are demonstrated by the efforts of Verizon to supplement its old copper phone networks with new FTTP networks in limited metropolitan areas within its existing footprint, which does not include Seattle.

Under Qwest's current plans, fiber will be deployed to the node—but the old copper will be retained for some of the plant--the architecture calls for retaining up to one mile of existing copper lines from the node to the home or business. The reason for implementing VDSL is clear—Qwest is avoiding the enormous expense (and time) to construct fiber down the majority of rights-of-way and to the premises. The actual fiber construction contemplated is a fraction of what Verizon is doing in its FTTP builds.

It's important to note that, even under the best of circumstances and assuming that Qwest's technology works as advertised, fiber to the node cannot, under any circumstances, offer comparable capacity or speed to FTTP.[112]

Theoretically, Qwest's new technology can provide as much as 20 Mbps downstream and a few Mbps upstream under ideal circumstances (such as close proximity to Qwest's central office) but these circumstances are rare and the product is pricey ($105 per month). Qwest has told investors that it is considering deploying "bonding" variations of DSL that would bond copper pairs and thereby boost speeds,[113] but such plans are, to our knowledge, aspirational only thus far, and assume the existence of sufficient copper "pairs" to bond to each other.

Qwest has not committed to a date certain by which even this limited technology will be widely-deployed in Seattle.

Even if Qwest's hoped-for technology does turn out to work on a large scale, Qwest's century-old copper plant inevitably runs up against the realities of physics—this technology, at best, can barely support the high-bandwidth applications of today, and certainly not the higher-bandwidth requirements of tomorrow.

The limitations of this technology are likely to be reached quickly--even assuming that the technology does turn out to work on a large scale, and assuming that Qwest does upgrade quickly to this architecture in Seattle. From a technical standpoint, fiber to the neighborhood is a short-term solution in a market where bandwidth needs are growing exponentially and high, symmetrical capacity is increasingly needed for small businesses and for popular emerging applications like gaming, video-gaming, video-downloads, and video-conferencing. Qwest's 100 year-old copper plant is not capable of meeting these needs in the medium or long-run.[114]

8.1.2.3 Contrast: Verizon FTTP in Surrounding Areas

Verizon is deploying Fiber-to-the-Premises (FTTP) in limited parts of the US – in other areas, like Qwest, it has chosen to rely on its current copper plant and DSL technology.

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[112] Ed Gubbins, "Qwest Greenlights $300 million FTTN Rollout," Telephony Online, October 30, 2007, http://telephonyonline.com/fttp/news/qwest_fttn_deployment_103007/.
[113] Ibid.
[114] Andrew Afflerbach, Ph.D., "Fiber to the Premises and the Node," Journal of Municipal Telecommunications Policy, Fall 2006.

Verizon's FTTP networks 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).

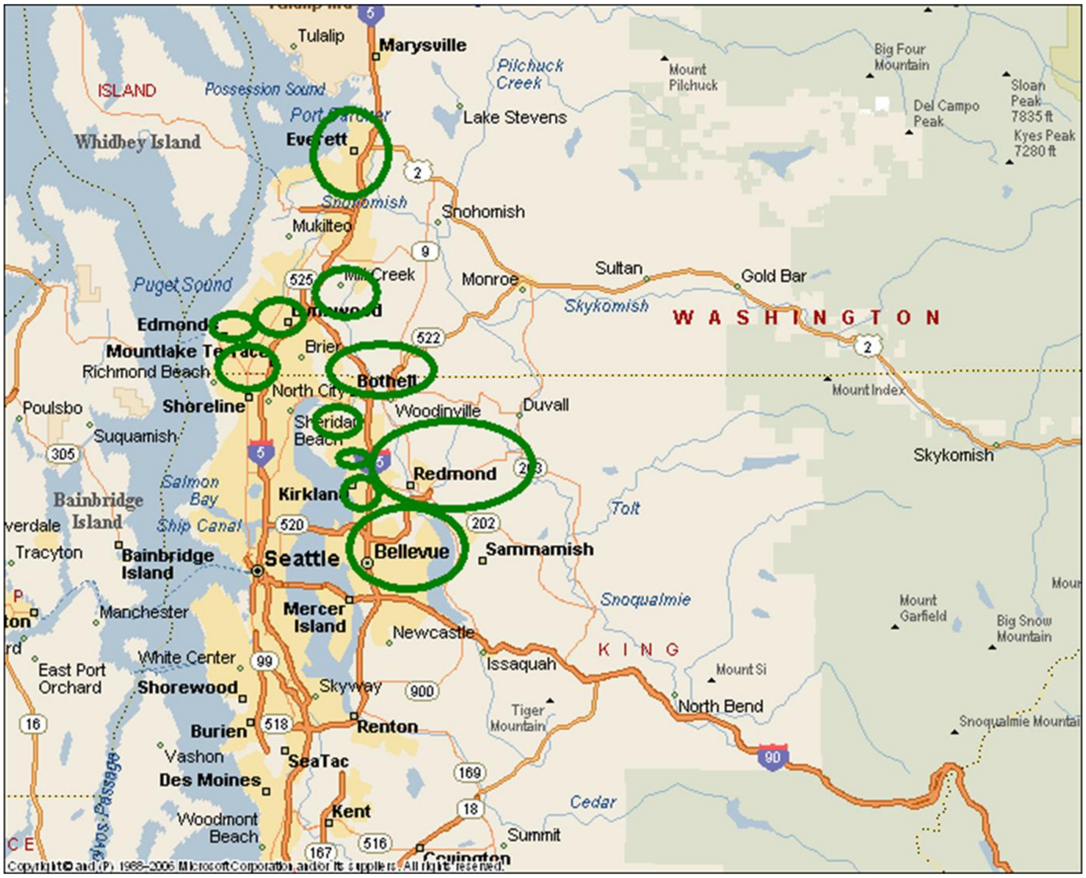
FTTP systems are theoretically capable of virtually unlimited speeds for data, though current Verizon plans call for ten to 50 Mbps downstream and two to 20 Mbps upstream.[115] Electronics and software changes make possible great increases in throughput without modification of outdoor fiber plant. In this way, fiber is considered a "future-proof" technology.

Verizon is currently in the process of obtaining cable television franchises in the state of Washington. Below is a list of localities where Verizon has obtained cable television franchises and FiOS services are available to residents[116]. Figure 30 shows the areas served by Verizon FiOS on a map.

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

[115] Data obtained from www.verizon.com, accessed August 08, 2008.
[116] http://www.fiberexperts.com/washington-fios.html accessed September 9, 2008

Figure 30: Areas served by Verizon FiOS in Washington



On May 1, 2008 Verizon announced the build of a regional video hub-office in Everett which will serve customers using FiOS. Verizon is still in the process of negotiating a cable television franchise agreement with King County and does not yet have FiOS service in Seattle.[117]

8.1.2.4 4G Wireless

4G is the term applied to promising new wireless technologies, many of which offer sustained data speeds of a few Mbps or more per user. These include technologies with standards developed by working groups of the Institute of Electrical and Electronics Engineers and known by Institute of Electrical and Electronics Engineers standards numbers 802.11 (WiFi), 802.16 (WiMax), and 802.20. 4G also includes new generations of wireless technologies planned by the incumbent cellular providers.

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117 http://newscenter.verizon.com/press-releases/verizon/2008/consumers-in-washington-state.html accessed September 4, 2008

4G receives significant cultural and press attention, but the excitement over this technology should not blur the fact that 4G, no matter how promising, is not capable of the same speeds as fiber and is likely to remain proportionately behind in the future.

4G does not currently represent a broadband technology that is comparable to fiber. 4G does not have comparable capacity to fiber, versions of 4G using unlicensed spectrum may be limited in range and subject to interference, and 4G is largely untested as a widespread broadband medium – a technology still in development.

The difference between fiber and wireless is discussed in detail above.

8.2 Existing Residential and Small Business Products and Services

Based on a review of providers' promotional material and discussions with SCL and City staff, it appears that DSL and cable service are relatively-widely available in Seattle. Qwest has a substantial footprint and most areas have DSL coverage.[118] To address the growing demand for data, Qwest has expanded fiber deep into some neighborhoods (though not to the home), enabling a 20 Mbps downstream DSL product.[119]

Service and availability gaps, however, do exist. Sophisticated residential data users and businesses are requiring capabilities beyond those offered by cable modems and DSL.

A number of competitive telephone providers serve the business market and use Qwest's infrastructure. In addition, there are other alternatives to traditional telephone services, such as wireless (Verizon Wireless, AT&T, Sprint/Nextel), cable television (Comcast, Broadstripe), Internet-based Voice over Internet protocol (VoIP) providers (Vonage, Skype, and others—assuming a sufficiently robust Internet connection).

More than 45 local and national Internet service providers (ISPs) offer services in Seattle, ranging from dial-up to high-speed connectivity (DSL, cable). There are also a number of higher capacity, higher cost options (ISDN, T1) available from providers such as Qwest. Mobile wireless broadband options are also available from companies such as AT&T, Sprint, and Verizon. Speeds and price vary greatly depending upon the level of service the user requires.

