MUNICIPAL BROADBAND CASE STUDIES & BENCHMARKING ANALYSIS

Prepared For:
The City of Fort Collins
(Draft 3.0)

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Executive Summary

Through the City of Fort Collins' 2015 – 2016 Strategic Plan, the community has identified the importance of encouraging the development of reliable and cost-effective next generation broadband ("broadband") services. "Next generation" broadband services are becoming available in a number of cities across the country, including high profile communities like Chattanooga, Kansas City, Lafayette, and Lawrence. Early evidence suggests that next generation broadband services have a net positive economic and social impact to local economies, while enhancing a community's quality of life through expanded innovation opportunities, workforce development training, the narrowing of the digital and/or economic divide and improved organizational operation efficiencies.

The City of Fort Collins' 2015 – 2016 Strategic Plan Objective 3.11 encourages the development of reliable and cost-effective high-speed Internet services throughout the community. As the demand for more advanced, reliable and affordable broadband services rises, the City must define its ongoing role in ensuring access is provided. Employing research driven outcomes, Fort Collins is committed to maintaining and enhancing the quality of broadband services that currently exists.

Fort Collins is at the early stages of developing feasible broadband strategies for its community. As such, it should gain a thorough understanding of its available options by building knowledge of municipal broadband concepts, which includes a wide spectrum of broadband programs that local governments have implemented over the past 20 years. What has been learned over this period is that no single approach exists to replicate the success that some municipal providers have enjoyed. Each community is unique and each municipal broadband program must be tailored specifically to community needs, organizational capabilities and market environments.

Building knowledge around municipal broadband is important to ensure that Fort Collins creates a solid foundation of understanding as it evaluates its options. This report provides extensive information and insight from communities that have implemented broadband programs using a range of strategies and business models. It provides factual information on the success and failures of municipal broadband through an analysis of each organization, including case studies, analysis and benchmarking a range of business models used by these organizations. This information should support informed decision making by applying the information in this report to the City's evaluation of broadband strategies in its environment.

The core of this report focuses on the various municipal broadband business models that Fort Collins should consider, with insight into how other municipal providers have implemented them. Determining the right business model is key to the success or failure of a municipal broadband project. Selecting appropriate business models should be based on a number of factors, including the municipality's stage of broadband development, local environment, funding capacity, organizational capabilities and desired benefits to the community. Exploring all available options will help the City understand which business models may fit best within its current environment. This process will result in a range of feasible options for the City to consider in a context of varied risk and reward. Figure 1 provides a high-level summary of the common business models used by municipalities.

Figure 1: Summary of Municipal Broadband Business Model Options

Business Model	Description	Examples	Summary
Public Policy Only	• City uses policy tools and standards to streamline construction and reduce the cost of building infrastructure.	• Santa Cruz County, CA • Knoxville, TN	• Low risk/reward option to support incentives to accelerate broadband investment but no "quick wins" to improve services.
Infrastructure Provider	• City provides conduit and/or dark fiber to businesses, broadband providers and other public organizations • City does not provide retail services	• Santa Monica, CA • Palo Alto, CA • Lakeland, FL	• Improves the cost and availability of fiber infrastructure to providers, businesses and community organizations, not generally used for residential.
Public Services Provider	• City financed or shared financing with other public organizations • Dark fiber or data services to community organizations • Sometimes retail services provided by the City to these organizations	• Seminole County, FL • Leesburg, FL • Columbia County, GA	• Improves the cost, access and collaboration among public organizations without forcing the City to compete with private broadband providers.
Open Access Provider	• City financed and operated • Wholesale services only to retail broadband providers • Retail providers deliver Internet, telephone and other services	• Palm Coast, FL • Danville, VA • Provo, UT	• Enables more competition and choice but difficult to incentivize broadband providers to use municipal infrastructure.
Municipal Retail – Business Only	• City financed and operated • Fiber services • Internet and often telephone and data services to businesses	• Fort Pierce, FL • Hudson, OH	• Enables City to directly improve services to businesses but requires the City to compete with broadband providers and operate the network.
Municipal Retail - Residential	• City financed and operated • Fiber and sometimes cable services • Internet and often television and telephone to residents and businesses	• Bristol, VA • Morristown, TN • Ashland, OR	• Enables City to provide a major improvement to residential services but requires significant investment and operational capabilities.

Equally important to these business models is the path that local governments have taken to implement them. In many cases, municipal broadband networks have been forged over many years to become what they are today. Cities such as Bristol, Morristown and Palo Alto did not develop their gigabit fiber networks in one iteration; their initial networks grew over time from small networks supporting specific municipal needs into the some of the most robust broadband networks in the country. Fort Collins should also consider the most feasible path to achieve its broadband goals.

Lessons learned from other municipalities will help the City avoid common pitfalls and help it craft broadband strategies that have demonstrated success elsewhere. Although the City's strategy must be unique to its community, certain truths are consistent across these initiatives, as stated by many of the cities analyzed through this study.

Paraphrasing these statements, these themes emerge:

- Moving too quickly can be as risky as moving too slowly to achieve broadband goals, cities should take measured steps to ensure their strategies are well planned and executed.
- Cities should consider broadband networks as long-term infrastructure programs similar to road, water and sewer systems as opposed to one-time projects.
- Cities should gain strong local support from their stakeholders through an understanding of local broadband needs and opportunities.
- Cities should focus on the benefits of municipal broadband rather than the technologies to ensure that their communities gain a clear understanding of the objectives of the programs.
- Municipal broadband initiatives generally require a careful balance of community benefit and financial sustainability to remain successful over the long-term.
- Cities should focus on their strengths when evaluating options for municipal broadband and find solutions that build on current competencies; where cities do not have these competencies, they should consider public and private partnerships to meet the needs.

As home to over 150,000 residents and the state's second largest public university, Fort Collins began as a hub for agriculture, namely sugar beet production. As its population grew, especially into the latter half of the 20th century, the City shifted its focus from an agriculture-based economy to a high-tech economy. Enabling this transformation is Colorado State University, which stands today as the City's largest employer at almost 7,000 employees with an enrollment of 22,000 students each academic year. As such, the city boasts facilities for some of the world's most recognizable names in research and technology, including Intel, AMD, Hewlett Packard, and National Semiconductor.

This economic diversity enabled Fort Collins to weather the Great Recession better than most Colorado cities and much better on average than the US.[1] Further, growing trends in clean energy, bioscience and agri-tech businesses hold promise for Fort Collins to continue economic growth, with

[1] http://fortcollinsworks.com/wp-content/uploads/2013/03/2012-Primary-Employment-UpdateFINAL.pdf

a projected 2.3% annual employment growth through 2020. This remarkable trajectory landed Fort Collins at #10 on the 2015 list of "Best Places for Business and Careers" by Forbes Magazine.[2]

With the solid economic foundation of corporate and university resources in place and a national economy on the mend, there is an extraordinary anticipated future for Fort Collins. With strong educational capacity and an impressive outlook for employment growth, the City now has the propensity to pursue innovative programs such as community broadband to further enable opportunities for innovation among its residents.

This report is designed to help Fort Collins evaluate the approaches other municipalities have utilized along with the best practices, policy decisions, and challenges they have encountered along the way. There is no right or wrong approach to municipal broadband, each approach simply has varying degrees of risk and reward. However, some similarities exist between Fort Collins and other cities examined in this report. The City should use these examples to learn about the community attributes that influenced their decision-making and apply this knowledge to the City's broadband approach.

Population size, density and demographics are important market factors that influence the direction cities take in considering municipal broadband options. This is particularly the case for cities that provide retail services because the larger the population and density, the more difficulty a municipal retail provider will encounter when entering the market. This is not exclusive to municipal retail providers; the same is true for private broadband providers trying to enter an existing mature broadband market. Competitive forces, deeply entrenched incumbents and high costs for broadband construction often create an unattractive business case for new entrants and municipalities alike.

These are key reasons why so few larger cities have seen municipal retail providers emerge. Of the 50 plus municipal retail providers operating today, the only two that operate in larger cities are Chattanooga, TN with a population of 173,000, and Lafayette, LA with a population of 124,276. The majority of the remaining providers operate in communities under 100,000 in population. A few of these include:

- Longmont, CO – 90,237
- Wilson, NC – 49,628
- Cedar Falls, IA – 40,566
- Morristown, TN – 29,329
- Thomasville, GA – 18,718 (28,000 total service area)
- Bristol, VA – 17,341
- Indianola, IA – 15,106

Population is an important factor for the City to consider as it evaluates the feasibility of various broadband approaches. With a population of 156,480,[3] Fort Collins is larger than most cities that have implemented municipal retail broadband programs.

For cities that have chosen a municipal retail option, market uptake is key. A residential market uptake of 40% is an emerging metric that measures the general financial sustainability of municipal retail

[2] http://www.forbes.com/best-places-for-business/list
[3] US Census 2014 estimate

(fiber to the home) projects. Although this varies somewhat among markets, a number of municipal retail providers that are in a mature stage have reached this goal, as follows:

- Chattanooga, TN – 50%
- Cedar Falls, IA – 87%
- Morristown, TN – 39.7% (.3% below)
- Bristol, VA – 76%
- Indianola, IA – 54%

For cities that have chosen routes other than municipal retail, a number of options have emerged to enable municipal participation in local broadband. Large and small cities alike utilize their fiber, conduit and wireless infrastructure to address a number of broadband issues, from improving access to local anchor organizations such as schools and hospitals, to equipping local businesses with enhanced broadband services to enabling broadband providers to reach more communities.

In these cases, municipalities use a wide variety of approaches and business models to support local broadband expansion. Many of these options are less structured than the municipal retail model and are more variable in the attributes of cities that utilize these options. Commonalities such as population size, density and demographics are not good profilers of the cities that implement these options. However, certain attributes do exist that contribute to a positive environment for municipal broadband, including:

- An environment that have seen consistent urban development
- The presence of community colleges, technical schools and universities
- A population exhibiting high education levels
- The presence of a municipal electric utility
- The availability of municipal fiber, conduit, pole line infrastructure and towers
- An engaged voter constituency

These features are shared by many municipalities that have engaged in municipal broadband programs. The City should consider these factors and a range of community attributes that may be important for consideration of municipal broadband programs. Figure 2 on the following page illustrates the attributes that Fort Collins possesses that are similar to other cities that have developed municipal broadband programs.

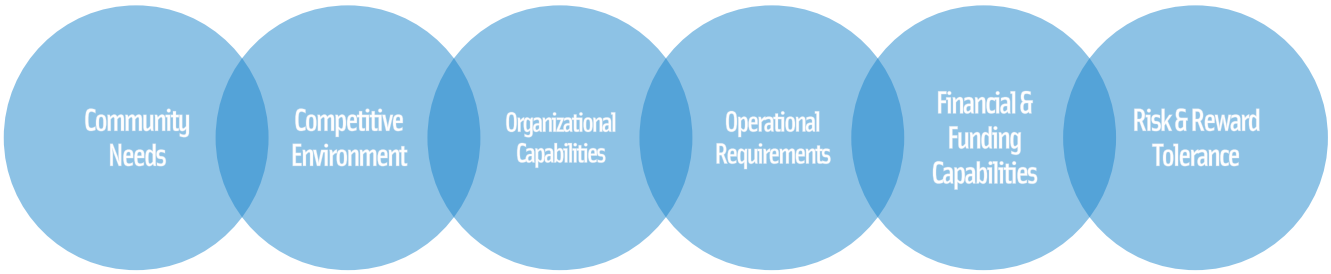
Figure 2: Community Attributes Common in Cities Participating in Municipal Broadband

Fort Collins' Community Attributes	Commonalities	Case Study Examples	Other Examples
Rapidly urbanizing	Cities with significant growth use special development programs to incentivize broadband development.	• Palm Coast, FL • Seminole County, FL	• Burbank, CA • Lakeland, FL
Home to Colorado State University	A high percentage of university communities have developed municipal broadband initiatives.	• Palo Alto, CA • Santa Monica, CA • Lakeland, FL	• Columbia, MO • Davis, CA • Riverside, CA • Westerville, OH
Highly educated with 51.9% of the population with 4+ years of college	High education levels lead to high subscribership, adoption and relevance levels in communities. These are important precursors to municipal broadband projects.	• Palo Alto, CA • Hudson, OH	• Boulder, CO • Centennial, CO • Gainesville, FL • Missoula, MT
Outstanding public school system	School systems that lead in technology programs are often enabled by municipal broadband providers in their communities.	• Palm Coast, FL • Palo Alto, CA • Santa Monica, CA	• Columbia, MO • Blacksburg, VA • Burbank, CA
City provides electric and water utilities	Many cities that own municipal electric utilities have enacted municipal broadband projects. Their competencies in providing critical services to their communities makes them good candidates to consider municipal broadband.	• Palo Alto, CA • Lakeland, FL • Fort Pierce, FL • Danville, VA • Morristown, TN	• Cedar Falls, IA • Waverly, IA • Lafayette, LA • Chattanooga, TN
Engaged in voter-approved community improvements	Progressive cities have made broadband infrastructure projects part of their capital improvement programs.	• Hudson, OH • Columbia County, GA • Danville, VA	• Hamilton, OH • Wilson, NC