[118] DSL coverage is difficult to project for a given location. A residence or business could be in an area where DSL is offered but still not get service because of the quality of the existing circuit or because all DSL capacity has already been allocated.
[119] Qwest's marketing materials are, as of the date of this writing, notably silent about the upstream speeds for this product, suggesting relatively slow average speeds, possibly below a megabit per second, with no guarantees as to any speed at all.

8.2.1 Internet Providers and Products

Seattle businesses and residents have a number of options for high-speed Internet access, including DSL, cable, satellite, and wireless. In addition, there are a number of local and national dial-up Internet providers in and around the city. The dial-up service options range in price from $8 to $24.99 per month. There are five companies in Seattle that offer high-speed Internet access through DSL with speeds ranging from 1.5 Mbps to 20 Mbps. The cost for the DSL service ranges from $29.95 to $189.95. There are fewer satellite and wireless Internet providers as compared to DSL and offer Internet service in the range of speeds from 1 Mbps to 3 Mbps. The cost for this service ranges from $59.99 to $209.99. Further details of these packages are outlined in Appendix B.

A summary of some Internet providers, who may be considered direct competitors of a City Internet offering, and their available service options are presented in Table 27.

Table 27: Internet Providers

Provider	DSL Facilities Based	DSL Reseller/ Added Value	Cable Modem	Cable Modem Reseller/ Added Value	Satellite	Dial Up Telephone	Wireless	EVDO/ UTMS	ISDN, Frame Relay, Other
AT&T	✓					✓	✓		✓
Broadstripe			✓						
Clearwire							✓		
Comcast			✓						
Dish Network (through Wild Blue)					✓				
EarthLink		✓			✓	✓			
HughesNet					✓				
Qwest	✓								✓
Speakeasy[120]		✓							✓
WildBlue					✓	✓			
Verizon[121]	✓								✓

Qwest has 11 central offices (COs) supporting SCL's service area. The central offices are:

- West- serving West Seattle.
- Duwamish- serving White Center, Georgetown, and Industrial Area.
- Parkway- serving Rainier Valley and Beacon Hill.
- Main- serving Downtown and North Industrial Area.
- Elliott- serving Northwest Downtown.

[120] Not available in all areas.
[121] Not available in all areas.

- East- serving Capitol Hill, Madison Park, and Madrona. Fiber to the node under construction which will allow support of a 20 Mbps DSL product.
- Atwater- serving Queen Anne, Interbay, and Magnolia.
- Sunset- serving Ballard, and Shilshole.
- Campus- serving University District, Laurelhurst, and Wallingford. Fiber to the node under construction which will allow support of a 20 Mbps DSL product.
- Lakeview- serving Green Lake, Ravenna, and View Ridge. Fiber to the node under construction which will allow support of a 20 Mbps DSL product.
- Emerson- serving North Seattle, Shoreline, and Lake Forest Park.

It is our understanding that all Qwest COs in Seattle are equipped to supply DSL. Given the number of CO's in Seattle and that they are all equipped with DSL, most residents and businesses should have a DSL option available to them. As indicated above Qwest is deploying fiber to the node at three of the central offices (East, Campus, and Lakeview). The fiber to the node extends fiber into neighborhoods served by the central office. The fiber equipment and related DSLAM equipment allows Qwest to offer a 20 Mbps product to residences and businesses in each neighborhood that is served by fiber. The neighborhoods served by these three central offices are show in Figure 31.

Figure 31: Neighborhoods in Which Qwest is Currently Deploying 20 Mbps (Downstream) DSL

Qwest is charging $104.99 per month for the DSL service with a download speed of 20 Mbps[122] and $51.99 for a download speed of 12 Mbps. A $5 per month discount is offered when the DSL service is combined with local phone service. A looming question with Qwest's 20 Mbps and 12 Mbps is the absence of information regarding upload speeds. We strongly suspect that the upload speeds are in the 1 Mbps or slower range.

8.2.2 Video Providers and Products

Broadstripe and Comcast are the cable systems operating in Seattle. They offer analog and digital packages, as well as a number of premium services. The basic and digital packages are summarized in Tables 28 and 29.

122 http://seattletimes.nwsource.com/html/businesstechnology/2004371385_apqwestdsl.html?syndication=rss "Qwest introduces 20 megabit DSL in some areas", April 28, 2008, The Seattle Times, and the Qwest web site for Seattle at http://www.qwestdeal.com/dsl.html

Table 28: Comcast Residential Cable Television Packages[123]

<table>
<tr><th>Package</th><th>Price Per Month</th><th>CPE</th><th>Installation</th><th>Miscellaneous</th><th>Add-ons per month</th></tr>
<tr><td>Limited Cable</td><td>$12.55</td><td>N/A</td><td>N/A</td><td></td><td rowspan="6">DVR $8.95
HD: $6.50
HDDVR $13.95
WWE $7.99
Howard Stern: $119.99 year, $10.99 month
Filipino on Demand $7.99
Hollywood on Demand $12.99
Family Tier $31.49
ESPN GamePlan: $109 single payment
Sports Entertainment $5.99</td></tr>
<tr><td>Basic Cable</td><td>$52.25</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><td>Digital Starter</td><td>$53.25[124]</td><td>N/A</td><td>N/A</td><td>Includes On Demand</td></tr>
<tr><td>Digital Preferred w/HBO</td><td>$84.23[125]</td><td>N/A</td><td>N/A</td><td>Includes On Demand</td></tr>
<tr><td>Digital Preferred Plus</td><td>$98.24[126]</td><td>N/A</td><td>N/A</td><td>Includes On Demand</td></tr>
<tr><td>Digital Premier</td><td>$117.24[127]</td><td>N/A</td><td>N/A</td><td></td></tr>
</table>

[123] Data obtained from http://www.comcast.com/default.html, accessed Aug. 4, 2008.
[124] Promotion: $29.99 for first six months.
[125] Promotion: $39.99 for first six months.
[126] Promotion: $49.99 for first six months.
[127] Promotion: $79.99 for first six months.

Table 29: Broadstripe Residential Cable Television Packages[128]

Package	Price Per Month	CPE	Installation	Miscellaneous	Add-ons per month
Limited Basic	$19.95	CableCARD $2.95 (rent) $80 (buy)	$34.95 (pre-wired home); $49.95 (unwired home)	Senior discounts available	
Expanded Basic	$34.04				
Limited Basic + Expanded Basic	$53.99	Digital cable terminal $6.95 or 9.95 (enhanced)			
Digital Double Play Lite (incl. Internet)	$85.03			Internet speed of 512 Kbps	Digital Basic Choice $11.99 Digital Sports & Adventure tier $5.99 HD tier $9.95 HBO multiplex $16.99 Cinemax mutiplex $14.99 Showtime/Movie Channel multiplex $14.99 Starz/Encore Superpak multiplex $14.99 TV Japan $24.95 Filipino Channel $11.95 Pay-per-view movies $3.99
Digital Double Play (incl. Internet)	$95.03	In-home wire maintenance $3.00		Internet speed of 6 Mbps	
Digital Triple Play Lite (incl. Internet & phone)	$120.03			Internet speed of 512 Kbps	
Digital Triple Play (incl. Internet & phone)	$130.03			Internet speed of 6 Mbps	
Classic Triple Play Lite (incl. Internet & phone)	$111.53			Internet speed of 512 Kbps	
Classic Triple Play (incl. Internet & phone)	$121.53	House amplifier $35 (buy)		Internet speed of 6 Mbps	

[128] Data obtained from http://www.broadstripe.com/, accessed Aug. 4, 2008.

Cable providers offer Internet and phone services along with cable television, the pricing for which is summarized in Appendix B. There are competing off-the-air operators which offers High Definition channels at no cost. Table 30 lists the off-the-air channels that are available in Seattle.

Table 30: Off-the-Air Television Channels

Station[129]	Channel No.	Channel Name
ABC	4.1 (38)	KOMODT
NBC	5.1 (48)	KINGDT
NBC	5.2 (48)	KINGWX
CBS	7.1 (39)	KIROHD
RTN	7.2 (39)	KIRODT
PBS	9.1 (41)	KCTSDT
PBS	9.3 (41)	KCTSCR
PBS	9.5 (41)	KCTSHD
CW	11.1 (36)	KSTWDT
FOX	13.1 (18)	KCPQDT1
TBN	14.1 (14)	KTBWDT
IND	16.1 (31)	KONGDT
TUBE	22.1 (25)	KMYQDT
TUBE	22.2 (25)	KMYQDT2
PBS	28.1 (27)	KBTCDT
PBS	28.2 (27)	KBTCDT2
PBS	28.3 (27)	KBTCDT3
PBS	28.4 (27)	KBTCDT4
ION	33.1 (32)	KWPXDT
Qubo	33.2 (32)	KWPXDT
ION Life	33.3 (32)	KWPXDT
Worship	33.4 (32)	KWPXDT
DAY	42.1 (42)	KWDKDT
SAH	44.1 (45)	KHCVDT
AZA	44.2 (45)	KHCVDT2
FUN	44.3 (45)	KHCVDT3
A1	44.4 (45)	KHCVDT4
UNI	51.1 (50)	KUNSDT1

DirecTV and Dish Network offer cable TV packages over satellite. Table 31 and Table 32 present a summary of the provider's pricing.

[129] Data obtained from http://www.titantv.com/quickguide/quickguide.aspx, accessed Sept 28, 2008.

Table 31: DirecTV Cable Television Packages

Package[130]	Price Per Month	CPE	Installation	Miscellaneous	Add-ons per month
Basic	$ 9.99	Receiver $5 each (waived for first one)	Free (up to 4 rooms) Handling free ($20 value) HD/DVR receiver upgrade free ($99 value)		HD programming $9.99
Preferred Choice	$ 19.99				
Family[131]	$ 29.99				
Choice[132]	$ 34.99				
Choice Extra[133]	$ 39.99				
Plus DVR[134]	$ 44.99				
Choice Extra + HD[135]	$ 49.98				
Plus HD DVR[136]	$ 54.99				
NFL Sunday Ticket[137]	$ 299.96 or four monthly payments of $74.99				
Lo Maximo[138] (Spanish)	$ 104.99				

Local channels are also available over DirecTV and are included in the above packages. Premium channels can also be purchased individually for the prices listed in the table.

Table 32 presents a summary of Dish Network's pricing. The network also charges a set-up fee. Local channels are also available over Dish Network for an additional fee per month.

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130 Data obtained from http://www.directv.com/DTVAPP/index.jsp, accessed Aug. 4, 2008.
131 Purchase of 18 consecutive months (24 months for advanced receivers) of any DirecTV base programming package ($29.99/mo. or above) or qualifying international services bundle required.
132 For customers who purchase 24 consecutive months (without interruption) of any DirecTV base programming package ($29.99/mo. or above) or qualifying international services bundle within 30 days of equipment lease. Offer valid for leased equipment only.
133 Ibid.
134 Ibid.
135 Ibid.
136 Ibid.
137 Ibid.
138 Ibid.

Table 32: Dish Network Cable Television Packages

<table>
<tr><th>Package[139]</th><th>Price Per Month</th><th>CPE</th><th>Installation</th><th>Miscellaneous</th><th>Add-ons per month</th></tr>
<tr><td>Turbo HD Bronze</td><td>$24.99</td><td></td><td></td><td rowspan="19">Activation fee waived with 24-month commitment

IR to UHF Pro Upgrade Kit $39.99

Phonex Easy Jack $39.00

Extra remote $19.99

Activation fee waived with 24-month commitment

IR to UHF Pro Upgrade Kit $39.99

Phonex Easy Jack $39.00

Extra remote $19.99</td><td rowspan="19">Add-ons:
Seattle Market $5.00
Bronze HD $10.00
Platinum HD $10.00
Latino $13.99
Latino Max HD Essential $10.00
Latino Max HD Ultimate $20.00
HBO $14.99
Cinemax $12.99
Showtime $12.99
Starz $12.99
Playboy $14.99
2 movie packages $22.00
3 movie packages $31.00
4 movie packages $40.00
5 movie packages, $50.00
DVRs available for rent
Many special packages</td></tr>
<tr><td>Turbo HD Silver</td><td>$ 32.99</td><td></td><td></td></tr>
<tr><td>Turbo HD Gold</td><td>$ 39.99</td><td></td><td></td></tr>
<tr><td>Dish Family</td><td>$ 19.99</td><td></td><td></td></tr>
<tr><td>America's Top 100</td><td>$ 32.99</td><td></td><td></td></tr>
<tr><td>America's Top 100 Plus</td><td>$ 37.99</td><td></td><td></td></tr>
<tr><td>America's Top 200</td><td>$ 44.99</td><td></td><td></td></tr>
<tr><td>America's Top 250</td><td>$ 54.99</td><td></td><td></td></tr>
<tr><td>America's Everything Pak</td><td>$ 94.99</td><td></td><td></td></tr>
<tr><td>Dish Latino</td><td>$ 27.99</td><td></td><td></td></tr>
<tr><td>Dish Latino Plus</td><td>$ 32.99</td><td></td><td></td></tr>
<tr><td>Dish Latino Dos</td><td>$ 39.99</td><td></td><td></td></tr>
<tr><td>Dish Latino Max</td><td>$ 49.99</td><td></td><td></td></tr>
<tr><td>Arabic Elite Super Pak</td><td>$ 44.99</td><td></td><td></td></tr>
<tr><td>Chinese Wall</td><td>$ 32.99</td><td></td><td></td></tr>
<tr><td>Greek Antenna Plus Ert</td><td>$ 32.99</td><td></td><td></td></tr>
<tr><td>Polish Superpak</td><td>$ 39.99</td><td></td><td></td></tr>
<tr><td>Brazil Elite Pak</td><td>$ 44.99</td><td></td><td></td></tr>
<tr><td>Russian Mega Pak</td><td>$ 32.99</td><td></td><td></td></tr>
</table>

[139] Data obtained from http://www.dishnetwork.com/, accessed Aug. 5, 2008.

8.2.3 Voice Providers and Products

8.2.3.1 Wireline Voice

Qwest is the Incumbent Local Exchange Carrier. It offers communication services to residences, small businesses, and large businesses. Its residential services include local and long-distance telephone and Internet. Qwest also offers complete network solutions for small businesses, large enterprises and wholesalers. Voice packages offered by Qwest are provided in Tables 33 through 35. There are many Competitive Local Exchange Carriers in Seattle some of which include Advanced TelCom, Inc, Air Speed, LLC, Axxis Communications, Inc., BullsEye Telecom, Inc, CenturyTel Solutions, LLC, CSK Communications, Inc., Eman Networks and many such others.

Table 33: Qwest Residential Voice Packages[140]

Type of Service	Plan	Price per Month (single line/double line)	Equipment/ Charges/ Installation	Additional Features (charges apply)
Landline	Basic Home (unlimited local)	$13.50	Installation of first jack: $99.00 Installation of other jacks: $60.00	Caller ID $7.50 Call Waiting $6.00 Voice Mail $7.95 Line-Backer™ 5.00 3-Way Calling $3.50 Last Call Return $3.95 Call Forwarding $3.00 Call Rejection $4.50 Continuous Redial $3.50 Security Screen™ $2.95 Call Waiting ID $6.00 Qwest can help set up its own services plus Electric, Gas, Water and more Long Distance Alert—Free w/Call Waiting Voice Mail w/Audible Message Waiting Indicator $7.95 Anonymous Call Rejection—free w/Caller ID or Last Call
	Choice Home (unlimited local)	$29.99 (w/choice of 3 calling features)/39.99 (2nd line has no calling features)		
	Choice Home Plus Local (unlimited local)	$34.99 (w/choice of 10 calling features)/$39.99 (2nd line has no calling features)/$44.99 (2nd line with choice of 10 calling features)		
	Unlimited Long Distance	$25.00		

140 https://myaccount.qwest.com/MasterWebPortal/appmanager/home/Shop?_nfpb=true&_pageLabel=LocalLandingPhonePage, accessed August 7, 2008

Type of Service	Plan	Price per Month (single line/double line)	Equipment/ Charges/ Installation	Additional Features (charges apply)
	5 Cent Long Distance	$5.99 + 0.05 per minute		Return Anywhere Voice Mail $14.90 Call Curfew $3.95 Call Transfer $6.00 Caller ID w/privacy $9.95 Custom Ringing $5.00 Dial Lock $3.95 Priority Call $3.50 Selective Call Forwarding $3.50 Selective Call Waiting $6.00 Selective Call Waiting ID $6.00 Speed Call 30 $3.00 Speed Call 8 $2.00 Voice Mail w/Audible & Visual Message Waiting Indicator $7.95 Qwest can help set up its own services plus Electric, Gas, Water and more
	15 Cent Single Rate Long Distance	$1.99 + 0.15 per minute		
	International Multilingual	$4.00		
	Ten Cents to Mexico	$2.00 + 0.10/minute		
	Mexico 180	$20.00 (180 minutes)		
	Mexico 360	$35.00 (360 minutes)		
	60 Minute Canada Savings	$3.50 (60 minutes + 7¢ for each additional minute)		
	Plan Latino	$3.25 + 5¢/minute		

Table 34: Qwest Residential Voice Packages

Type of Service	Plan	Price per Month (single line/double line)	Equipment/ Charges/ Installation	Additional Features (charges apply)
VoIP	Broadband Phone Service	$39.99		

Table 35: Qwest Residential Voice Packages

Type of Service	
Wireless	To be offered in conjunction with Verizon in future.

Broadstripe and Comcast offer phone services over their hybrid/fiber coax networks and their plans are summarized in Table 36 and Table 37.

Table 36: Comcast Telephone Offerings[141]

Plan	Price per Month (single line/ double line)	Equipment/ Charges/ Installation	Additional Features (charges apply)
Unlimited (for existing customers also subscribing to TV and Internet)	$39.95[142]/$49.95	• Modem Lease fee: $3.00 for two lines • $5.00 for 4 lines • Installation: $99 per event • Service activation: $29.95 per event • Reconnect charge: $27.99 per event	• International Rates • Directory listing(s)/non-listing(s) • Additional line calling features
Unlimited (for existing customers also subscribing to TV or Internet)	$44.95/$54.95		
Unlimited (for phone service only)	$44.95/$54.95		

[141] Data obtained from http://www.comcast.com/MediaLibrary/1/1/About/PhoneTermsOfService/PDF/DigitalVoice/StatePricingLists/Washington/Washington%20pricing%20list.pdf, Residential Pricing List (Effective: July 01, 2008), Western Washington, Version 16, accessed Aug. 6, 2008.
[142] Promotional price: $33.00 for first 12 months.