1. Introduction

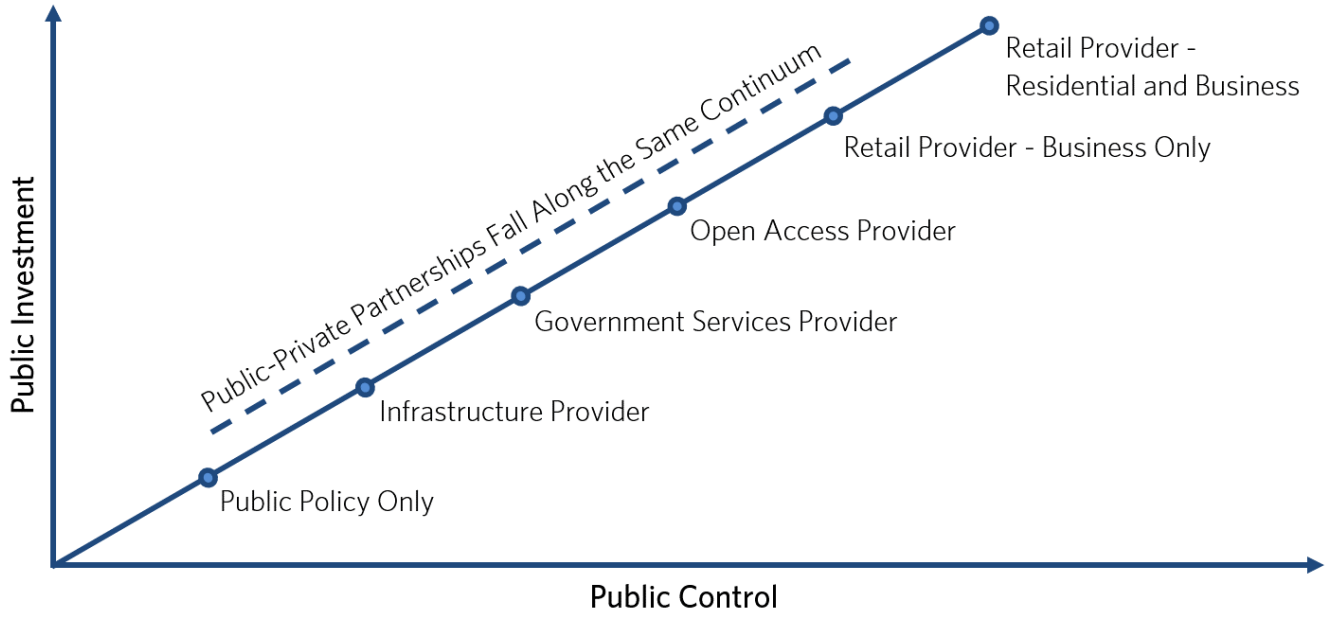
Local governments must analyze a number of factors to determine the right broadband business model to effectively meet community needs. The ability to understand the dynamics around each of these factors will dictate the most appropriate business model for a municipal broadband effort to organize and develop. An understanding of the community needs, knowledge of the competitive market and determining organizational and operational capabilities all play into the selection process. Equally important is an understanding of the financial commitments and risk and reward factors that participating organizations are willing to commit in order to fund and sustain a successful broadband initiative.

Figure 3: Inputs to Selecting the Right Broadband Business Model



Commonly implemented business models fall on a continuum that ranges from low risk, low investment options to high risk, high investment options. As a local government evaluates the various business model options along the continuum, it will encounter greater degrees of risk and reward. The risks are often in terms of financial, operational, and regulatory risk. The rewards are in terms of community benefits, revenue generation, and growth potential.

Figure 4: Continuum of Municipal Broadband Business Models



Moving "up" and along the continuum implies greater local government participation in the delivery of broadband services. Models that provide only public policy support or provide only infrastructure are considered "passive" business models, whereby the government does not operate the broadband network. Business models that provide a public service, function as open access, or have the goal of providing retail service to residents and business all indicate the municipality actively operates a broadband network. Public-private partnerships fall along the continuum because unique partnerships take many forms and with responsibilities that vary among partners and situations.

Municipalities must determine which business models satisfy their risk/reward tolerance to achieve the community's broadband goals. Figure 5 on the follow page describes the key features of each broadband business model in practice today. There are variations on each business model but they generally fall into the categories below.

In some cases, an organization may select multiple options to achieve their goals, while in other cases a local government will not utilize multiple models, as they may conflict with one another. For example, local governments generally utilize public policy with any of the business models, as the policies implemented by a local government will complement the other chosen business model. Conversely, a local government would not likely implement a retail model and public-private partnerships together, as these would lead to competition between the local government and one or more private partners.

This report describes each of the prevailing municipal broadband business models and provides case study examples of municipalities that have implemented them to varying degrees of success. This report is structured to provide a comprehensive knowledge base on municipal broadband, providers, business models, and relevant anecdotal and quantitative data.

The report is broken up into sections, with Section 1 introducing the range of municipal broadband business models used by local governments today, and Sections 2-8 providing a description of each business model and a summary of the case study information for local governments that have implemented the model.

Each section contains varying degrees of specificity, content, benchmarking data and case study information, based on the information that was gathered by the project team. Some business models have little or no financial information, including those where active investment in broadband is either limited or non-existent; this is the case for the "public policy" option and public-private partnerships. In some cases, benchmarking data is also limited or less detailed than in other models, which was dependent on the amount of detail the project team was able to receive.

Discussion around the services, rates, markets, organizational features, and financial profiles is provided, and any relevant benchmarking and industry trend data is incorporated. Following this information are detailed case studies for each business model, providing detailed accounts of the municipalities that have implemented them.

Figure 5: Comparison of Municipal Broadband Business Models

	Public Policy Only	Infrastructure Only	Public-Private Partnership	Public Services Provider	Open Access Wholesale	Retail Provider - Business Only	Retail Provider - Residential and Business
Services Provided	None	Dark Fiber Only	None	Dark Fiber, Transport, Internet, Phone	Transport	Internet and Phone	Internet, TV, Phone, Value-Added Services
Customers	None	Broadband Providers	None	Public Organizations Only	Broadband Providers	Businesses	Businesses and Residents
Funding Required	Low	Moderate	Low to High	Moderate	Moderate	High	High
Competing with Service Providers	No	No	No	No	No	Yes	Yes
Operational Requirements	Low	Low	Low	Low	Moderate	High	Very High
Regulatory Requirements	Low	Low	Low to High	Low	Moderate	High	Very High
Revenue Generation	Low	Low	Low to High	Low	Moderate	High	Very High
Operational Costs	Low	Low	Low	Low	Moderate	High	Very High
Financial Risk	Low	Low	Low	Low	Moderate	High	Very High
Execution Risk	Low	Low	Moderate	Low	Moderate	High	Very High

[1] Funding required equals total capital costs plus ongoing requirements.

2. Public Policy Only

2.1 Overview

This option is not considered a true business model, but does impact the local broadband environment and is therefore included as one option. Rather than a business model, this option provides policy direction to local governments interested in fostering the development of broadband in their communities, without moving into an active program of building infrastructure. Local governments also enact these policies in conjunction with other business models.

The municipality utilizes its public policy tools to influence how broadband services are likely to develop in its community. Public policies and local ordinances are shaped to streamline the processes of designing, constructing and managing broadband infrastructure in a local government's jurisdiction. Focus areas include right of way access, permitting processes and costs, construction practices and placement methods, and franchises and utility fee assessments.

Many local governments have also established "broadband standards" that provide engineering specifications for installing infrastructure in public right of way. These standards also establish policies for joint trenching that enable various organizations to cooperatively utilize a single open trench that has been dug for installation of utility or broadband infrastructure. Joint trenching and "dig once" policies are not simple to execute and often times take significant coordination between utility and broadband providers. These agreements are often executed on a per-project basis rather than as blanket agreements between public and private organizations.

More effective public policy standards set requirements for the incorporation of broadband infrastructure into an organization's capital projects. Many municipalities have embedded broadband development standards into their land development record to ensure that underground conduit is installed with any applicable capital projects. These include utility relocations that result from road widenings, water/sewer installations and lighting projects. Underground conduit simply becomes part of the design process for the capital project, ensuring that the infrastructure is incorporated as part of the project, rather than an afterthought that may often be overlooked.

To be effective, these standards require a funding mechanism to ensure that there are monies available for the added design, labor and materials needed for installing underground conduit coincident with the capital projects. Budgeting for this fund is best accomplished by analyzing the local government's capital project plan over a multi-year period and determining which projects present opportunities to install conduit. Costs for the design, labor and materials to install underground conduit can be determined through local construction contractor rates, discounting construction costs by a percentage that is saved through use of the open trench already utilized in the project.

2.2 Public Policy Case Studies

2.2.1 Santa Cruz County, California

Community Profile

Santa Cruz County is known for its moderate climate, the natural beauty of its coastline and redwood forests, as well as its alternative community lifestyles and socially liberal leanings. It is also home to the University of California, Santa Cruz, a premier research institution and educational hub, as well as the Santa Cruz Beach Boardwalk, an oceanfront amusement park operating continuously since 1907. The county's population is approximately 262,000 and the City of Santa Cruz population is approximately 62,000.

Development of Broadband-Friendly Policies

The Santa Cruz County board of supervisors in November 2013 approved an eight-month timeline to overhaul its broadband infrastructure plans and regulations. Specific areas of focus include permitting fee reductions and a proposed "dig once" ordinance that would make it easier to install new fiber-optic cables during other work on area roads or utilities lanes.

The County continues a focus on broadband infrastructure throughout the county to enable businesses to function in the digital era, and students and households to have high quality access to information and communication. The county works with industry providers to develop a Broadband Master Plan in order to identify focus areas within the county that will be most suitable for gigabit services, particularly as the Sunesys backbone is constructed during 2014 and 2015 (Sunesys provides fiber connectivity to schools within Santa Cruz County). Through this, the County works with last mile service providers to ensure that these focus areas are deemed a priority, in order to support streaming requirements, product development, job creation and online selling capability."

Zach Friend, Santa Cruz County Supervisor, said, "Many regions throughout the country face a situation similar to ours: deemed too rural for real capital investment by the Internet Service Providers but urban enough that this lack of investment really puts us at an economic and community disadvantage. To have these policies recognized at a national level shows their applicability and value throughout the country." County departments had one-on-one meetings with service providers, including AT&T, who applauded the efforts of the County.

Implementation of Broadband-Friendly Policies

The initiatives were crafted together into a comprehensive set of policies:

- A "dig once" process that requires notification and an opportunity for broadband companies to join in whenever a street is cut open.
- Development of master lease agreements to simplify access to county facilities.
- Including conduit as part of public works projects, new developments, and land divisions
- Treating broadband projects like any other utility, subject only to a technical and safety review by county engineers.

That last measure produced a surprised and delighted gasp from Laurie Miller, AT&T's director of construction and engineering, who deals daily with the complicated and time consuming approval process that is otherwise typical in California. "It doesn't have to be baby steps," Miller told the roundtable audience. "I encourage you to be aggressive and forward thinking."

The County's policies have been established since 2014. Key action items that were implemented during the process include:

- Allow the installation of equipment within public right of ways, subject only to "time, place and manner" of access, through the County's encroachment permit process.
- Streamline the application process and ensure permit fees are based on actual costs.
- Draft amendments to County regulations that facilitate the deployment of broadband technology.
- Work with broadband providers on economic development opportunities.
- Work with utility companies on their financing and installation of conduit as part of municipal projects.
- Draft an ordinance based on the San Francisco "dig once" model.

Impact to the Community

As the policy changes have only been recently codified in Santa Cruz County, their impact remains to be seen in the coming years. The County and City of Santa Cruz have embarked on a broadband master planning process to determine the most feasible ways to expand broadband within their communities, for which the policy tools will become a contributing factor. The County is already assessing opportunities to install broadband infrastructure with companion projects by evaluating its capital project program over the next 10 years.

Challenges

The key challenges to policy development and implementation relate to internal departments working together and communicating the gaps or shortcomings in current practices and policies. With a better understanding of overlapping or interdependent responsibilities, policies can be improved. For example, if broadband standards enable municipal stakeholders to install conduit with companion capital projects, it will need coordination from many municipal departments, local utilities, and even the local property development community. In addition, changes often come with an associated cost, so the municipality will also need to establish a fund to financially assist the early adoption of certain policies. Water and sewer projects will need to include infrastructure that may create issues with public works requiring separation between conduit and water and sewer assets. Part of the challenge in working together is learning the domain of broadband infrastructure, and how broadband works with other infrastructure, and this process simply takes time.

2.2.2 Knoxville, Tennessee

Community Profile

Knoxville is located in east Tennessee, along the Tennessee River basin created by the foothills of the Appalachian Mountains to the east and the Cumberland Plateau to the west. The city's population is around 180,000, with 1.1 million in the metropolitan area, ranking it as the 64th largest MSA in the country. Knoxville is within a day's drive for nearly half (49.4%) of the US population, ranking it sixth among metro areas (the top five are in Ohio) with the largest population base within a day's drive.

Home to the University of Tennessee, a top-rated Carnegie research institution and educational hub, and the US Department of Energy's Oak Ridge National Lab, Knoxville serves as regional gateway to the Great Smoky Mountains National Park, the most visited national park in North America with more than 10 million annual visitors.

Knoxville is located 100 miles northeast of Chattanooga and its well-known fiber-optic network. About 100 miles to the northeast of Knoxville is Bristol, Virginia, which has also seen significant job gains as a result of Bristol Virginia Utilities Authority's publicly owned fiber-optic network that stretches into southwestern Virginia.

Development of Broadband-Friendly Policies

There is no municipal network in Knoxville or even a broadband development plan or formal broadband policy in place. The prevailing opinion of city leadership is that when demand exists in Knoxville that service providers will grow to meet that demand. In other words, the city's strategy is a hands off approach – let consumers and service providers find each other. The downtown coordinator on the Knoxville Mayor's staff says, "If [service providers] call us, we can be encouraging of them to come to our market and take a look at it."[4]

The Knoxville Utilities Board (KUB) provides electric, gas, water, and wastewater services to customers in Knoxville and parts of seven surrounding counties. KUB is governed by a seven-member board, who each serve seven-years terms and are appointed by the Mayor and confirmed by Knoxville City Council. The KUB has long maintained the position that their mission is to serve Knoxville with traditional utilities, and that telecommunications has no place at an electric and water utility. The KUB recently revisited the topic of becoming a broadband service provider, but the issue was quickly dismissed.[5]

Implementation of Broadband-Friendly Policies

While not wanting to get into the broadband business directly, city officials do recognize the importance of broadband to the economy and a modern quality of life, and say they are more than accommodating when service providers want to expand infrastructure. Further, the city does

[4] http://electronicstaff.com/2013/downtown-knoxvilles-broadband-internet-access-kinda-sucks-can-it-be-fixed
[5] http://muninetworks.org/content/knoxville-news-station-envious-chattanooga-fiber-network

acknowledge the prohibitive cost involved when installing new fiber, so there is talk of codifying a "dig once" ordinance that would require installation of fiber-optic cables or conduit during construction phases of roads and developments when ground is open.

Further, should a provider want access to existing underground conduit, the city and KUB claim they do all they can to assist. When surface roads are opened for construction, the city and KUB reportedly reach out to service providers to let them know that ground will be open during a given period and that arrangements can be made to install conduit or blow fiber should the provider desire.

Impact to the Community

Downtown Knoxville's network infrastructure is comprised of an inconsistent patchwork of AT&T DSL, Comcast and a very limited amount of private provider fiber optics. Some areas of downtown have no access, while others have no choices.[6] In areas of the city outside of downtown, a similar patchwork of infrastructure and limited choice in providers exist.

While several providers exist in Knoxville, one would think the city is well served with choices of providers in a healthy and competitive market. However, seldom do service provider coverage areas overlap, and as a result, residents and businesses are left with few choices. As a result, Knoxville residents and businesses pay more for less bandwidth.

City leaders have been quoted in local media as saying they do not believe their broadband policy has deterred any businesses from locating in Knoxville.[7] The City believes that existing service providers are able to meet broadband demand as the demand is generated. However, the local NBC affiliate, WBIR, archives examples of companies that deliberately chose to expand to Chattanooga rather than Knoxville specifically because of the lack of Internet access.[8]

Challenges

While the city tries to encourage downtown commerce with tax credits for developers and a new entrepreneur center, critical broadband connections are missing. City officials say the downtown area has a limited amount of aging conduit that is discouraging private providers and is cost prohibitive to expand. Likewise, old buildings with substandard internal wiring further discourage investment from private companies

[6] http://insideofknoxville.com/2013/04/broadband-in-downtown-knoxville-reality-for-some-dream-for-others
[7] http://muninetworks.org/content/knoxville-downtown-wondering-where-all-broadband
[8] http://archive.wbir.com/news/article/197475/2/Chattanooga-fiber-optic-network-attracts-Knoxville-business-expansion

2.3 Public Policy Considerations for Fort Collins

Organizational & Operational	• Passive model of broadband expansion only, no active participation • Tied to City's development programs only, no additional staffing required • Requires the coordination of multiple departments to implement policy ordinances and follow them • Requires oversight and management of the policies to ensure they are being followed • Requires the City to track infrastructure as it is being added to capital projects
Competitive Environment	• The City does not participate in the competitive environment • Infrastructure can be utilized across a number of business models • All "active" business models are available for the City to consider
Political Environment	• Ordinance changes of this type are generally not politically sensitive • Use City's capabilities to improve the broadband environment without committing to "getting into" the business • Ordinances that impact developer costs may be unpopular with developers
Funding Environment	• Lower funding requirements than all other business model options • Funding is only needed to pay for conduit and fiber included with companion capital projects, as needed • Funding should be allocated to ensure a budget is available for new infrastructure
Community Benefits	• Improve the broadband environment gradually without any downside risk to the City • Leverage public policy tools to make the City and providers more efficient and reduce the cost of building broadband infrastructure

3. Infrastructure Provider

3.1 Overview

Cities that provide conduit and dark fiber services to local organizations are generally considered infrastructure providers. They lease these assets to community organizations, businesses and broadband providers. These organizations use municipal fiber to connect to one another and to data centers to reach the Internet, cloud services and other content networks. Many municipal providers who have deployed these services began by building their own fiber networks to serve purely municipal functions. As their networks grew, they realized that these networks could provide access to local organizations needing fiber connectivity.

Cities that lease conduit and dark fiber services generally do not provide any retail services over this infrastructure. Dark fiber connections are either leased directly by businesses needing to connect multiple local offices to one another or to connect a local office to a local data center, where the business can purchase Internet services and other content. In other cases, cities partner with broadband providers who market and sell their services to customers and use municipal fiber to connect these customers to their networks. Municipal fiber networks generally become the "last mile" between a provider's local point of presence and the end customers.

Many cities have seen success in leasing dark fiber to the small and medium business (SMB) market. Since SMBs represent the largest segment of commercial businesses in most cities and contribute significantly to overall GDP, cities focus their fiber products on this market segment. Often SMBs want fiber broadband but cannot afford it. Cities have used their municipal networks to enable SMBs to purchase an affordably priced fiber product.

Cities differ on their policies for dark fiber access. Some cities require customers to pay the upfront costs of the fiber construction to reach their facilities and levy a smaller monthly operational charge to manage the fiber connection. Other cities will finance the cost of the fiber construction and charge the customer a higher monthly fee that includes the amortized amount of the fiber construction, spread over a period of several years. Many cities have realized that financing the fiber construction leads to higher uptake of their services by SMBs in the local market. Generally, an SMB cannot afford the upfront cost of the fiber construction so a city will develop a pricing policy for its fiber service that recoups the investment over the term of the contract. In some cases, the City will take a bet on a longer payback of the fiber construction costs simply to ensure that the SMB is able to afford the service. Cities realize the economic development value of getting their businesses connected to fiber is an important factor to consider along with the payback on their investment.

3.2 Services and Rates

Dark fiber is the core product of most infrastructure providers. In some cases, they also offer conduit; however, conduit is generally utilized by wholesale providers or utility companies. Dark fiber is generally utilized by businesses, community anchor organizations and in a few cases residents. In the most common case, municipalities lease dark fiber strands using mileage-based pricing. Pricing

depends on the amount of new fiber that must be constructed to the customer. Leasing existing fibers on a municipal network will not incur construction costs for the municipality, resulting in a simple mileage-based price calculation to the end user. However, in most cases, customers will require new construction to reach their facilities, resulting in construction costs to be incurred by the municipality and which will be charged back to customers to allow the municipality to recoup its investment. Several pricing models exist for municipal dark fiber services:

Dark Fiber Leasing

Dark fiber is leased on a monthly basis for the number of strand miles utilized, including existing strand miles and newly constructed strand miles. A strand mile is a single strand of fiber optic cable over a linear mile in the network. The lease rate calculation for the existing fiber under lease is generally a formula that accounts for the total cost of the network plus ongoing maintenance divided by the number of strand miles available for leasing. New construction costs to extend the network to the customer's location are factored into this calculation as well. Some municipalities charge this cost upfront, others will amortize it over time and include it in the lease. For example, illustrates the City of Palo Alto Utilities' most recent dark fiber pricing policies, which has two pricing components, (1) pricing for dark fiber backbone license fees, and (2) pricing for drop and custom cable management fees:

Figure 6: City of Palo Alto Utilities Dark Fiber Pricing Policies

C. FEES:

1. DARK FIBER BACKBONE LICENSE FEES:

The values or ranges for each of these price components are shown below:

(1) Price for first fiber on public agency project routes may range between…… $213-$362/mile/month
  a. Additional fibers used in the project on same route, per each $142.00/mile/month
(2) Price for first fiber on non-public agency project routes may range between…. $250-$425/mile/month
  a. Additional fibers used in the project on same route, per each $166.67/mile/month

2. DROP AND CUSTOM CABLE MANAGEMENT FEES:

Customer responsibilities and fees for drop and custom cable construction are described in the CPAU Rules and Regulations, Rate Schedule EDF-2, project proposals and other associated documents. In all cases, the Licensee shall also pay the applicable Drop or Custom Cable Management Fees based on the following:

(1) Drop Cable Management Fees for public agencies (per 12 fiber drop)…… $179-$213/mile/month
(2) Drop Cable Management Fees for non-public agencies (per 12 fiber drop)…… $210-$250/mile/month
(3) Custom Cable Management Fees (first 12 fiber cable on a project route) $0.25/ft/month
(4) Custom Cable Management Fees (per additional 12 fiber cable on a project route)…….. $0.05/ft/month

Indefeasible Rights of Use

An Indefeasible Rights of Use (IRU) is a capital lease of dark fiber. Instead of a monthly lease pricing model, an IRU requires a single upfront payment for the term of the lease plus an ongoing operations and maintenance fee for the use of the fiber. IRUs are not generally used when providing dark fiber to commercial customers or community anchor organizations. An IRU is a telecom-pricing model that is generally used between wholesale carriers, and as such, municipalities generally enter into these

transactions with broadband providers. Broadband providers favor IRUs because their capital leasing structure allows them to record these leases as assets on their balance sheet rather than operating expenses on their income statements. illustrates IRU rates from a range of municipal providers.

Figure 7: Dark fiber Leasing and IRU Benchmarked Rates

	State	Monthly Lease Rate	20 Year IRU Rate	IRU Annual Maintenance Fee
City of Lakeland	FL	$100		
City of Bartow	FL	$125		
Eugene Water & Electric Board	OR	$21		
Palo Alto Utilities	CA	$336		
Springfield Utility Board	OR	$16		
City of Holly Springs	NC	$50	$1,000	$250
City of Rock Falls	IL	$100	$1,100	$200
City of Gillette	WY		$12,000	$500
Black Rock Cable	WA		$1,898	$12
UC2B Champaign	IL		$1,500	$300

3.3 Market Penetration

Market penetration among infrastructure providers is challenging to determine due to the varied geographic coverage of each provider's networks in their respective cities. The two providers evaluated in this study reported connecting over 100 businesses to their networks over a period of ten years. Although this represents only a small percentage of their respective markets, the cities' goals were not to achieve a certain market penetration. Instead, their goals were to supply local organizations with fiber connectivity that required it.

In each case, the cities expanded their network "on demand" in areas where there was a high probability of achieving uptake. Rather than incurring sunk costs by deploying large networks ahead of demand, they marketed their services in areas that were in close proximity to existing fiber and waited for customers to sign up prior to building out further. This incremental approach allowed them to deploy capital only with new revenue opportunities that would enable the cities to recoup their investment. For this reason, it is difficult to measure the penetration of these providers' services in their local markets.

3.4 Organizational Profiles

Infrastructure providers generally have developed their fiber networks in conjunction with municipal electric utilities, which has allowed them to develop an initial inventory of dark fiber. In many cases, these providers have begun their dark fiber leasing programs using the existing stock of available

fiber and have grown into a formalized program of extending their networks for commercial purposes. Some examples demonstrate how municipalities have developed their dark fiber networks over time:

The City of Bartow, FL began expanding the dark fiber network that serves its electric utility substations to also include County and school district facilities in 2009. Today the majority of Polk County School sites are connected to the network, providing direct gigabit dark fiber connectivity to 12 schools in the Bartow area. In addition, ten County facilities are connected to the City's network as well as several public safety functions and other electric utility sites. The City maintains its dark fiber program under the electric utility enterprise fund. Today the Information Technology department manages the fiber system and all services connected with it. The City uses shared resources from Electric and Information Technology departments to manage the network, consisting of 3-4 full time equivalents that are allocated to fiber services.

The City of Rock Falls, IL maintains a dark fiber network that connects its electric utility substations to one another throughout the town. The City leases a portion of its available capacity to competitive providers in town to reach local businesses and community organizations. The City provides Indefeasible Rights of Use agreements to competitive providers for long-term capital leases of its infrastructure. The Electric Utility department manages the dark fiber network and all customers connected to it.

The City of Hamilton, OH owns an extensive 80-mile dark fiber network connecting municipal facilities and electric utility assets throughout town. The City's Information Technology department manages active services on the network while the electric department manages the physical fiber. Hamilton recently began a dark fiber leasing program that has attracted multiple providers to the area to use its network. The City also recently extended its network to connect three local schools, and developed a partnership with a new provider to serve local businesses, technology incubators, and business districts through a dark fiber expansion program.

3.5 Infrastructure Provider Considerations for Fort Collins

Organizational & Operational	• Electric utilities like Fort Collins are well positioned to use an infrastructure provider model • They have operational capabilities to finance, expand and manage these networks, in an incremental approach • Staffing and resource management is key to ensuring capabilities meet demand for services • Must be able to meet provider service level agreements or supplement O&M with outside fiber contractors
Competitive Environment	• Cities become enablers of competition by introducing a new source of fiber to markets, rather than competing directly • Cities become "market makers," by introducing a competitively priced fiber product that isn't available in current markets • Cities must cooperate with providers to ensure they use municipal networks; recruitment and incentives are important for "buy in" • Focused heavily on bringing fiber to businesses and community organizations
Political Environment	• Strong focus on economic development creates a popular public opinion • Cities remain out of the competitive environment: they enable competition by allowing any qualified provider to use municipal fiber resources
Funding Environment	• Incremental funding is a popular way to expand on existing municipal fiber networks • Strategic build outs in business parks and corridors applies funding to specific projects rather than citywide • Cities vary their payback window to positively influence the pricing for services; longer paybacks equal lower prices to businesses
Community Benefits	• Large improvements in affordability of fiber broadband services • New fiber-based business Internet products that did not exist in the current market • Expanded choices for local businesses

3.6 Infrastructure Provider Case Studies

3.6.1 Santa Monica, California

Community Overview

The City of Santa Monica is a beachfront city in Los Angeles County, California. Santa Monica is home to approximately 91,812 people across 8.3 square miles, giving it a population density of 10,662 people per square mile. The city has approximately 50,192 households with a median household income of $71,400. With a mild and agreeable climate, Santa Monica has long been a resort town and home to many people involved with the Hollywood entertainment industry. The city has experienced a boom since the 1990s with the revitalization of its downtown core, along with significant job growth and increased tourism.