Table 37: Broadstripe[143]

Plan	Price per Month (single line/double line)	Equipment/ Charges/ Installation	Additional Features (charges apply)
Voice	$49.99	Activation/ Deactivation $39.99 In-home wire maintenance $3.00 Self-installation, free Professional Installation, charge applies	Voice Mail $1.99
Voice (with basic cable subscription)	$39.99		

In addition to traditional wireline voice services, Voice over Internet Protocol (VoIP) is quickly becoming a competitor in the voice communications industry. VoIP providers, such as Vonage and SpeakEasy, are offering low-priced packages that do not distinguish between local and long distance. Vonage, for example, offers unlimited calling anywhere in the United States and Canada for $24.99 per month. Vonage and other VoIP providers do not have to have a physical presence in the community because the application resides over the Internet. The user (customer) simply needs a high-speed Internet connection.

8.2.3.2 Wireless Voice - Existing

There are a number of cellular telephone providers with coverage in Seattle, including:

- Verizon
- Nextel
- AT&T,
- T-Mobile
- Sprint

Many of these packages do not distinguish between local and long distance calling, and pricing is based on the number of minutes used per month.

Further details of the residential phone packages are outlined in Appendix B.

[143] Data obtained from http://www.broadstripe.com/rates/Seattle_Rate_NW.pdf, accessed Aug. 5, 2008.

8.2.3.3 Future Wireless Data Providers

There are currently eleven wireless providers holding sets of licensed frequencies in the Seattle region, of which six are operational. Table 38 lists the license holders and the frequencies they hold in Seattle.

Wireless providers use either fiber or microwave links to communicate between cell sites and backhaul traffic to its headends. Leased circuits used between cell sites prove costly and sometimes cause bandwidth issues. As wireless providers increase both data capabilities and the number of subscribers, the capacity required at each cell site will increase. Providing backhaul connectivity to mobile service providers can open up a potential new revenue stream for SCL. Backhaul connectivity can be offered as dark fiber, wavelength services or Ethernet.

1. Dark Fiber is the simplest product to offer since electronics are not required. Since this would be unmanaged service, the wireless provider would be responsible for adding electronics, monitoring uptime and contacting SCL during outages due to fiber breakage.

2. Use of wavelengths conserves the use of SCL fiber. A fiber pair can be used to offer multiple wavelengths which would enable the wireless provider to manage its capacity needs, control 24x7 monitoring, and meet Quality of Service requirements. SCL would be responsible for the uptime and availability of the leased wavelength.

3. Ethernet is desirable since the providers want to connect multiple cell sites to a central switch. The Ethernet solution will need Quality of Service levels sufficient to support voice applications. Since this is a completely managed solution, SCL would be responsible for 24 x 7 monitoring of electronics and fiber and the link's uptime and availability.

Table 38: Licensed Frequency Holders in Seattle[144]

License Holder	System	Technology Deployed	Web Site	Comment
AT&T	850 MHz (cellular)	GSM/GPRS	www.wireless.att.com	
	1.9 GHz (PCS) 1.7/2.1 GHz (Future - AWS)	EDGE		
	700 MHz (Future)	UMTS/HSDPA		
Metro-PCS	1.7/2.1 GHz (Future-AWS)	CDMA	www.metropcs.com	PCS service is not available in Seattle
Nextel	806/886 MHz (SMR)	iDEN	www.sprint.com	Sprint acquired Nextel
Sprint	1.9 GHz (PCS)	CDMA	www.sprint.com	
		CDMA2000 1xEV-D (EvDO)		
T-Mobile	1.9 GHz (PCS)	GSM/GPRS	www.t-mobile.com	
	1.7/2.1 GHz (Future – AWS)			
Verizon Wireless	850 MHz (Cellular)	CDMA	www.verizonwireless.com	
	1.9 GHz (PCS)	CDMA2000 1xEV-D (EvDO)		
	700 MHz (Future)			
Comcast	1.7/2.1 GHz (Future-AWS)		www.comcast.com	
Frontier Wireless	700 MHz (Future)		www.echostar.com	Echostar owns Frontier
Vista PCS	1.9 GHz (PCS)		www.verizonwireless.com	Verizon owns controlling stake in Vista[1]
Vulcan Spectrum	700 MHz (Future)			Investment company owned by Paul Allen
Wirefree	1.9 GHz (PCS)	Enterprise Cellular Service	www.strata8.com	Wirefree is an investor in Strata8 Networks

[1] http://news.vzw.com/investor/pdf/Cellco_10Q11.8.05.pdf

144 www.wirelessadvisor.com accessed September 9, 2008

8.3 Existing High-Capacity Business Providers and Products

During the course of our research, we identified 17 service providers in the Seattle area that offer a range of services from dark fiber connectivity to data transport services, with speeds that range from 1 Mbps to 40 Gbps. The data transport services can be broadly classified by the technology used as Dark Fiber, Ethernet services, Wavelength services, and Synchronous Optical Network (SONET) services. Individual providers tailor these services to a customer's requirements such as bandwidth required, configuration desired and such. Competitors in each service area are discussed in the following sections. The existing competitors for Ethernet (100 Mbps to 1 Gbps), SONET (OC-1 to OC-192), and wavelength (2.5 Gbps and 10 Gbps) services are listed in Table 39.

Table 39: Seattle Existing Competitors

Sr. No.	Carrier	Dark Fiber	Ethernet (Mbps)			Wavelength	SONET
			100	1000	10000		
1	360 Networks	YES	YES	YES	NO	2.5 Gbps and 10 Gbps	OC-3/OC-12/OC-48
2	Abovenet	YES	YES	YES	YES	2.5 Gbps and 10 Gbps	DS-3 to OC-48
3	AireSpring	NO	NO	NO	NO	NO	DS-1/E-1, DS-3, OC-3–OC-48
4	At&t	NO	YES	YES	YES	2.5 Gbps and 10 Gbps	DS1, E1, DS3, OC3c, OC12c, OC48c, OC192c
5	Cross Stream Communications	NO	YES	YES	NO	NO	DS-1 to DS-3 to OC-x
6	Global Crossing	NO	YES	YES	NO	2.5 Gbps and 10 Gbps	DS-3 (45 Mbps), OC-3 (155 Mbps) to OC-48 (2.488 Gbps)
7	Integra Telecom	NO	YES	YES	YES	1Gbps to 10Gbs	DS-1 (1.5Mbps) to OC-192 (10Gbps)
8	Level (3)	YES	YES	YES	YES	2.5 Gbps and 10 Gbps	DS-1 to OC-192
9	Noel Communications	NO	NO	NO	NO	NO	DS-1, DS-3, OC-N (OC-192?)
10	PAETEC	NO	YES	NO	NO	NO	
11	Qwest	YES	YES	YES	YES	1GbE, 2.5Gbps, 10Gbps	DS-1 to OC-192
12	Silver Star Telecom	YES	YES	YES	NO	2.5 Gbps and 10 Gbps	DS-1 to at least OC-48
13	Threshold Communications	YES	NO	NO	NO	NO	up to OC-192
14	TW Telecom (Time Warner)	NO	YES	YES	YES	1.06 Gbps, 2.125 Gbps, 10 Gbps	DS-1, DS-3, OC-3, OC-12, OC-48
15	Verizon	NO	YES	YES	YES	8 Mbps to 10 Gbps	sub-56Kbps all the way up to OC-192
16	WCI	NO	NO	NO	NO	NO	DS-1 to OC-48
17	XO Communications	NO	YES	YES	YES	1 Gbps to 10 Gbps	OC-3, OC-12, OC-48

The range of pricing offered by existing competitors in Seattle is shown in Table 40.

Table 40: Pricing Comparison Table

Service	Bandwidth Range	Pricing		
		Low	High	Unit
Dark Fiber	Variable	$17,000	$35,000	per mile per fiber pair
Ethernet	1 Mbps to 10000 Mbps	$1,210	$6,734	monthly recurring charge*
Wavelength	1.25 Gbps to 10 Gbps	$7,000	$62,800	for a 20-mile circuit
SONET	51.84 Mbps to 10 Gbps	$1,100	$27,000	monthly recurring charge*

* Excludes non-recurring charge

8.3.1 Dark Fiber Services

Six service providers in the Seattle region offer dark fiber services: 360 Networks, Abovenet, Level 3 Communications, Qwest, Silver Star Telecom, and Threshold Communications.

360 Networks is located at 2001 6th Avenue in Seattle, WA. It provides dark fiber, collocation services and use of conduit, where available, on an individual case basis.[145] Dark fiber however is not available widely as are some of their other communication products.

Abovenet serves both national and local customers. Dark fiber can be leased by the month or procured using an Indefeasible Right of Use for 20 years. Dark fiber lease costs approximately $2,500 per mile per fiber pair per month; a 20-year Indefeasible Right of Use [146] would be approximately $17,000 to $20,000 per mile per fiber pair. Their fiber map is shown in Figure 32.