The City of Santa Monica has grown its fiber business steadily over the past 5 years and in conjunction with technology programs that reduce costs for the government itself. Connecting community anchors provided Santa Monica valuable anchor tenants that helped build the business case for its fiber expansions. The City accommodated future investments in its network by setting a policy that reinvested any excess revenues and savings that the network generated back into expanding the network. The City successfully markets its fiber services in Santa Monica and provides a list of "lit buildings" where fiber connections are available.

Development of the Initial Network

In 2002, when the City renewed its franchise with the local cable provider, it also included as a provision to the agreement a lease of fiber-optic network capacity to connect 43 city sites and a variety of school and community college sites. The City paid upfront construction costs of $530,000 and shared the ongoing costs of the network with the schools and community college. These organizations saved a combined $400,000 in annual telecommunications costs, which grew to $500,000 over several years.

The savings were used as seed capital for the development of the City's own fiber-optic network. The City invested in fiber connectivity and 10 Gigabit networking equipment to power the network. The City expanded its own fiber to connect traffic signals, surveillance cameras, smart signs and other municipal applications to the network. As the network grew, the City built fiber into local data centers for its own Internet connectivity needs, but this quickly became a resource that created demand for business connectivity using Santa Monica's fiber.

Development of Broadband Services

The City began leasing its fiber network to local businesses in 2006. Larger businesses became the first users of Santa Monica's fiber to establish connectivity between their locations within the City. In most cases, these businesses paid the upfront costs for fiber extensions from the City's current network to reach their facilities. The City connected about 15 customers to its network initially between 2006 and 2008. The City started a marketing campaign to determine the demand for City fiber from the small and medium business community. The campaign focused on businesses in close

proximity to the City's current network, surveying about 3,000 businesses within 200 feet of the current network. The results indicated that there was demand for the City's fiber; however, businesses were looking for a complete solution for their Internet services, rather than just dark or lit fiber.

The City realized the demand for these services warranted the investment in building an Internet infrastructure capable of providing commercial Internet services to businesses. The City leased a wholesale Internet circuit connected to the One Wilshire colocation facility in downtown Los Angeles and purchased equipment necessary to provide Internet services. It chose to enable both direct Internet services and open access services as part of its offering, which allowed other providers to utilize its network to deliver Internet access to businesses in the City. The City now offers a combination of dark fiber, transport and Internet access services to organizations in Santa Monica.

Today, 126 businesses are connected to CityNet and approximately 5 additional ones are added on a monthly basis. CityNet has also been successful with its MDU strategy. Facing high vacancy rates, the City encouraged property owners to install fiber cabling into their buildings as a way to entice tenants to occupy commercial properties. CityNet heavily discounted the cost of installing, operating and maintaining fiber infrastructure into buildings if the owners passed that savings directly to potential tenants and aggressively marketed the gigabit broadband service. The City reported increases in tax revenues and commercial property values for parcels that were equipped with fiber. The network covers approximately eight square miles of Santa Monica and soon will be delivering up to 100Gbps per second of symmetrical broadband access. Prices for services are negotiated for each business customer individually.

Impact to the Community

Santa Monica's CityNet fiber network was able to achieve the following goals for the community:

- Lower costs of Internet access for the City and schools
- Centralize or integrate municipal services through core data systems
- Establish free Wi-Fi in 35 public hot zones as well as distribute 375 computers in kiosks and libraries in town for free access
- Nurture existing businesses, attract new businesses, support startups, VCs, and incubators
- Create an environment for other incumbents to invest in city infrastructure. The city has no plans to provide residential service to its 90,000 people

Challenges

Santa Monica faced challenges in providing only dark fiber services to local businesses. As demand for high-speed Internet services grew over the past 5 years, small and medium businesses desired an affordable Internet solution that was enabled by a single provider. This differed from Santa Monica's model of providing simply dark fiber or bandwidth services to local businesses. While larger organizations had IT staff capable of managing dark fiber and bandwidth, small and medium businesses looked for a solution that was handled directly by the provider, as many of them lacked the sufficient resources to manage dark fiber alone. The struggle Santa Monica faced was maintaining

lean operations and a "hands off" approach while still serving a range of business customers. Retail was a new business model that Santa Monica had not encountered yet. This required Santa Monica to "change its thinking" and to have true impact in the small and medium business market, it made the decision to offer direct Internet services as part of its portfolio of services.

3.6.2 Palo Alto, California

Community Overview

Palo Alto is a city located in the northwest corner of Santa Clara County, California. Part of the larger San Francisco Bay Area, the city shares its borders with Mountain View, Menlo Park, and includes portions of Stanford University. The city's population of 66,955 is spread across a total land area of 23.8 square miles for a population density of 2,696 people per square mile.

Palo Alto is one of the most expensive cities in the United States to live, and its residents are among the most educated in the country. There are approximately 26,229 households in Palo Alto, with a median household income of $121,465, and a per capita income of $73,329. Almost 80% (79.8%) of people over 25 years have bachelor degrees, compared to the California rate of 30.7%

Palo Alto is headquarters to a who's who of technology companies, including Hewlett-Packard, SAP, VMware, Tesla Motors, Ford Research and Innovation Center, PARC, Ning, IDEO, Skype, and many others. The City has also served as an incubator to several other high-technology companies such as Google, Facebook, Logitech, Intuit, Pinterest, and PayPal. Stanford University is the largest employer in Palo Alto at 11,128.

Unlike surrounding communities, the City of Palo Alto provides electric and gas service within city limits. Services traditionally attributed to a cable television provider were sold to a regulated commercial entity, after previously being operated by a cooperative called Palo Alto Cable Coop.

Development of the Initial Network

The City of Palo Alto Utilities (CPAU) fiber network first began construction in 1997. A dark fiber ring was first envisioned to serve multiple purposes, including commercial telecom services, SCADA communications and municipal connectivity. CPAU has maintained ongoing operations of the fiber network. The first phase of the network passed the major city facilities and business parks. It consisted of 33 miles of 144-count fiber cable. The original network was funded under the CPAU enterprise fund via a $2 million loan at 0% interest. The loan was repaid ahead of schedule in 2008 and a separate enterprise fund was established specifically for the fiber business.

Development of Broadband Services

The significant number of technology businesses in Palo Alto created demand for fiber connectivity over CPAU's network to reach the Palo Alto Internet Exchange (PAIX). PAIX was one of the first and most important Internet peering exchanges where a large number of Internet and content providers

interconnect with one another; a data center provider, Equinix, now operates the facility.[9] Palo Alto provided businesses with dark fiber connectivity from their locations to PAIX, through which they have their choice of more than 100 Internet providers. This creates value for businesses as they are able to purchase their Internet services in PAIX for very low cost through its local competitive market. The connectivity to PAIX creates a significant economic development opportunity for the City by marketing its community as one of the most connected in the nation.

CPAU provides a number of dark fiber options for businesses, depending on the level of redundancy that businesses desire:

- Point-to-Point - *This configuration can be used to directly connect any two points in Palo Alto. The four options below are variations of this basic configuration.*
- Route-Diverse Ring/Single Drops - *With the proper network equipment, this configuration can be used to enhance reliability. Two diverse paths are available on the backbone to prevent service interruptions even if the fiber backbone is damaged along one of the two paths.*
- Route-Diverse Ring/Dual Drops - *With the proper network equipment, this fiber configuration can be used to further enhance reliability. Two diverse paths are available end-to-end to prevent service interruptions even if the fiber backbone and/or the drop cable are damaged along one of the two paths.*
- Star Configuration - *This configuration can be used to establish a single location as a hub from which individual point-to-point connections can be made.*
- Hybrid Configuration - *Options 1-4 may also be combined for a custom-tailored network solution consisting of a hybrid of the other configuration options.*

Impact to the Community

CPAU's network has provided vital fiber connectivity services to the technology industry in Palo Alto. The network has become the network that technology businesses utilize to purchase fiber connectivity into PAIX. CPAU currently licenses dark fiber service connections to approximately 90 commercial customers. The fiber system also serves the following City departments: IT Infrastructure Services, Utilities Substations, Utilities Engineering, Public Works, Water Quality Control Plant and Community Services. CPAU is also in the process of installing dark fiber service connections at 19 Palo Alto Unified School District facilities. The total number of dark fiber service connections serving commercial customers and the City is 222 (some customers have multiple connections). As of the end of fiscal year 2013, the licensing of dark fiber service connections has resulted in a fiber fund reserve of $15.3 million.[10]

[9] http://www.equinix.com
[10] http://www.citiesassociation.org/files/Fiber.pdf

Challenges

Although CPAU's network has provided value to the business community and public organizations, it has struggled with a plan to expand the network to serve any segment of the residential market. Palo Alto's high median household income and residential density favors the development of a fiber to the home network; however, the City has struggled developing a business case to expand the network in a financially sustainable way.

Numerous studies have been completed over the past 10 years to determine the feasibility of fiber to the home. In all cases they have concluded that the City should not pursue fiber to the home on a citywide basis. The City is in the process of evaluating a range of incremental approaches to accomplish its fiber to the home goals in conjunction with competitive service providers in the Palo Alto area. The City has decided that a practical approach to attracting these providers is to develop a Master Plan, which includes an engineering study, network design specifications, and a cost model to deploy a citywide fiber network.

4. Public Services Provider

4.1 Overview

If the organization becomes a public services provider, it will utilize its fiber and broadband resources to interconnect multiple public organizations with fiber or wireless connectivity. These organizations are generally limited to the community anchors that fall within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and occasionally healthcare providers. The majority of these anchors require substantial connectivity and often, the local government's network can provide higher capacity at lower costs than these organizations are able to obtain in the commercial market.

Local government and utility networks across the country have been built to interconnect cities, counties, school districts, and utilities to one another at lower costs and with long-term growth capabilities that support these organizations' future needs and protect them from rising costs. In these cases, public services providers may be cities, counties, or consortia that build and maintain networks. The providers utilize inter-local agreements between public agencies to establish connectivity, rates and the terms and conditions of service. In many cases, these networks may be restricted from commercial use, in others local governments also deploy commercialized broadband services across them.

Many of these networks grow organically from serving a single entity, such as a municipality or school district, to serving multiple entities throughout the local area or even region. Municipalities have been particularly successful deploying these networks for their own needs and expanding them to serve surrounding public organizations. In many cases, the networks are established by municipal IT, public works, or utilities departments, and through relationships with surrounding organizations; they expand to facilitate more connectivity needs. The success of these networks depends on the relationships held between local organizations and their willingness to collaborate with one another.

Public service providers generally do not engage in providing any commercial broadband services across their networks. The fiber networks have not generally been designed to provide commercial broadband and they sometimes lack the capacity and redundancy to facilitate commercial services. Instead, they have been designed to meet local organizational needs for fiber connectivity over which Internet, phone, cloud and other services are carried.

4.2 Public Services Provider Case Studies

4.2.1 Seminole County, Florida

Community Overview

Seminole County is in central Florida, northeast of Orlando on the I-4 corridor. With a population of 422,718, Seminole County has been one of Florida's fastest growing counties over the past 10 years

in terms of economic growth and residential development. Between 2004 and 2014, the county's population grew about 30%.

Development of the Initial Network

Seminole County owns and operates a 450-mile fiber-optic network that was installed over the past 20 years by the county's Public Works departments primarily to serve the needs of transportation. The county's Traffic Engineering Group initially developed the network by connecting traffic signals to fiber in the early 1990s to provide enhanced communications and better reliability. What was originally conceived to be a network used exclusively for transportation became a resource that connected public organizations across the county. By 2000, multiple agencies were connected to the county's fiber network.

Inter Local Fiber Maintenance Agreements were signed with Seminole Community College, Seminole County School Board, and the Cities of Lake Mary, Altamonte Springs and Winter Springs. Most fire stations at this time were connected by frame relay services, for which the county was paying the telecom providers for connections, repairs and maintenance. These connections were disconnected as new fiber connectivity provided greater capacity at lower costs to the local organizations.

To date, the county's Traffic Engineering Department has connected 26 fire stations, 58 county buildings, 44 schools, 4 Seminole Community College campus, 41 city buildings and 17 water treatment plants to the fiber network. In addition to the network, the department maintains over 375 traffic signals, 148 school flashers at 73 locations, 46 beacons and flashers and 29 variable message signs. The fiber network consists of different types of cables and strand counts: single mode, multi-mode and hybrid. This results in approximately 1,246 active strand pair miles of fiber.

Development of Broadband Services

Although the county has benefited significantly from the fiber program, including the connection of a number of county buildings, Traffic Engineering's main goal and reason for the network has been and continues to be traffic safety, improved traffic signal management, citizen information and driver safety. In 2009, the County conducted a broadband study to determine how this network could expand broadband services throughout Seminole's communities.

The study identified specific opportunities to expand the county's network in partnership with broadband providers; however, several obstacles were identified that limited these potentials. First, some portions of the network were constructed using Federal Highway Administration funding, which placed certain restrictions on commercial use of the fiber. Second, some portions of the network were shared with the Florida Department of Transportation, which also placed restrictions on commercial use of the fiber. The County identified ways to mitigate some of these obstacles, however, they did not want to risk the existing benefits of the network to local public organizations and has since tabled the broadband initiative.

Impact to the Community

The county's network has saved the public organizations connected to the network millions of dollars that would have otherwise been spent on broadband connections between facilities. The network now connects several hundred government, city, county, school and community college facilities as well as provides a far-reaching communications network for the vast majority of Seminole County's traffic signals. The network has enabled the county and its cities to:

- Share resources between the county, cities, schools and community colleges
- Aggregate demand for public procurements to attain volume purchasing power
- Provide inter-jurisdictional public safety communications between the County and cities
- Reduce public organizations spend on communications services on a countywide basis
- Future-proof the communications needs of all organizations connected to the network

Challenges

Significant challenges were identified in certain portions of the County's network, resulting from the commingling of fiber assets with the Florida Department of Transportation (FDOT). The restricted use of the FDOT's assets limited the County's opportunities to utilize this fiber in commercial transactions. However, the County was still able to utilize these assets for its own purposes as well as other public organizations connected to the network.

4.2.2 Leesburg, Florida

Community Overview

Leesburg is in Lake County, located in central Florida between Lake Harris and Lake Griffin at the head of the Ocklawaha River. Leesburg is part of the Orlando–Kissimmee–Sanford Metropolitan Statistical Area. According to the US Census, the city has a total area of 24.4 square miles, 5.8 square miles of which is water.

The City of Leesburg is home to 20,464 people and 8,485 households; with a population density of 653.2 inhabitants per square mile. The median income for a household in the city was $33,698, with per capita income for the city at $19,409. About 16.2% of families and 21.4% of the population were below the poverty line.

Several major highways pass through Leesburg, including US 27, US 441, and SR 44. The Florida Turnpike passes just to the south and west of Leesburg. Leesburg is the home of Beacon College and Lake-Sumter State College with campuses also in Clermont and Sumterville.

In the early 20th century, Leesburg developed as an agricultural center important for watermelon production and later for the citrus industry, which was the principal business in Leesburg for many years until colder winters pushed citrus to the south. Today, most of Leesburg's growth and economic development is the result of the increasing popularity of the area as a retirement destination and the rapid growth of nearby Orlando.

Development of the Initial Network

In 2001, Lake County began offering private businesses access to one of Florida's most extensive, municipally owned broadband networks, which at the time included about 185 miles of fiber. The fiber-optic network connected to hospitals, doctor offices, private businesses and 44 schools. While the majority of communities find success in supplying broadband, Leesburg has actually gained notoriety using fiber for other purposes.

Faced with sky-high wholesale power costs, Leesburg took action to reduce those costs using smart grid technology. The utility was an early adopter of smart grid and automatic meter reading, and in 2008, the utility put together a smart grid business plan that projected operational savings of $900,000 for the city's electric system and an additional $400,000 for the water system.

Then, in 2009, Leesburg became one of 33 public power utilities to win smart grid grants from the Department of Energy under the American Recovery and Reinvestment Act. The utility received $9.75 million for its smart grid project, plus a $1.4 million energy efficiency and conservation block grant. With the grants, Leesburg is installing smart meters for all of its 23,000 customers, plus more than 4,000 energy management systems that allow customers to program when they operate their electrical appliances and heating and cooling systems.

Development of Broadband Services

Leesburg has used its success as an infrastructure provider to enable advanced municipal services. The City's network now connects Lake County government, Central Florida Health Alliance and all of Lake County's 59 schools, securing over $400,000 in federal E-Rate dollars in 2014. The City of Leesburg desires to remain an infrastructure provider, and prefers not to serve as a retail service provider. However, in an effort to expand its services without the risk of operating a residential network, the City applied for the Google Gigabit project.[11]

When Leesburg applied for the Google Gigabit project, the City marketed its fiber-optic assets to Google in order to attract the provider to operate within the City. The City's network provided 185 miles of fiber-optic resources that the City was willing to contribute to the project. At the time the Leesburg City Manager explained, "Leesburg can offer Google a well-established and well-maintained fiber-optic backbone from which they can launch their fiber-to-the-home initiative. Our community's diverse demographic will be an excellent test bed for all kinds of bandwidth intensive consumer applications."[12] Leesburg was not selected by Google; however, its network continues to provide significant value to the community and the City is considering options to expand the network to local businesses.

Impact to the Community

Leesburg and Lake County had prior experience with fiber deployments in the late 90s, before many higher profile communities considered their own deployments. Therefore, in the 2000s, when many

[11] https://fiber.google.com/newcities/
[12] http://www.leesburgflorida.gov/news/news_item.aspx?item=Leesburg_Seeks_Partnership_with_Google

communities began formulating the economic development justifications for deploying their own networks, many economic researchers turned to Lake County to measure the economic impacts of the system on the local economy. An early study[13] of the economic impact of municipal networks shows that Lake County experienced approximately 100% greater growth in economic activity relative to comparable Florida counties since making its municipal broadband network generally available to businesses in the county.

Further, the benefits of Leesburg's fiber network deployment are not limited to supplying enhanced broadband services to the community. Until the late 2000s, the City of Leesburg had some of the highest power rates in the state. However, today the municipal utility employs end-to-end smart grid technologies – from smart meters to transmission system upgrades, to deliver power less expensively and more efficiently to Leesburg residents than elsewhere in the state. The fiber network has enabled smart grid communications throughout the City enabling it to employ power saving programs and it is now one of the lowest-cost retail providers of electricity in Florida.[14]

4.2.3 Columbia County, Georgia

Community Overview

Columbia County is located on the northeastern border of Georgia, along the Savannah River about midway along the state line with South Carolina. The legal county seat is Appling, but the location of Columbia County's government and courts is Evans. As of 2013, the population was 135,416 with almost 44,000 households. The county is approximately 308 square miles, of which about 18 square miles is water, giving the county a density of 428 people per square mile.

Transportation access is excellent in Columbia County, with east-west Interstate 20 passing through the county, three US highways, including US 78, US 221, US 278, and several state highways. The median income for a household in the county is $69,306, with per capita income at $30,949. About 8.3% of the population is below the poverty line.

In post-WWII era, the county's population increased dramatically as military personnel stationed at Fort Gordon settled in Columbia County. Soon after, agriculture declined, as farmland was redeveloped to suburban housing for people employed in nearby Augusta. Columbia County is included in the Augusta, GA-SC Metropolitan Statistical Area, and is considered one of the fastest growing counties in the United States.

Development of the Initial Network

The National Telecommunications and Information Administration (NTIA) awarded the Columbia County Information Technology Department a $13.5 million Broadband Technology Opportunity

[13] "Broadband and Economic Development: A Municipal Case Study from Florida" *Applied Economics Studies*. Ford and Koutsky, April 2005.
[14] https://www.smartgrid.gov/files/City_of_Leesburg_Project_Description.pdf

Program (BTOP) grant to build an $18 million 220-mile fiber-optic network to better serve county residents and businesses. The goals stated in the BTOP application were those of economic development, job creation, improved educational opportunities and support of a high-capacity data center at the Medical College of Georgia.[15]

On December 13, 2010, Columbia County initiated construction on the fiber-optic network at a groundbreaking ceremony near the Columbia County Library in Evans. This library was the first Internet access point for the network and houses much of the network equipment. Upon completion, Columbia County had connected nearly 100 community anchor institutions to its countywide fiber middle mile network. The county improved access to healthcare, public safety and government facilities, as well as provided dozens of free Wi-Fi hotspots to community locations, including parks, libraries and community centers. The county constructed seven wireless towers (five are BTOP-funded) to improve wireless communications capabilities throughout the region.[16]

Development of Broadband Services

The Columbia County Broadband Utility is a department of the Deputy County Administrator's office, which operates and maintains the Columbia County Community Broadband Utility, or C3BU for short. The C3BU's mission is to provide a cost-efficient, self-sustaining middle-mile fiber network for the community.[17]

One of the primary stated goals of the network was to enhance public safety communications in the county. Using the new towers, the county connected more than 30 public safety entities and connected traffic devices, including; stop lights, surveillance equipment and notification boards to the statewide Intelligent Transportation System. These connections improved public safety and traffic flow along the major transportation corridors.

The County is also leasing excess capacity in its fiber network to competitive mobile and broadband providers in the area. C3BU's network allows providers to reach many areas of the county with high-speed fiber-optic connectivity. This has led to new deployments to communities in the more rural areas of the county and increased capacity in the mobile services that utilize C3BU's network for backhaul.

Impact to the Community

The first entity to benefit from the high-speed access was the Sheriff's Office, which was previously in serious need of improved communications. In addition to county government facilities, public services and community anchors, the network provides free Wi-Fi in Columbia County parks and libraries.

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[15] http://www2.ntia.doc.gov/files/grantees/ga_columbiacounty_final.pdf
[16] http://www2.ntia.doc.gov/grantees/ColumbiaCounty
[17] http://www.columbiacountyga.gov/how-do-i/broadband-utility

In February 2014, a brutal ice storm swept through the South. Power was lost to most of Columbia County. Many landline services were disconnected as the storm resulted in power outages to many telecom providers. . Cellphone service was spotty and unreliable. However, the County's fiber network never lost connectivity. Geared for public safety, the entire 220-mile fiber-optic network is underground[18] and powered through a series of emergency generators that maintained the system during the storm. Public safety, emergency operations and other vital constituents connected to the network maintained connectivity throughout the period.

Challenges

The director of the broadband utility said there have been some challenges in explaining the functions of the network to the public. He mentioned that it was not built to provide free Internet. "That's just not feasible."[19] "We're not here to compete with commercial interests, but this is about economic development. We see this as another reason people may be attracted to Columbia County. We are wholesalers. Who the customers are remains to be seen."

Also, as true in many states, the strength of incumbent providers and their lobbying efforts often gain the support of state representatives. Through the last decade, incumbents have fought to overrule local authority on broadband and telecommunications issues.[20] The Georgia State Assembly's mulling of Municipal Broadband restrictions each year (2012 SB313, 2013 HB282) could potentially curb a community's ability to transport digital commerce. These legislative activities could also severely affect the option of growing municipal fiber services in communities in the future. However, for the time being, and after many years of fighting the telecom lobby in Georgia, municipalities look to have defended their authority and the ability to compete in the broadband market.[21]

[18] https://www.benton.org/node/180775
[19] http://chronicle.augusta.com/news/metro/2012-09-21/new-broadband-sytem-brings-speed-columbia-county-communications
[20] http://chronicle.augusta.com/news/government/2012-01-26/bill-would-limit-government-internet-systems
[21] http://stopthecap.com/2013/03/11/georgia-votes-down-municipal-broadband-ban-in-bipartisan-94-70-vote

4.3 Public Service Provider Considerations for Fort Collins

Organizational & Operational	• Expands the model the City is using today • City can implement other business models that complement public services, including open access • Lower operational burden than open access or any retail model • City must maintain high quality services to community anchors, commensurate with the private sector
Competitive Environment	• Services to other public organizations keeps the City out of the competitive environment • City can continue to develop its broadband program and add complementary services and/or business models • Open access complements the public service provider model, allowing the City to provide wholesale services that can improve the residential and business markets if it chooses
Political Environment	• Non-controversial, approach to serve schools, hospitals and other public community anchors • Inter-local agreements avoid private sector contracting issues
Funding Environment	• Funding can be deployed on a project by project schedule • Very few sunk costs, all funding is tied to a revenue opportunity • No "bets" on uptake, opportunities are codified before funding is committed
Community Benefits	• Future-proof community organization needs • Create strong collaboration and sharing between public organizations • Improve resiliency of local networks for public safety, utilities, schools, hospitals and local governments

5. Open-Access Provider

5.1 Overview

Open-access provides a business model whereby the local government generally owns and operates the physical infrastructure and the network electronics necessary to provide a lit transport service. A lit transport service is a data connection from a location where the local government network interconnects with one or more broadband providers to a customer's premise. Local governments generally own the entire fiber infrastructure along this path and the terminating equipment at either end. Open access networks establish a transport connection, similar to a Type II telecommunications service from a network-to-network interconnection to an end user, which could be a business, residence, or community anchor organization.

Local governments that adopt open-access generally own substantial fiber-optic networks in their communities. Open-access allows these local governments to "light" the fiber and equip the network with the electronics necessary to establish a "transport service" or "circuit" to service providers interconnecting with the local network. Service providers connect from a common interconnection point and have access to all customers connected to that network.

Open-access defines a network that is available for any qualified service providers to utilize to reach end users in the serving area. It allows a local government to aggregate demand on a single network, that they are able to interconnect with participating service providers. The concept of open-access enables competition among service providers across a network that is owned by the local government. The local government remains neutral and non-discriminatory with providers who deliver services over the network. The local government establishes a standard rate structure and terms of service for use by all qualified participating service providers. Service providers lease access to the network based on the amount of bandwidth required by the end customer.

In practice, open-access networks in the US have experienced varying degrees of success and failure. Some of the most notable open-access networks include iProvo in UT, nDanville in VA, and FiberNET in Palm Coast, FL, with each included in this report. iProvo has experienced its fair share of issues, many of which are not directly a result of its open access business model. However, open-access complicates the operations, management and financial sustainability of networks because multiple parties are reliant on each other's success for the network to sustain itself financially. A number of considerations are common when developing and operating open-access networks:

- What are providers willing to pay for access and can these rates sustain competitive retail pricing to the end users?
- Can the local government set rates to providers low enough to incentivize demand and use while still generating enough revenue to cover operating expenses and debt service?
- What incents broadband providers to market and sell services on the network, as they will ultimately determine the revenues received by the local government to sustain the network?
- Will the open-access network stimulate competition or drive significant market share to a single dominant provider while other providers cannot compete?