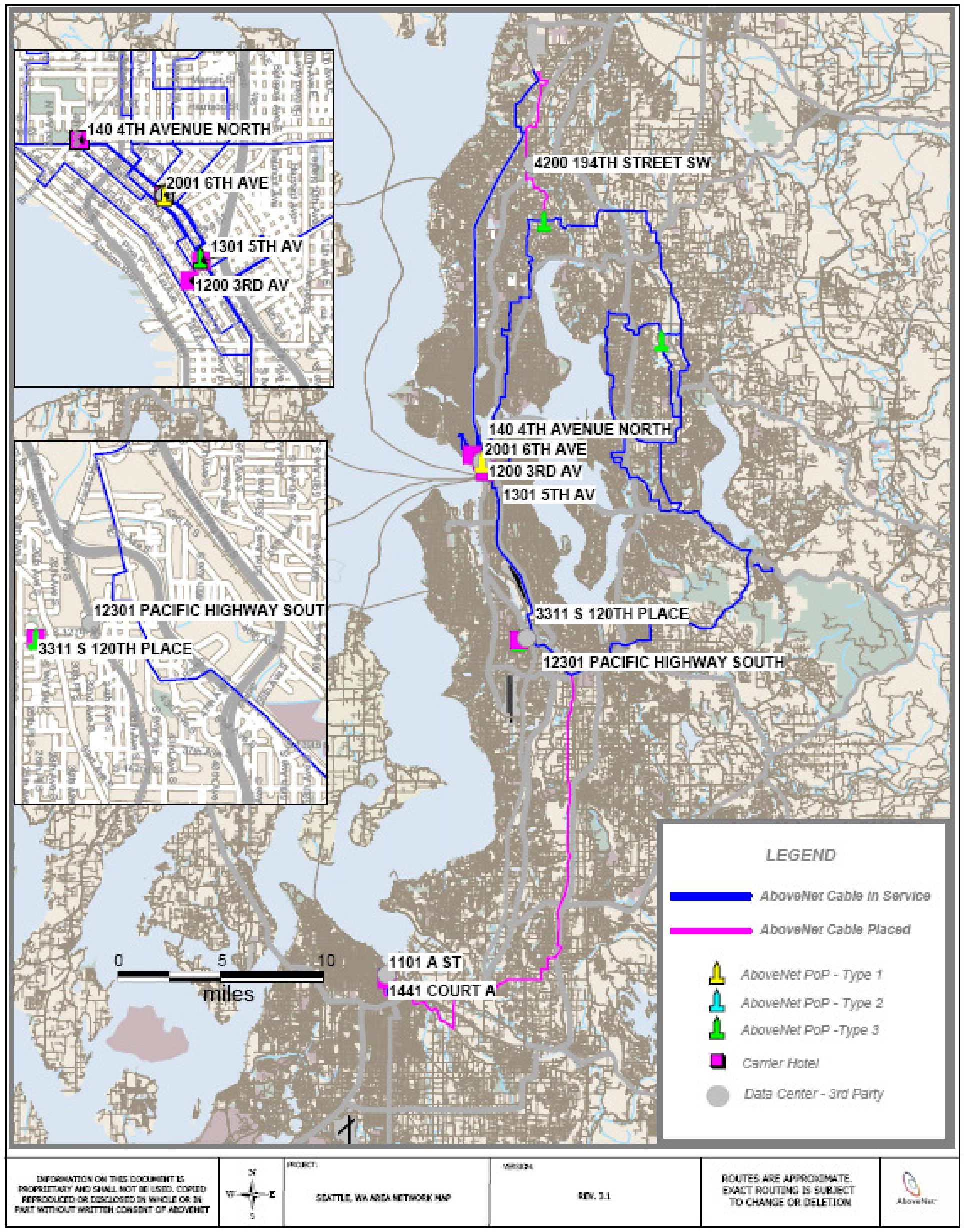
Level 3 Intercity Dark Fiber serves national customers as well as local ones. It charges approximately $30,000 to $35,000 per mile per fiber pair as part of a 20-year Indefeasible Right of Use. Seattle is one of its Metro Dark Fiber markets. The Level 3 office and operations facility is located at 1000 Denny Way, Seattle, WA, 98109 and houses local staff and gateway switch equipment, along with additional space for expansion and collocation services. Level 3 also provides collocation services; the pricing is typically a non-recurring charge of $2,200 and monthly recurring charge of $990 for a standard 19" 42-RU (rack unit) cabinet with a 20 amp power feed. [147]

Qwest Commercial Dark Fiber (QDF) is a deployed, unlit strand or pair of fiber optic strands that connects two points within Qwest's network within the same LATA and state. QDF is a single, existing transmission path that terminates on a Qwest Fiber Distribution Panel (FDP) or equivalent, between two non-impaired Qwest Wire Centers or between any Qwest Wire Center and an end user premises, Meet Point or CLEC switch. [148] Qwest Commercial Dark Fiber (QDF) has been provisioned in the following configurations:

- Qwest Commercial Dark Fiber Interoffice Facility (QDF-IOF) is a deployed route between two Qwest Wire Centers.
- Qwest Commercial Dark Fiber Loop (QDF-Loop) is a deployed route between a Qwest Wire Center and the end-user premises.
- Qwest Commercial Dark Fiber MQDF/EQDF (QDF - MQDF/EQDF) is a deployed route between a Qwest Wire Center, and Meet Point facility or CLEC switch.
- Qwest Commercial Dark Fiber Suploop (QDF - Subloop) is a deployed route that is any fractional portion of a Loop.

[145] http://www.360networks.com/default.asp?ID=9 accessed August 5, 2008
[146] http://www.abovenet.com/about/ accessed August 5, 2008.
[147] http://www.level3.com/brochures/e_brochures/Intercity_Dark_Fiber_e_brochure.pdf accessed August 5, 2008.
[148] http://www.qwest.com/wholesale/pcat/qwestdarkfiber.html accessed August 5, 2008

Figure 32: Abovenet – Seattle, WA Fiber Map[149]



Silver Star Telecom has Master Service Agreements with many CLECs and IXCs throughout the United States. Silver Star Telecom resells dark fiber procured from other vendors such as AT&T, Verizon and Sprint with whom they have partnered.[150]

[149] http://www.abovenet.com/products/maps2/maps/WA%20Seattle%20market%2011-13-07.pdf accessed August 5, 2008

Threshold Communications, Inc. serves the local Seattle area and offers dark fiber services.[151]

8.3.2 Ethernet Services

Thirteen of the seventeen providers offer Ethernet services with bandwidths ranging from 1 Mbps to 10000 Mbps (10 Gbps). The carriers who provide these services in the Seattle region are 360 Networks, Abovenet, AT&T, Cross stream communications, Global Crossing, Integra Telecom, Level(3), Paetec, Qwest, Silver Star Telecom, TW Telecom, Verizon and XO Communications. Prices depend on the bandwidth, network configuration (i.e., point-to-point or point-to-multipoint), and whether the service is protected or unprotected, switched or mesh structure or dedicated configuration.

360 Networks offers limited coverage in the Seattle area. They provide 1 Gbps Ethernet long-haul transport service, which is aimed more at national customers than local ones. This service is priced on an individual case basis.[152]

Abovenet's Ethernet service is offered as a managed service at a bandwidth of 1 Gbps and 10 Gbps over a dedicated pair of fibers in the metro region. The 1 Gbps point-to-point Ethernet service typically carries a monthly recurring charge of $5,565 to $6,734 for a three-mile circuit.[153]

AT&T has four different types of Ethernet products—GigaMAN, DecaMAN, Opt-E-MAN and EPLS-MAN. GigaMAN provides a native rate interconnection of 1 Gbps between customer end points. AT&T uses Coarse Wavelength Division Multiplexing (CWDM) to carry the traffic between end points; the handoff can be either single-mode or multi-mode fiber. DecaMAN connects the end points at 10 Gbps and is delivered over a wavelength division multiplexing system as well. The data is transmitted in native Ethernet format similar to GigaMAN, only 10 times faster. Opt-E-MAN service provides a switched Ethernet service within a metropolitan area. It supports bandwidths ranging from 1 Mbps to 1000 Mbps, and configurations such as point-to-point, point-to-multipoint, and multipoint-to-multipoint. A typical 100 Mbps Opt-E-MAN service would have a non-recurring price of $1,630 and monthly recurring price of $1,210 to $1,850 for a period of approximately one year. Similarly, a typical 1000 Mbps Opt-E-MAN service carries a non-recurring charge of $1,780 and a monthly recurring charge of approximately $2,040 to $3,540. The Ethernet Private Line Service-Metropolitan Area Network (EPLS-MAN) is a point-to-point, fixed-bandwidth Ethernet transport service within a metropolitan area and is available at speeds ranging from 50 Mbps to 1 Gbps. The Ethernet data in this case is transmitted using SONET technology. For Gigabit Ethernet service, customers can choose from 50 Mbps, 300 Mbps, 600 Mbps or 1 Gbps and have the option of single mode or

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[150] http://www.silverstartelecom.com/es_privateline.htm accessed August 5, 2008
[151] http://www.thresholdcommunications.com/product1.html accessed August 5, 2008
[152] http://www.360networks.com/default.asp?ID=8 accessed August 5, 2008.
[153] http://www.abovenet.com/products/transport-metroenet.html accessed August 5, 2008.

multimode hand-off. For Fast Ethernet service, one can choose from 50 Mbps or 100 Mbps with electrical hand-off.[154]
A fifth Ethernet service offered by AT&T is the Ultravailable Managed OptEring, which leverages the Resilient Packet Ring (RPR) SONET technology to provide optical Ethernet service supporting any-to-any Local Area Network or MAN connection. Businesses can also get Internet access through this configuration. This technology is interoperable with Dense Wavelength Division Multiplexing (DWDM) technology and can support a mix of Time Division Multiplexing (TDM) technology as well as packet technology.[155]

Global Crossing offers Ethernet service over SONET, WDM or using MPLS. Its product Ethersphere provides point to multipoint and any to any services from 1 Mbps to 1000 Mbps and is available globally. Its offers another product Etherline provides point to point services between its point-of-presence or between its POP and customer location and speeds of 10, 100 and 1000 Mbps. Bespoke Ethernet service product where fiber is constructed by Global Crossing to the desired customer premises and uses either SONET or wavelength based on the customer requirements to transport its Ethernet data.[156]

Integra Telecom carries Ethernet traffic over its SONET network. It offers speeds of 100 Mbps, 1000 Mbps and 10 Gbps. Its Ethernet service product Ultra Ethernet – MAN is offered in 18 metropolitan regions.

Level(3)'s Ethernet Virtual Private Line (VPL) is offered in speeds ranging from 1 Mbps to 1 Gbps. It is an end-to-end Layer 2 switched Ethernet service delivered via a Multi-protocol Label Switched (MPLS) backbone. Fast Ethernet (FastE) and Gigabit Ethernet (GigE) interfaces are available, with virtual circuit bandwidths up to 600Mbs in 1Mbps, 10Mbps and 50Mbps increments. Customers can allocate bandwidth by application, prioritize traffic into two different Classes of Service, and provision Virtual Circuits in point-to-point and hub-and-spoke configurations. The Level(3) Metro Ethernet Private Line and the Intercity Ethernet Private Line solutions provide Ethernet over SONET (EoS) service. Different bandwidths can be chosen in the Metro region with capacities ranging from 3 Mbps to 1000 Mbps and intercity service from 50 Mbps to 1000 Mbps. The backbone SONET ring is protected; however, the handoff to the customer is not. [157]

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[154] http://www.business.att.com/service_overview.jsp?repoid=Product&repoitem=w_ethernet&serv=w_ethernet&serv_port=w_data&serv_fam=w_local_data&state=California&segment=whole accessed August 5, 2008.

[155] http://www.business.att.com/enterprise/Family/eb_access_and_local_services/eb_ultravailable_managed_optering_service/ accessed June 04, 2008.

[156] http://www.globalcrossing.com/enterprise/managed_ethernet/managed_ethernet_landing.aspx accessed August 6, 2008

[157] http://www.level3.com/brochures/e_brochures/Metro_Ethernet_Private_Line_e_brochure.pdf, accessed August 5, 2008.

Paetec has a national IP network over which it offers Ethernet services using MPLS. Target customers include those currently on Frame Relay or ATM circuits. [158]

Qwest provides point-to-point and point-to-multipoint service configurations for native Ethernet service over a pair of fibers to the customer's location. Speeds of 5 Mbps to 1 Gbps are offered over a meshed Ethernet network. The solution is based on a shared transport data bandwidth. A protected OC-12 SONET circuit is priced by Qwest at a non-recurring charge of $7,600 and a monthly recurring charge of $7,000 for a period of one year.[159]

Silver Star Telecom provides LAN to LAN connectivity throughout Oregon and Washington. It supports speeds from 1Mbps to 1 Gbps. The service is a Layer 2 solution that supports Virtual Local Area Networks (VLANs), allowing one circuit to support both Internet service and point-to-point connections as well as point to multipoint connections.[160]

Time Warner offers Metro Ethernet with the choice of dedicated full-duplex 10 Mbps, 100 Mbps, or 1000 Mbps Ethernet service. Protected and Unprotected configurations are available.[161]

Verizon offers Ethernet services under three different product categories—Ethernet LAN, Ethernet Private Line, and Ethernet Virtual Private Line. The Ethernet LAN is a multipoint-to-multipoint bridging service at native Local Area Network (LAN) speeds. It is configured by connecting customer User Network Interfaces (UNIs) to one multipoint-to-multipoint Ethernet Virtual Connection or Virtual LAN (VLAN), and provides two Class of Service options—standard and real time. The Ethernet Private Line is a managed, point-to-point transport service for Ethernet frames. It is provisioned as Ethernet over SONET (EoS) and speeds of 10 Mbps to 1 Gbps are available. The Ethernet Virtual Private Line (EVPL) is an all-fiber optic network service that connects subscriber locations at native LAN speeds; EVPL uses point-to-point Ethernet virtual connections (EVCs) to define site-to-site connections. It can be configured to support multiple EVCs to enable a hub and spoke configuration and supports bandwidths from 1 Mbps to 1000 Mbps.[162]

XO Communications offers Ethernet services at four different speeds—10 Mbps, 100 Mbps, 1 Gbps, and 10 Gbps (LAN/WAN PHY). The services support copper, single mode, and multimode interfaces.[163]

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158 http://www.paetec.com/data/mpls_vpn_overview.html accessed August 5, 2008
159 http://www.qwest.com/largebusiness/enterprisesolutions/products/ethernet/moe.html accessed August 5, 2008
160 http://www.silverstartelecom.com/es_ethernettransport.htm accessed August 6, 2008
161 http://www.twtelecom.com/Documents/Resources/PDF/MarketingCollateral/2701NativeLAN.pdf, accessed August 5, 2008
162 http://www.verizonbusiness.com/products/data/ethernet/ accessed August 5, 2008
163 http://www.xo.com/carrier/transport/Pages/ethernet.aspx accessed August 5, 2008

8.3.3 SONET Services

Sixteen of the 17 providers offer data transport using Synchronous Optical Networking Technology. Synchronous Optical Networking services are available in speeds ranging from Optical Carrier-1 or OC-1 to OC-192, which is from 51 Mbps to 10 Gbps.

360 Networks' Synchronous Optical Networking service is capable of carrying voice, data, and video traffic and is available at access speeds of OC-3 (155 Mbps), OC-12 (622 Mbps), and OC-48 (2.5 Gbps). OC-192 is available on some long-haul routes. The optical point-to-point service provides the backbone network for higher-layer protocol networks such as ATM and Internet Protocol (IP). 360 Networks also offers tiered protection/restoration based on the customer's requirements. The network can be unprotected, hardware-redundant (in which a secondary port takes over when the primary fails), ring-protected (in which the network has two diverse paths, each of which is equipment-protected and rides on two diverse wavelengths), and 1+1 protected (in which equipment-protected circuits are further protected by redundant cards that automatically switch in case of a failure).[164]

Abovenet has an extensive Dense Wavelength Division Multiplexing (DWDM) network nationally and uses wavelengths to carry Synchronous Optical Networking traffic. The Synchronous Optical Networking services are priced in the same way as the wavelength services.[165]

AireSpring is primarily a voice company and offers Synchronous Optical Networking services to carry mainly voice traffic and some data ranging from DS-1 to OC-48 over its fiber network.

AT&T's Dedicated Synchronous Optical Networking Ring Service (DSRS) provides a customized, dedicated self-healing ring network for two or more customer locations. The ring, with bandwidth levels of OC-3, OC-12, OC-48, or OC-192, supports voice, video, and data via DS-1 and higher interfaces. The ring architecture, including sub-rings, is designed to provide increased reliability and functionality. Dedicated Synchronous Optical Networking Ring Service provides Automatic Protection Switching, which increases the availability of the services on the ring. The cost for an OC-12 DSRS network is approximately $1,325 to $1,350 per mile. AT&T also offers the Self-healing Transport Network (STN), which is an optical fiber service connecting two or more access nodes using optical fiber in a dual-ring structure. STN provides transport of various transmission bandwidths, allowing the use of voice, data, and video service on a single platform serving numerous locations. STN service includes self-healing characteristics, multiplexing, performance monitoring, and network supervision. AT&T's third Synchronous Optical Networking service, ACCU-Ring,® provides a reliable, cost-effective solution for customers that are spread out in many locations. ACCU-Ring® is a private network backbone that uses a dedicated high-speed fiber ring to carry all of a customer's network traffic.

[164] http://www.360networks.com/default.asp?ID=28 accessed August 5, 2008.
[165] http://www.abovenet.com/products/transport-wdm.html, accessed August 5, 2008

ACCU-Ring® service accommodates private line, switched, and enhanced services to carry local and long distance voice, data, and video traffic.[166]

Cross stream communications offers Synchronous Optical Networking services with bandwidth ranging from DS-1 (1.5 Mbps) to OC-192 (10 Gbps). The company says they offer 100 percent network availability and is available in Seattle and other cities within the United States.

Global Crossing offers Synchronous Optical Networking/SDH self-healing rings which employ 4-fiber bidirectional line switched ring (BLSR) rings. Customer access options include local loop, PoP interconnection and metro service. It offers bandwidths from DS1 to OC-48 over its global network. The company targets more customers looking for international connectivity.