5.2 Services and Rates

Open access providers have deployed fiber services primarily to businesses, community anchors and in some cases residents. They generally charge wholesale rates to retail broadband providers to use their networks. Figure 8 provides a comparison of the services offered by three municipal open access providers. They publish rates to competitive service providers, charging a monthly recurring fee based on either bandwidth of the service utilized or a flat fixed fee per month.

Figure 8: Municipal Open Access Provider Service Portfolios

	Danville, VA	Palm Coast, FL	Burbank, CA
Commercial			
Internet	✓		
Telephone	✓	✓	✓
Data Connectivity (Transport)		✓	✓
Wholesale			
Data Connectivity (Transport)	✓	✓	✓
Dark Fiber	✓	✓	✓
Community Anchor			
Internet	✓		
Telephone	✓		
Data Connectivity (Transport)	✓	✓	✓
Dark Fiber	✓	✓	✓

5.3 Market Penetration

Open access providers focus primarily on equipping local businesses and community anchors with improved connectivity. Their markets are determined by extending fiber to business parks, school campuses, hospitals, and other key business and community locations. As such, penetration of their services in these local markets is not clear-cut and should be tied to the specific geographies that they cover versus the entire market. As a result, low market penetration is not an indication of the success or failure of an open access provider.

Figure 9 illustrates the number of customers connected to each of these providers' networks. In these cases, providers have low market penetration because their fiber networks are not deployed on a citywide basis; rather they are deployed strategically to connect the customers that require service.

Figure 9: Market Penetration Benchmarking – Municipal Open Access Providers

	Danville, VA	Palm Coast, FL	Burbank, CA
Commercial			
Premises Passed	2,500	1,500	6,000
Subscribers	200	70	58
Penetration	8%	4.67%	0.97%
Community Anchors			
Schools	17	16	8
Libraries			3
Healthcare	50	9	
Municipal		28	15
Years to Achieve Penetration	7 Years	4 Years	5 Years

5.4 Organizational Profiles

Municipal open access providers are organized either under electric utility divisions or within the information technology divisions for each municipality. Cities generally start small, providing a limited amount of fiber out to key customers and grow their organizations "inside" these divisions. In many cases, these operations remain small and are not developed as enterprise funds of their own to minimize the overhead associated with operating a new fund. This has allowed them to grow at a moderate pace and maintain the benefits of operating within a current utility or general services environment.

5.5 Financial Profiles

Financial information for municipal open access providers is more limited than with providers that implemented municipal retail business models. In the three cases, each provider utilized existing enterprise or general fund resources to "startup" the fiber program. In the case of Palm Coast, the annual appropriations were made over a period of 5 years to arrive at a total funding of $3.2M. The cities of Burbank and Danville have followed similar practices.

Figure 10: Funding Sources for Municipal Open Access Providers

	Danville, VA	Palm Coast, FL	Burbank, CA
Investment	$2,500,000	$3,200,000	$2,700,000
Funding Source	Enterprise Fund	General Fund	Enterprise Fund
Term of Debt	No debt	No debt	No debt
Interest Rate	No debt	No debt	No debt

Evaluating financial performance of this class of municipal providers proves difficult. Less financial information was readily available, and in some cases capital and operating costs were "buried" in other funds and were not easily identifiable in CAFRs or though discussions with City personnel. This

is common in cases where broadband programs are not codified as enterprise funds or utilities within each city. High-level summary figures for gross revenues, operating costs, net income, and capital investment were available; however, revenue and cost line items were more obscure.

Figure 11: Profit & Loss Statements from Municipal Open Access Providers (Most Recent Year)

	Danville, VA	Palm Coast, FL	Burbank, CA
Gross Revenues			
Commercial	$1,000,000	$140,000	
Community Anchor	$800,000	$382,000	
Wholesale	$1,000,000		
Other Revenue			$3,300,000
Total Gross Revenue	$2,800,000	$522,000	$3,300,000
Operating Expenses			
Cost of Services		$190,000	$344,000
Sales, General & Administrative Costs	$1,700,000	$170,500	$583,000
Total Operating Expenses	$1,700,000	$360,500	$927,000
Operating Income	$1,100,000	$161,500	$2,373,000
Net Income	$1,100,000	$161,500	$2,373,000

5.6 Open Access Considerations for Fort Collins

Organizational & Operational	• Absence of retail services allows for lower overhead and management • Wholesale services require operational expertise and staffing • Service level agreements must be met by municipal provider • Slow-start approach can minimize risk exposure • Open access can move toward municipal retail
Competitive Environment	• Open access enables competition rather than selecting a single provider or providing dark fiber alone • Providers must be recruited and convinced to use the open access network, some will choose not to • Ideal in environments with multiple providers and low fiber penetration • Useful in business markets to incentivize economic development
Political Environment	• Lower political exposure, particularly if services are only deployed to businesses • Less funding required, more phasing opportunities • Good opportunity to showcase progressive economic development
Funding Environment	• Funding can be easily phased, pilot projects can be staged prior to full funding commitments • Funding is focused on long-term capital assets (fiber primarily) and some equipment • Operations and maintenance costs are significantly lower than retail options • Modest staffing can be used to manage the open access network or it can be outsourced to a third party
Community Benefits	• Businesses have more choices for Internet services • Affordable fiber services for small and medium businesses • Retail open access benefits are yet to be determined, there are few test cases with full retail open access today • Not generally seen as a profit center for municipalities, soft benefits are more valuable

5.7 Open-Access Provider Case Studies

5.7.1 Palm Coast, Florida

Community Overview

Palm Coast is a city of 75,000 residents in northeast Florida about an hour south of Jacksonville. The city provides a wide range of services including development services, fire services, street construction and maintenance and parks and recreational activities. Palm Coast contracts with the Flagler County Sheriff's Office for law enforcement services. The municipality's number one goal is to "Provide quality services, maintaining the City's financial soundness." From this goal emerged several initiatives designed to provide a greater level of service and an expansion of capabilities while reducing the government's costs. Information Technology has been a key driver for innovation and increased efficiencies across various departments.

Development of the Initial Network

In 2006, the Palm Coast City Council approved a 5-Year fiber-optic deployment project funded at $500,000 annually to build out the City's municipal fiber network. The network was developed to support growing municipal technology needs across all public organizations in the area, including city, county, public safety and education. It was also planned to support key initiatives such as emergency operations, traffic signalization, collaboration and video monitoring.

Palm Coast utilized a phased approach to build its network using cost-reducing opportunities to invest in new fiber-optic infrastructure. As each phase was constructed, the City connected its own facilities and coordinated with other public organizations to connect them, incrementally reducing costs for all organizations connected to the network. Showing a reasonable payback from each stage of investment allowed the city to continue to fund future expansion of the network. About $500,000 in annual funding was appropriated from the general fund each year to build various components of the backbone network. The city achieved offsetting cost reductions by disconnecting its current connections with telecom providers in the area.

Through deployment of this network over the 5-year period, the city realized a savings of nearly $1 million since 2007 and projects further annual operating savings of $350,000 annually. In addition to these savings, the network provides valuable new capabilities that enhance its mission of serving the residents and businesses of the community.

Development of Broadband Services

Palm Coast experienced staggering population growth between 2000 and 2010, which nearly doubled its size; however, the housing downturn in the late 1990s hit the city particularly hard. Palm Coast's economy suffered from this retraction and the city began a program in 2006 to stimulate economic development. Palm Coast determined that its network could provide enhanced benefits to economic development and launched a program to take its network commercial. The City evaluated the opportunities to use its network to expand broadband services, particularly focused on retaining

local businesses. The City developed a business plan to expand its network in cooperation with local service providers and executed this plan to deploy the network in 2007.

The City employed an open-access business model whereby the City provided the physical fiber-optic network and electronics to connect broadband providers with individual businesses in key serving areas of the community. Broadband providers were charged monthly access fees based on the speed (bandwidth) of the service required by the business. The City builds new connections from its current fiber network to individual businesses, deploys premise equipment to businesses and interconnects broadband providers to them. Broadband providers are responsible to market, sell and manage all retail services on the network and pay the City access fees to utilize the system, on a per customer basis.

As FiberNET was deployed, the City realized that its network could become a significant resource for other public organizations in Flagler County. In 2009, the City bid and won a competitive E-Rate contract with the Flagler County School Board to provide Gigabit and 10 Gigabit fiber services to 16 county schools. The City incurred a $250,000 upfront cost to extend the network to these schools and generates about $300,000 in annual revenue from this contract. In addition, the City has connected Flagler County offices and various other public organizations that make use of the competitively priced fiber services. In 2010, the local hospital contracted with the City to provide Gigabit connectivity to its main campus in Palm Coast and upgraded fiber connectivity to eight of its affiliated doctors' offices throughout the community. This provided significant upgrades for each local doctor's office and reduced each office's costs from approximately $750 to $300 per month.

The City manages FiberNET through its internal Information Technology Department. Shared staff resources within IT manage FiberNET, providing technical expertise, engineering, customer management, provider management and related services for FiberNET; approximately two full-time employees manage FiberNET today. The City outsources operations and management of the physical fiber-optic network to a local fiber contractor who provides design, construction, repair and maintenance.

Impact to the Community

In a market where local fiber was scarce and unaffordable for all but the largest businesses, Palm Coast FiberNET now provides cost-effective fiber access to businesses for as little as $50 per month for a 10Mbps connection. Service providers utilize the network to deliver Internet and business communications services for significantly lower costs than were previously available. FiberNET has reduced the costs of business Internet services across the city by 30%. The City has enabled new competition and introduced a competitively priced fiber product into the wholesale market within Palm Coast. Doing so has enabled competition among local providers using the network and the local incumbents.

Most recently, the Allied Fiber Backbone, a long-haul fiber network that interconnects Miami to Atlanta has been integrated into Palm Coast FiberNET, and service providers connected to Allied Fiber have now entered the Palm Coast market. This further diversifies the competitive landscape in Palm Coast and enables local businesses more choices for their broadband needs. FiberNET has four

providers operating on its network to date, two of which are new to the Palm Coast market. Key benefits include:

- Multi-use network connecting city, county, school, healthcare and support organizations
- Reduced overall government spend by nearly $1M per year
- Lowered business Internet costs by 30% across the city
- Reduced education spending by $300,000 annually
- Upgraded education services to 1 and 10 Gbps speeds
- Secured future bandwidth needs for the community, 100 Gigabit and beyond
- Financially sustainable, cash flow positive within 6 years
- Expanded competition, choice and availability of broadband services for local businesses
- Increased reliability, performance and availability of fiber broadband across the city
- Introduced two new service providers to the Palm Coast market
- Reinvested system revenues into expanding the network to cover more of the city's geography
- Future-proofed local business needs with speeds up to 10 Gig
- Secured future bandwidth needs for the community, 100 Gigabit and beyond

Challenges

Palm Coast has struggled with developing the business case for new fiber connections in circumstances where local businesses are not in close proximity to the network. FiberNET attempts to set rates for fiber services consistently across the city so that broadband providers pay the same wholesale rates across the entire service area of the network. This ensures that Palm Coast businesses pay consistent costs for their broadband services, regardless of location.

The municipality has experienced some issues with its broadband providers in building new fiber connections that may not present a strong business case. In these cases, the costs for fiber connections exceed the City's payback threshold; however, the broadband provider has customers ready to subscribe for service. For example, a new 2,500 foot fiber connection to a business costs the City $20,000 in construction costs with a revenue opportunity of only $1,200 per year, which results in a payback of 16.6 years.

Palm Coast must make the decision whether to build out to this customer in line with City's overall goals of supporting local economic development. In some cases where the payback has been beyond the City's threshold, it has opted to not build the connections; however, in most cases the City has proceeded with these connections., This has been a recurring issue facing FiberNET and several other municipally owned networks. General connection costs range from $2,500 to $10,000 per business, and the City is looking at ways of reducing these costs through alternative construction methods.

5.7.2 Danville, Virginia

Community Overview

Danville is a city of about 43,000 residents in south central Virginia, near the North Carolina border about an hour north of Greensboro, NC, and under two hours from Richmond and Roanoke, VA, and Raleigh, NC. Historically a textile and tobacco town, the City's economic output declined when these industries and jobs were outsourced to foreign countries.

During the last decade Danville has utilized broadband to revitalize its economy. Hoping for economic diversification through technology, the open-access network has helped Danville transform its economy from a languishing textile based economy to a thriving technology-based economy and now promotes its status as a Gigabit City.

The City brands its network nDanville, which simply stands for "Network Danville." At the time of *n*Danville's inception, Danville Utilities was the only municipal utility in Virginia that served natural gas, electricity, water, sewer and telecommunications.

Development of the Initial Network

In 2004, Danville built the original network to serve government facilities, municipal buildings and schools. The network quickly expanded to include local industrial parks, business centers, and additional City properties. In 2012 and as the network spread to more areas of the community, the City expanded nDanville to include some city residential developments. nDanville was funded with a $2.5 million start-up loan from the city's electric fund and has since shown 10 years of incremental growth, giving nDanville revenues of $1.8 million in 2014, while contributing $300,000 towards the city's general fund.

A critical key to the network's early success is the connection to the Mid-Atlantic Broadband Communities Corporation (MBC), which provides wholesale middle mile access to the nDanville network. MBC covers 26 counties with 1700 miles of fiber and connects nDanville to Internet points of presence in Washington DC, Atlanta and Charlotte. The partnership allows nDanville to be more sustainable, and allows MBC to reinvest excess earnings into regional economic development efforts.

nDanville's network was built on a platform of Ethernet to serve local community anchor organizations and City facilities. The residential component of nDanville's network is GPON (Gigabit Passive Optical Network). A colocation facility in downtown Danville provides access to multiple local providers and offers direct fiber links to Charlotte, Atlanta and Washington DC. nDanville employs a staff of three full time employees to manage a network of 175 miles.