Integra Telecom's Synchronous Optical Networking network is diversely routed and can be designed to have 1+1 protection. Bandwidths are offered from DS-1 to OC-48 and SLA offers an availability of 99.999 percent.

The Level 3 Metro Private Line service uses redundant local Synchronous Optical Networking rings to move data traffic between customer end points. The service supports speeds of DS-1 (1.544 Mbps), DS-3 (45 Mbps), OC-3 (55 Mbps), OC-12 (155 Mbps), OC-48 (2.5 Gbps), and OC-192 (10 Gbps). The transport can be in a point-to-point, hub, or Private Dedicated Ring (PDR) configuration, depending on the customer's needs. The Level 3 Private Dedicated Ring (PDR) configuration provides a protected SONET service offered at ring capacity speeds of OC-48 (2.5 Gbps) or OC-192 (10 Gbps). The Synchronous Optical Networking equipment is dedicated for the customers' use and is provisioned over the Level 3 Metro network. With the Private Dedicated Ring service, the customer can configure the drop side, or lower bandwidth circuit capacity, at each of the nodes on the ring to enter and exit the ring in increments ranging from DS-1 to OC-48 or 50 Mbps, 150 Mbps, 300 Mbps, 600 Mbps and 1GB for Ethernet interfaces. Level 3 Private Line Hub service provides point-to-point, dedicated high bandwidth private line connections between a major data aggregation point and an end site. The Private Line Hub service allows a customer to aggregate private line traffic at a Level 3 point of presence, from metro and intercity sites, and provides a single, high-bandwidth, private-line connection to another location.[167]

Noel Communications provides uni-directional path switch ring (UPSR) within cities in Washington State. The company has an OC-12 and OC-48 fiber network and a failover to a microwave network.

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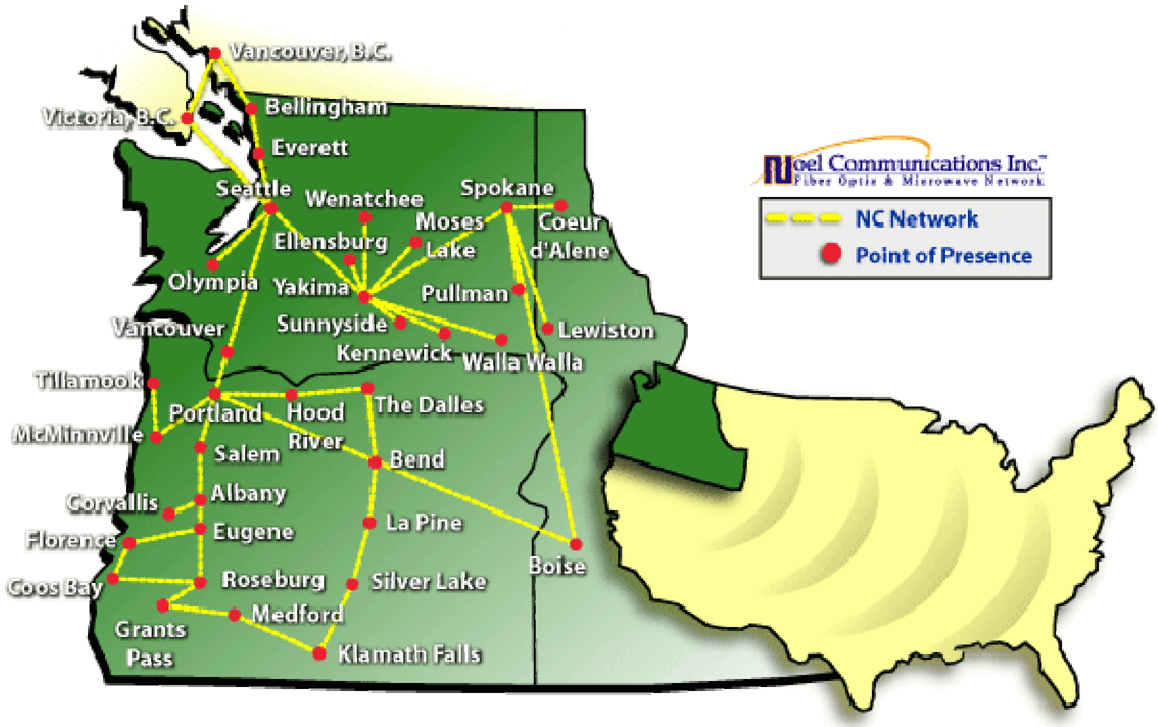
[166] http://www.business.att.com/service_fam_overview.jsp?repoid=ProductSub-Category&repoitem=eb_accuring_service&serv_port=eb_access_and_local_services&serv_fam=eb_accuring_service&segment=ent_biz accessed August 5, 2008

[167] http://www.level3.com/brochures/e_brochures/Metro_Private_Line_e_brochure.pdf accessed August 5, 2008

Figure 33: Noel Communications Service Area[168]



Qwest provides speeds ranging from DS-1 to OC-192 under their Metro Private Line Service. It's a redundantly routed Synchronous Optical Networking network. The network runs Bidirectional Line Switched Ring (BLSR), in which one ring is active and the second ring passive. The second ring is used for path protection. In case of a fiber cut and the failure of the active ring, the second ring will take its place and route in the opposite direction within 50 milliseconds.

Silver star telecom offers speeds of DS-1, DS-3, OC-3, OC-12 and OC-48 within the United States and mainly concentrated in the areas of Washington state and Oregon. They have agreements with other carriers to provide a more complete solution as the customer needs.

Threshold communications offers private line solutions which offers Synchronous Optical Networking speeds from T1 to OC-192 within the US and internationally.[169]

Time Warner Telecom offers different services using Synchronous Optical Networking technology. The Native LAN or Metro-Ethernet services include speeds of DS-1, DS-3, OC-3 and OC-12 and act as an extension of the organization's Local Area Network. [170] The Dedicated

[168] http://www.noelcommunications.com/ourNetwork.php accessed August 6, 2008
[169] http://www.thresholdcommunications.com/product1.html accessed August 6, 2008
[170] http://www.twtelecom.com/Documents/Resources/PDF/MarketingCollateral/2701NativeLAN.pdf, accessed August 5, 2008

High Capacity service includes speeds ranging from 1.5 Mbps to 10 Gbps.[171] Both services are available in different configurations, such as Point-to-point, Point-to-multipoint, and Multipoint-to-multipoint.

Verizon Metro Private Line Synchronous Optical Networking Service provides Synchronous Optical Networking handoff at speeds of OC-3 (155 Mbps), OC-12 (622 Mbps), OC-48 (2.5 Gbps) and OC-192 (10 Gbps). Verizon offers various configurations such as concatenated (full bandwidth) services and channeled services, point-to-point, point-to-multi-point, linear, and protected path. Verizon's Dedicated Synchronous Optical Networking Ring (DSR) has dual-fiber, dedicated ring architecture. It can carry traditional voice, data, and video applications, and supports Synchronous Optical Networking interfaces such as Ethernet, DS-1 access, and Trans-Multiplexing. DSR is available at OC-3, OC-12, OC-48, and OC-192 bandwidths.[172]

WCI uses other carrier's networks such as Global Crossing, Broadwing, Level(3), Qwest and XO Communications. The fiber network offers bandwidths from T1 to OC-48 with 100 percent availability.

XO Synchronous Optical Networking service provides customers with a secure, high-capacity customized network. The ring architecture of the Synchronous Optical Networking services provides the security needed for high-bandwidth transmissions. Bandwidths of OC-3, OC-12 and OC-48 are supported with this service and point-to-point, point-to-multipoint and multipoint configurations are available.[173]

8.3.4 Wavelength Services

Eleven of the 17 providers offer data transport using wavelength services with speeds ranging from 2.5 Gbps to 10 Gbps.

360 Networks offers wavelength services at 2.5 Gbps and 10 Gbps. The company has limited coverage in the Seattle region and serves more national carriers than local ones.[174]

Abovenet has an extensive DWDM network in the United States. Their Metro WDM service supports speeds of 2.5 Gbps and 10 Gbps. It supports protocols such as Gigabit Ethernet and Synchronous Optical Networking.[175]

Wavelength services from AT&T can be purchased under the WaveMAN service, the Metropolitan Optical Ring (MON) Service, or the Ultravailable Network Service. WaveMAN service is a point-to-point data transport service for interconnecting to interLATA, interstate

[171] http://www.twtelecom.com/cust_solutions/services/ded_hi_capacity.html, accessed August 5, 2008
[172] http://www.verizonbusiness.com/us/products/data/ring/#dsr accessed August 5, 2008
[173] http://www.xo.com/carrier/transport/Pages/privateline.aspx accessed August 5, 2008
[174] http://www.360networks.com/default.asp?ID=26 accessed August 5, 2008
[175] http://www.abovenet.com/products/transport-wdm.html accessed August 5, 2008

networks. The service uses a Coarse Wave Division Multiplexing (CWDM) signal over fiber, connects intraLATA networks to long-haul services, and provides interconnection handoffs of intraLATA Synchronous Optical Networking and Interexchange Carrier Optical Wave service at Synchronous Optical Networking interface levels of 2.5 Gbps and 10 Gbps. The MON Ring Service provides optical transport using Dense Wave Division Multiplexing (DWDM) technology in a dedicated ring configuration. The Ultravailable® Network Service (UVN) is a managed, custom Dense Wavelength Division Multiplexing or Synchronous Optical Networking -based solution. It provides the communication path between a customer's premises and the nodes of AT&T's POP/AT&T Local Network Services (LNS) or a third-party fiber provider's.[176]

Global Crossing offers wavelength services at 2.5 Gbps and 10 Gbps in unprotected, bidirectional point to point links. Global Crossing's EtherWave Service provides point to point Ethernet connectivity over a 10 Gbps wavelength.[177]

Integra Telecom's Dense Wavelength Division Multiplexing network serves parts of Seattle and provides wavelength bandwidths ranging from 1 Gbps to 10 Gbps. They offer customers the option of both flat fee and usage fee billing options and the solution can be customized to the user's needs.[178]

Level(3) Intercity Wavelength is a point-to-point, unprotected wavelength service at 2.5 Gbps, 10 Gbps, and 10GE LAN PHY. It supports speeds between DS-1 to OC-192 and 10 GigE LAN PHY and 40 Gbps waves.

Qwest wavelength service, termed "QWave," is a managed private point-to-point service delivered over a dense wave division multiplexing network. Qwest provides an end-to-end solution with a wide range of transport bandwidths, including 1 Gbps, 2.5 Gbps and 10 Gbps. A single-path 1.25 Gbps wavelength is priced by Qwest at a non-recurring charge of $14,600 and a monthly recurring charge of $14,000 for a period of one year.[179]

Silver star telecom offers speeds of 2.5 Gbps and 10 Gbps wavelength services within the United States and mainly concentrated in the areas of Washington state and Oregon. They have agreements with other carriers to provide a more complete solution as the customer needs.

Time Warner Telecom offers wavelength transport services under its Dedicated High Capacity service. It offers speeds of either 2.5 Gbps or 10 Gbps. This is available in a point-to-point configuration.[180]

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176 http://www.business.att.com/service_overview.jsp?repoid=Product&repoitem=w_wavelength&serv=w_wavelength&serv_port=w_data&serv_fam=w_local_data&state=California&segment=whole accessed August 5, 2008
177 http://www.globalcrossing.com/carrier/carrier_wavelength.aspx accessed August 6, 2008
178 http://www.integratelecom.com/products/private_networking/man.asp accessed August 6, 2008
179 http://www.qwest.com/largebusiness/enterprisesolutions/products/ethernet/qwave.html accessed August 5, 2008.
180 http://www.twtelecom.com/cust_solutions/services/ded_hi_capacity.html , accessed August 5, 2008

Verizon's Dedicated Wavelength Ring Service is a Layer 1 transport technology that allows protocol-independent transport over a single fiber pair and eliminates the need for layered networks. The ring architecture operates as a single network and allows easy addition and drop of channels at desired locations. Dedicated Wavelength Ring Service also supports a broad range of protocols, with bandwidths ranging from 8 Mbps to 10 Gbps. Verizon also offers different types of protection, depending on the customer's network needs.[181]

XO wavelength services support bandwidths of 1 Gbps Ethernet to 10 Gbps Ethernet or 2.5 Gbps to 10 Gbps (protocol-independent). The protocol-independent (XO Clear Channel) accommodates multiple protocols including Ethernet, Asynchronous Transfer Mode (ATM), Synchronous Optical Networking, and Frame Relay.[182]

8.4 Potential Competition for a Municipal Network

The following providers and services are likely to compete with any Fiber-to-the-Premises (FTTP) project that results from this initiative:

- **Internet Access:**
  AT&T
  Broadstripe
  Clearwire
  Comcast
  Dish Network
  EarthLink
  HughesNet
  Qwest
  Sprint
  Speakeasy
  Wild Blue

In addition to high-speed Internet providers (DSL and cable modem), another key source of Internet competition is national and local providers who offer low-priced dial-up services. Given the magnitude of a FTTP investment, competing on cost is difficult. To capture customers, a FTTP provider must demonstrate that a broadband connection will give the consumer better value.

Digital Subscriber Lines (DSL) and cable connections offer reliable and cost-effective Internet access. DSL and cable service are currently available in many locations.

T1, frame relay, and ISDN access is currently available in some areas. HughesNet and other satellite-based providers offer an Internet service that does not require a telephone line.

The use of WiFi[183] to deliver retail Internet services for the residential and small business markets has received much attention over the past three years. However, results have been disappointing. For example, EarthLink once viewed WiFi as a fundamental part of its strategy to move away from its status as a fledging Internet Service Provider business. The company's venture into WiFi was unsuccessful, and it is now liquidating all its WiFi investments.

[181] http://www.verizonbusiness.com/us/products/data/ring/#dwr accessed August 6, 2008
[182] http://www.xo.com/carrier/transport/Pages/wavelength.aspx accessed August 6, 2008
[183] Either privately or publicly owned.

Discussions regarding the use of WiMax have accelerated over the past year. Sprint is looking towards WiMax as a key to its next generation of mobile data products. WiMax does have the potential to deliver high-speed Internet access that would compete with cable and DSL. However, it is not a solution for organizations looking for the next level of speed and reliability.

- **High-Capacity Data Connection:**
  360 Networks
  Abovenet
  AireSpring
  AT&T
  Cross Stream
  Global Crossing
  Integra Telecom
  Level(3)
  Noel Comm.
  Paetec
  Qwest
  Silver Star Telecom
  Threshold Comm.
  TW Telecom
  Verizon
  WCI
  XO Comm.

There are 17 providers in Seattle offering high-capacity data services with bandwidths ranging from 100 Mbps to 40 Gbps as well as leasing dark fiber. The high-capacity providers offer dedicated and switched bandwidth services using technology such as Ethernet at 100 Mbps, 1000 Mbps or 10 Gbps, Coarse or Dense Wavelength Division Multiplexing and Synchronous Optical Networking Technology.

There are six providers offering dark fiber in Seattle, twelve providers offering Ethernet services both switched and dedicated, eleven providers offering wavelength services ranging from 1 Gbps to 40 Gbps wavelengths and sixteen providers offering Synchronous Optical Networking Technology services. Dark fiber is offered by lease either on a per month basis or for an Indefeasible Right-to-Use (IRU) term of 20 years.

Most of these providers are national and some are present internationally and offer local and long-distance services. Section 8.4 provides further details on each service product and the providers that offer each service product.

- **Local Telephone:**
  AT&T
  Broadstripe
  Comcast
  Earthlink
  Qwest
  Competitive Local Exchange Carriers
  VoIP Providers
  Wireless Providers

The incumbent telephone company is not the only competition for local telephone service. The capability and reliability of wireless services is increasing, and Personal Communications Service (PCS) providers have a long-term objective of becoming an alternative local telephone provider. Incumbent telephone providers have already seen a decrease in services due to wireless options. In 2005, wireless telephone usage surpassed traditional landline telephone service, and the number of users relying on wireless communication continues to grow. Today it is estimated that 20 percent of adults in the US do not have a traditional landline telephone and rely exclusively on a wireless or Internet connection.[184] This phenomenon is not limited to young people. More than half the adults who use a cell phone only are older than 30.

[184] The Harris Poll No. 36, April 4, 2008

To compete with Qwest and other competitive service providers, new market entrants will need to obtain a large local or low-cost call area, and telephone number portability will be essential. Otherwise, if a new entrant's local calling area is restricted to the City limits, the competition will have a perceived advantage. During the registration process and negotiation of interconnection agreements with the Incumbent Local Exchange Carriers (ILECs), newcomers will need to address issues related to the local call area and number portability. The bundling of local and long-distance telephone services, as well as wireless service in some areas, allows providers to become "one-stop" services for business and residential customers.

Many business and residential users are looking to new alternatives to traditional landline local telephone service. Alternative service providers, such as Vonage and Skype, provide voice services over the Internet. These VoIP offerings require a robust Internet connection and quality of service to provide adequate voice communications.

- **Cable Television/Video:** *Broadstripe* *Comcast* *Earthlink* *DBS (Dish Network and DirecTV)* *IP Video Providers (CinemaNow, Movielink, etc.)*

Broadstripe and Comcast each operate a two-way Hybrid Fiber Coaxial system. They offer a range of packages that include digital services, HDTV, movie channels, pay per view, and music. They also provide digital video recording (DVR), video on demand, and cable modem service. Broadstripe and Comcast cover different areas of Seattle and consumers do not have a choice between these providers. Direct Broadcast Satellite offers an alternative to traditional cable television. With a smaller dish than their predecessors, aesthetics are not as much of an issue as they were in the past. The cost of Direct Broadcast Satellite continues to decline. With digital quality, near video-on-demand, and Internet access, Direct Broadcast Satellite providers have substantially increased its share of the cable television and Internet markets. IP-based video programming competes with video on demand programming offered by traditional cable providers. This service is becoming more popular as a result of the flexibility and convenience it offers users.

IP-based services, such as CinemaNow and Movielink, offer movies and video programming that are downloaded from the Internet. These services allow customers to watch programming at times and places that are convenient for them using media that has Internet access. Cable television VOD programming does not have the mobility advantage that the IP-based service offers, because customers of cable VOD must watch the programming on a television connected to the cable system.