Development of Broadband Services

In 2009, the expansion of nDanville into residential areas was heavily debated. At the time, the City wanted to take out a substantial $2.5M loan to quickly build out the network, but with challenging economic factors and potential competition from incumbents, City Council decided that the risk was

too high, opting instead for the incremental route to building out residential services, which conserved capital and mitigated financial risk.

Three years later, in 2012, the City determined the potential market base was large enough to justify the financial requirements for build out and the City began its deployment of residential fiber to the home infrastructure. As an open access provider the City does not directly provide services, but leases network access to a local provider, Gamewood, which provides triple-play retail services to residents and businesses in Danville.

Impact to the Community

Incremental, low-risk strategic investments enabled Danville to grow its network over the past 10 years. The network now passes over 2,500 customers in a city of 26,000 homes. This rate is increasing incrementally, as more net profit allows for additional reinvestment in new buildouts. The City has met its take rate requirements of 20% the first year of operation and 5% each year that followed.

Next-generation broadband has significantly improved Danville's economic development positioning. Zeyuan Flooring International, a Chinese wood floor manufacturer plans to invest $15-million in a 40,000 square foot manufacturing plant that will employ 100 people within three years. Chinese furniture assembler GOK International announced it will invest $12.5-million to establish its U.S. headquarters and showroom in Danville. GOK International plans to employ 300 people within three years.

The companies above are located in Cane Creek Centre, one of Danville's five industrial parks connected to nDanville's fiber network. nDanville passes more than 1,000 businesses including every parcel in each of the industrial parks. Many businesses subscribe to 100 Mbp or 1 Gbp fiber connections. nDanville also attributes its broadband network to recent economic successes, including the recruitment of Goodyear, IKEA, EcomNets, and CBN Technologies.

Danville is home to one of the first non-government sponsored Cray Supercomputers. The Cray XMT2 supercomputer is part of the Noblis Center for Applied High Performance Computing, which is located in a former tobacco plant. Noblis uses the supercomputer to process massive amounts of data for clients in fields such as computational biology, DNA sequencing, air traffic management, fraud detection and counterterrorism.

Challenges

Finding the first service provider to operate over the City's network was a key challenge as it took nearly a year to solidify the agreement. After the first provider joined the network, other local providers began to show interest and nDanville has 3 providers on its network today.

The City developed public policies to help provide for network deployment and growth, which included the utility installing ¾" conduit in road, water and sewer in cases where trenches allowed

the installation of additional duct.. Coordination with building contractors early enough in the planning, permitting and construction process proved challenging and many projects were missed.

Danville residents and businesses are typically unaware of nDanville's services. Marketing is a key component that communities often overlook. Once the network is operational, marketing is important to raise awareness of service availability. Residents and businesses must know that other options exist. Danville's marketing approach has been executed through community meetings as new phases of the network are planned for activation. The City meets with community groups when a new development is planned to educate developers, building owners and residents of the nDanville network.

5.7.3 Provo, Utah

Community Overview

The City of Provo is county seat for Utah County and lies 4,610 feet above sea level. Provo has a population of 114,801 people, which represents 4.07% of the total population of Utah (which has 2,763,885 people), making it the state's third most populous community. Nestled between Utah Lake and the Wasatch Range, Provo has immediate access to excellent outdoor recreational opportunities in the Mountain West.

With a $16 billion economy and home to the country's third-largest private college, Brigham Young University, Forbes has ranked Provo as the best place in America for business and careers. Provo receives consistent national rankings for job growth, entrepreneurship, affordability and livability. The New Yorker proclaimed that Utah is "the next Silicon Valley," as it claims two of the world's 73 private venture-funded companies with valuations over $2 billion, and is home to Digital Economy companies like Bluehost, Navatek, Novell, Qualtrics and Wavetronix.

Provo unemployment levels have stayed well below the national average, and the cost of living has remained less expensive than the majority of the nation. Credited with this is the creation of Provo Power, which supplies all of Provo with energy and sells power to other cities and states, which offers a revenue stream to the city that keeps taxes low.

The municipal broadband system in Provo has been recognized as a failure that has cost taxpayers approximately $60 million. Sold to Google in 2013 for $1, the community is still burdened with the remaining debt, which is currently estimated around $40 million. The debt is scheduled to be fully paid by 2025.[22]

Development of the Initial Network

The roots of Provo's municipal Fiber to the Home (FTTH) network date back to 1998, when the City started investigating ways it could build a municipal broadband network. By 2001, the City

[22] https://xmission.com/blog/2013/04/18/the-1-fiber-optic-network

successfully built its first backbone network consisting of three fiber rings, which connected an array of municipal assets, including electric substations, city buildings, major traffic signals and schools.

Soon after, the City explored the feasibility of extending the network directly to residents and businesses. The City's expansion plans did not include retail services and instead employed an open-access model to enable local providers to use Provo's network. Provo embarked on a network deployment that entailed construction and operation of a wholesale FTTH network to 300 single-family houses and 30 apartment buildings. The City collaborated with retail providers to offer consumers television, telephone, and high-speed data services.

The city council viewed this limited pilot as a success and voted to pursue a more community-wide build out in November 2003. The following year, it agreed to issue $39.5 million in tax revenue bonds to finance the network. These funds would be used to build a fiber, open access network that would also be used for an array of internal purposes (control of traffic, electrical and water systems, internal communication, etc.).

Council estimated that iProvo would be completed by 2006 and be capable of generating positive cash flow by 2008. The projected success of iProvo was tied directly to the ability of its primary ISP, HomeNet, to grow a subscriber base and generate revenues that would cover the costs of maintaining and expanding the network. By 2005, less than a year after the network went live, HomeNet and iProvo began facing competitive difficulties. In particular, HomeNet was only able to sign up 2,400 customers at its peak, and by 2005, it had lost one-third of them, reducing iProvo's subscribership to 1,600 residents. Consequently, HomeNet terminated its contract in July 2005 and filed for bankruptcy. This sent the network into a situation where no revenues were being generated to cover the network's costs.

In 2006, low revenue and subscriber rates forced iProvo to approach the city and request a loan of $1 million from its electricity reserve fund to cover costs for the next fiscal year. iProvo continued borrowing city funds through 2007. Subscriber and revenue growth, however, remained disappointing. The network had projected it would be able to sign up an average of 60 subscribers per week, but averaged only 16 per week.[23]

By 2008, the network was costing the city $2 million a year. It was becoming increasingly clear to the City that iProvo was unsustainable. The city was already investing millions of dollars annually to prop up the network and was on track to lose more than $15 million in subsequent years if it continued to subsidize the network.

As a result, the iProvo network was sold to a private company, Broadweave Networks, in May 2008 for $40.6 million. As a condition of the sale, Broadweave agreed to pay off the $39.5 million bond that had been issued. But less than a year later, after merging with another company to form Veracity Networks, the newly formed entity realized it could not pay off lingering debt associated with the network. Veracity asked the city to restructure the debt.

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[23] http://www.nyls.edu/advanced-communications-law-and-policy-institute/Provo-Case-Study-June-2014.pdf

Veracity had been drawing on a $6 million surety bond while it attempted to conserve cash to pay down debt.. In 2011, Veracity defaulted on its purchase agreement, and control of the network reverted back to the City. The City settled with Veracity and leased the network back to the company while it looked for a new buyer. In addition, in 2011 the City began charging $5.35 a month on residential power bills to pay the outstanding bond payments.

In April 2013, the City finally sold the $40 million network to Google for one dollar. In summary additional taxpayer subsidization totaled $19.3 million, on top of the $39.5M bond issues. The sale of the municipal network to Google does not remove the burden of debt from taxpayers. Quite the contrary as the City, and taxpayers by implication, are still responsible for the remaining debt on the original bond, which works out to $3.3 million in bond payments per year for the next 12 years. In addition, the City will incur additional costs as a result of its deal with Google. It will have to not only retire the debt, but also buy new equipment so it can operate City services independently from Google's, and hire engineers to document locations of all the fiber in the system.

Development of Broadband Services

Prior to its sale to Google, iProvo offered triple-play packages to subscribers through contracted private ISPs. As an example of the services offered, in 2004, HomeNet, iProvo's original retailer, offered several bundled packages of Internet access (up to 10 Mbps), telephone, and VoIP service, which ranged from $90 to $125 per month. The services and pricing changed numerous times over the years as the network changed hands between public and private entities. Google Fiber will offer subscribers free 5Mbps service for a $30 activation fee, while 1 Gbps connections will retail for $70 per month. At this time, Google has no plans to offer services to businesses but has committed to providing "free Gigabit Internet service to 25 local public institutions like schools, hospitals, and libraries."[24]

Impact to the Community

In 2004, then-Mayor of Provo Lewis Billings talked about the many benefits he foresaw for the fledgling network. These included advanced telemedicine services, interactive distance learning, remote meter reading, and "other things I can't even comprehend that will be enabled by the immense capacity of our network."[25] Over a decade later, few of these goals have been realized as the Provo municipal network transitions to yet another owner. Some have touted the benefits of gigabit connectivity in the City's schools, but there is little evidence that the network itself has generated tangible gains in outcomes.

Over the course of its history, iProvo has been described as an example of government overreach, with residents, journalists and elected officials all critical of the network. The Utah Taxpayers Association characterized Provo's investment as a waste of taxpayer money. Early on, the group questioned, "Why is the city gambling with taxpayer money on a speculative venture when many

[24] http://googleblog.blogspot.com/2013/04/google-fiberon-silicon-prairie-silicon.html
[25] http://www.municipalfiber.com/benefits-of-a-community-broadband-network

private companies and cities have failed while attempting the same thing? Shouldn't we as taxpayers be able to vote before risking $40 million of OUR money?"

The previous Provo Mayor George Stewart, the predecessor and mentor of the mayor responsible for launching iProvo, has also been critical of the network that was built. After a heated exchange during a city council meeting, Stewart concluded that, "if I had been here, I would not have proposed iProvo." The current mayor of Provo, John Curtis, has also been critical and was quoted as saying, "If I could, I would get a plot in the city cemetery and bury it. iProvo is gone, it was sold. I would never like to utter iProvo again."[26]

The total cost of the network, estimated at around $60 million, likely outweighs any benefits to the City up to that point. In fact, the only impact that many Provo residents and businesses see today is the extra $7 per month for all Provo utility customers.

Challenges

The story of iProvo offers several insights that should inform ongoing debates over the efficacy of a city pursuing a municipal broadband network. In just over 10 years, iProvo had become a troubled asset that represented a failed venture into the competitive marketplace by a city government. While little published information can be found that details the performance of Provo's failed partnerships with HomeNet, Broadweave, and Veracity, certainly some lessons can be learned regarding their experience with customer service and the marketing of broadband.

The reluctance of residents and businesses to subscribe to municipal broadband services may hold insight into the decisions of businesses and residents to sign on or retain services. Perhaps the competitive broadband environment satisfactorily met the needs of Provo residents and businesses, and locals were comfortable with existing service providers to not take the chance on a municipal network provider. Another possibility for low subscribership was the controversy and political turmoil that plagued the effort early in the process, and many potential subscribers simply did not want to take the risk.

While there could be a challenge into changing Provo's prevailing attitudes regarding broadband providers in the past, Provo now certainly benefits from the co-branding as a Google fiber city. While it will cost the city and utility customers several million dollars for the next few years, some critics have said the Google save is proof that sometimes it is better to be lucky than financially responsible.

Looking back, iProvo faced some unique challenges in a number of areas and certainly produced some benefits for the community. Because of incumbent-protection legislation from the state, iProvo had the challenge of being required to use a pure open-access model, which means it could not directly offer any services. Though some communities in the U.S. have now found ways to make this work,

[26] http://www.heraldextra.com/news/local/provo-mayor-gives-update-on-city-s-economic-development-iprovo/article_e3ace13e-ea4f-51e4-a5d3-ad64adae91e6.html

most do not even attempt the model because offering direct services is generally required to generate sufficient revenue to pay down the debt from the system.

Therefore, aside from using a challenging business model and a fiber-optic technology that most community broadband networks have not used, iProvo made mistakes from which many have learned and few repeat. Although Provo succeeded in its goal of selling the failing network, Google might likely end up benefiting more than the customers it will serve.

Indeed, even though iProvo did not succeed, the sale of iProvo to Google is not the end of the story. While Google has committed to investing in the existing infrastructure to support gigabit connections and build out the network to all homes, it did not assume the nearly $40M in debt that the City had previously tried to transfer on to its original purchaser, Broadweave. The deal with Google requires Provo to spend upwards of $1.7 million on an array of items related to the transfer of ownership to Google. Moreover, with so much uncertainty surrounding Google's actual motivations for its relatively small-scale gigabit network, Provo residents could find themselves in another broadband experiment.

6. Municipal Retail Provider – Business Only

6.1 Overview

Municipalities that provide Internet, phone and other services to businesses customers are considered retail service providers. Most commonly, local governments provide Internet and phone services to local businesses in their jurisdictions. A common goal for municipalities that deploy broadband networks is to support local economic development needs. Local governments do so by equipping their business and industrial districts with fiber infrastructure through which they can provide cost effective, high-speed Internet and other services to local customers.

Municipalities that provide these services are responsible for managing business customers at a retail level. They manage all operations necessary to connect customers to the network and provide services. In nearly all cases, they provide Internet access as the primary service but many also provide a range of other communications services including business telephone, business security and data transport services. Municipalities that offer retail services compete directly with service providers in the local business market, which requires the organization to manage an effective sales and marketing function in order to gain sufficient market share to operate at a sustainable level.

Local governments have been known to underestimate the amount of effort required to successfully market and secure businesses as revenue-generating customers. Many of them have made the mistake of believing that the superiority of their product and pricing alone will result in customers subscribing to their service. Therefore, significant time must be dedicated to pre-marketing, testing products, setting rates and establishing the competitive strategy to overcome the tactics that competitive providers will use to stifle the government's ability to sign up new customers. The effort does not end with conversion of a potential into a revenue-generating customer. The correct back-office systems, business processes, and operational functions must work in unison to ensure a smooth activation of a new customer and a seamless transition from their former provider.

6.2 Services and Rates

Municipal business providers offer competitively priced Internet and communication services that are generally very competitive in the small and medium business market against other provider offerings. They compete on both price and quality, generally focused on the following value proposition to the end customer, all at a lower monthly cost:

- Higher bandwidth, scalable to Gigabit speeds
- Symmetrical service, the same upload and download
- Higher quality fiber connections with less downtime and a stronger service level agreement
- Responsive local customer service

Most municipal retail providers that offer residential services also offer business services, while some providers only offer business services, as shown in Figure 12. Some cities have focused their strategies on providing business services only and others use it as a first phase before moving into the residential

market. For example, the City of Hudson has launched business Internet services and plans to offer residential services once it has demonstrated success providing business services.

Figure 12: Municipal Retail Provider Service Portfolios

	Independence, IA	Fort Pierce, FL	Hudson, OH
Commercial			
Internet	✓	✓	✓
Telephone	✓	✓	✓
Data	✓	✓	✓
Wholesale			
Data		✓	
Dark Fiber		✓	
Community Anchor			
Internet	✓	✓	✓
Telephone	✓	✓	✓
Data	✓	✓	✓
Dark Fiber		✓	✓

Rates for business Internet services are less "commoditized" than for residential services and vary across markets. Figure 13 illustrates the range of Internet prices for Value, Standard, Premium, and Gigabit Internet service level packages in markets with municipal business providers. Gigabit packages offered in Cedar Falls, IA and Fort Pierce, FL have significantly higher prices than more "standardized" Internet packages offered by these providers at $895 and $999.95, respectively.

Figure 13: Business Internet Price Benchmarking for Municipal Retail Providers

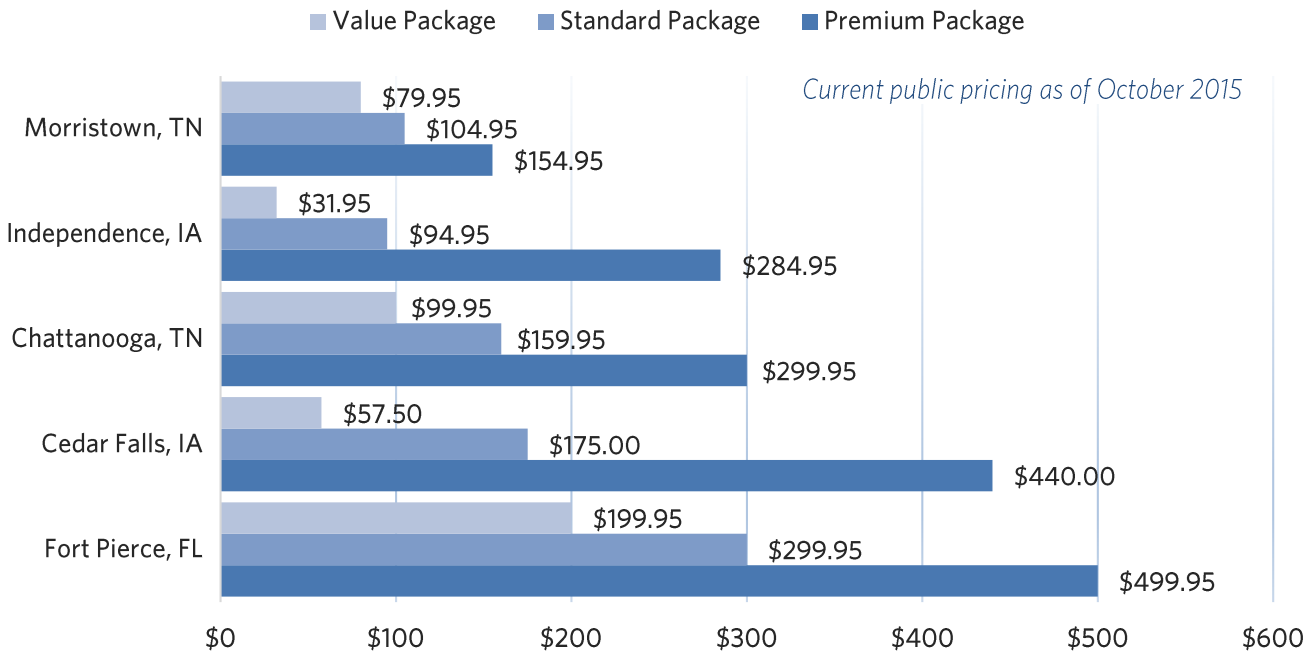
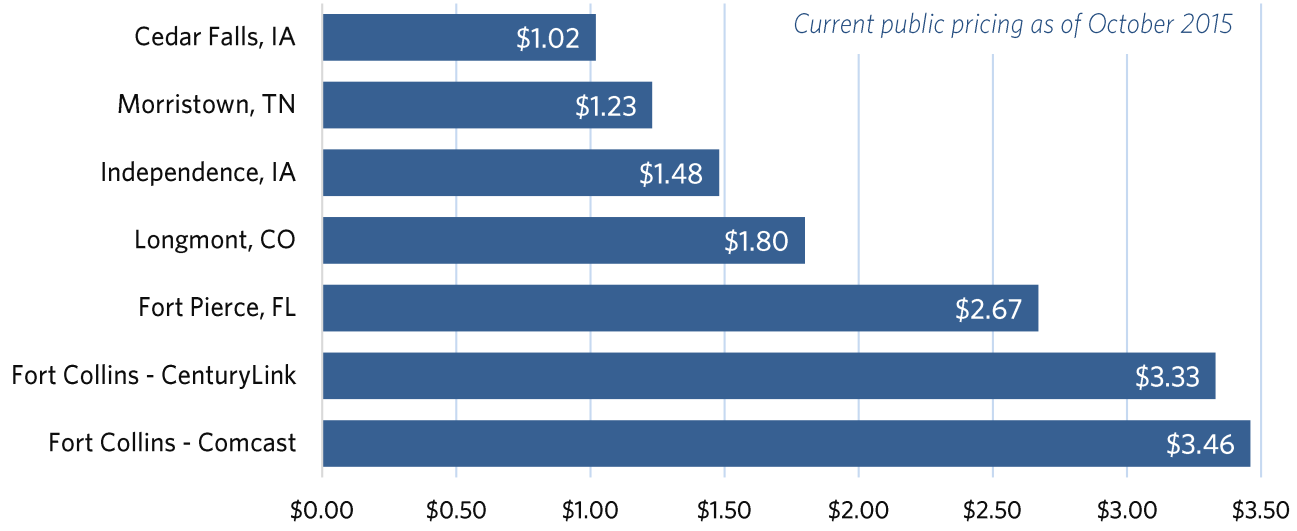


Figure 14 benchmarks the cost per megabit for business Internet services in Fort Collins against markets with municipal business providers. Cost per megabit is an important gauge that describes the cost that a business pays for each megabit of Internet service per month for a residential Internet connection. Since each provider offers unique speeds and prices, this measure allows one to compare costs for Internet services across multiple providers by simply dividing the price of an Internet connection by its speed.

Figure 14: Cost per Megabit Benchmarking – Fort Collins Compared with Municipal Retail Providers



As shown in the chart, the cost per megabit that residents pay in Fort Collins from CenturyLink and Comcast is considerably higher than in markets with municipal business providers. Effectively, in these markets businesses get "more for their money," as the cost per megabit is significantly lower. The lower the cost per megabit, the more Internet bandwidth residents get for each dollar spent.

6.3 Organizational Profiles

Section 6 covers a range of municipal retail providers that also offer business services and provides organizational profiles for these providers. Limited organizational and financial information was received from municipal business providers and sufficient data was not obtained to assess any benchmarking or trending in the report. For the municipal business providers studied, Fort Pierce Utilities Authority and Independence, IA were structured under municipal utilities, similar to the municipal retail providers covered in Section 6.

6.4 Municipal Retail Provider (Business Only) Considerations for Fort Collins

Organizational & Operational	• Retail business services give the municipality greater impact in economic development than in passive, non-retail models • Businesses require strict service level agreements and quality • Business services can be a stepping stone toward residential services • The municipality can deploy business services in a pilot project and use a phased approach that doesn't require "universal service" • Businesses require 24x7 support and the City should appropriate staff accordingly
Competitive Environment	• Small and medium business markets do not have highly competitive fiber products • Competitively priced fiber Internet services are a differentiator in most markets • Providers will use tactics to "lock up" the business market, using long-term contracts and promotions
Political Environment	• Lower political exposure than residential services but high stakes because businesses will complain if service is poor • Strong support for economic development and making businesses more competitive
Funding Environment	• Funding can be easily phased, pilot projects can be staged prior to full funding commitments • Operational funding is required for staffing, network operations, billing and reporting • Higher margins from business subscribers may yield a better payback and return on investment
Community Benefits	• Drives lower costs and higher quality for small and medium businesses • Economic development tools to attract and retain business • Greater competition with a new market entrant • More diversity of services to meet business needs

6.5 Municipal Retail Provider Case Studies (Business Only)

6.5.1 Fort Pierce, Florida

Community Profile

Fort Pierce has been the hub of St. Lucie County, Florida for over 100 years. Situated on the "Treasure Coast," Fort Pierce is one of the oldest communities on the east coast of Florida. The city's population is 42,645 and covers 29 square miles. Downtown has retained its old Florida charm and scale, as it has welcomed new development and revitalization. Fort Pierce is home to educational and research facilities, like the top-ranked Indian River State College, Smithsonian Marine Station, Manatee Observation and Education Center and Harbor Branch Oceanographic Institution at Florida Atlantic University.

Deployment of the Initial Network

In 1994, Fort Pierce Utilities Authority (FPUA) began to build a fiber optic network to replace the leased data links between its buildings in Fort Pierce. The new network proved more reliable and cost effective, and was built with sufficient capacity for external customers. In 2000, FPUA allocated separate fibers through which it began to offer dark fiber connectivity to other institutions under the brand FPUANet. This soon expanded to include businesses and anchor institutions in the local area. As the general municipal utility, FPUA, maintains ownership of the fiber network and allocates a portion of the costs to FPUANet for the portion of the network utilized to provide communications services. This enables FPUANet to maintain a lean operational structure and offer low cost services to the market.

Development of Broadband Services

FPUA is in the process of expanding the FPUANet network into adjacent counties. This will enable regional interoffice links, and improve the efficiency of local governments throughout the multi-county area. FPUANet is also expanding its service portfolio and offerings to offer competitively priced fiber connectivity, Internet and related services to the business market across these counties. Although FPUANet receives many requests to provide residential services, FPUANet does not currently have any plans to enter the residential market.

FPUANet also provides wireless broadband Internet and wireless bandwidth connections, which extend FPUA's fiber through wireless communications in order to reach more businesses in the area. The FPUANet mission statement is "To help promote economic development and meet the needs of our community with enhanced, reasonably priced communications alternatives."

FPUANet's product portfolio includes the following:

- Dedicated Internet Access
- Fiber Bandwidth Connections
- E-Rate Eligible IP Services
- Dark Fiber Services

Impact to the Community

FPUANet services provide the only affordably priced fiber-optic broadband services available in the City of Fort Pierce. Aging copper infrastructure and a lack of significant business concentration has limited the deployment of fiber infrastructure from competitive broadband providers in the area. With costs starting around $1,200 per month, only the largest businesses and anchor institutions have been able to afford the high price of bringing direct fiber connectivity to their facilities. The small and medium business market in Fort Pierce is forced to utilize existing cable and DSL services from the incumbent providers and many businesses have complained that these services have not been sufficient to meet their needs.

Challenges

FPUANet reported its significant challenges have centered on evolving from its electric utility heritage and operations into a full-fledged telecom company. As FPUANet services have grown to serve more of Fort Pierce's customer base, FPUANet has realized the importance of establishing the right technical infrastructure, equipment and operating procedures to support and manage its services. With that in mind, FPUANet is currently redesigning its network to scale, giving the utility the ability to serve more customers with greater reliability and lower operational overhead.

This process has focused on how FPUANet's physical fiber network grows to support more connections that can provide gigabit services and beyond. The analysis has also determined new access architecture and equipment to provide more cost effective GPON and Active Ethernet services using industry standards and best practices. FPUANet has experienced these "growing pains," common to many municipal utilities and is beginning the implementation of its new network infrastructure this year.

6.5.2 Hudson, Ohio

Community Overview

Hudson is a city located in northeastern Summit County, Ohio, with a population of 22,262 and 7,620 households. Hudson is considered a commuter town and is part of the Akron Metropolitan Statistical Area, which is part of the larger Cleveland Combined Statistical Area. The city has a total area of 25.87 square miles, of which 25.60 square miles is land, giving Hudson a population density of 869.6 residents per square mile.

In 2010, Hudson was named of the 100 Best Communities for Young People by America's Promise. The award was based on the city's "Community First" organization that was developed in the 1990s to promote better choices in the city's youth by providing additional educational and cultural opportunities. In 2007, the median household income in the city was $112,740, with per capita income of $40,915. About 1.3% of families and 1.7% of the population were below the poverty line. Of the city's population over the age of 25, 68.0% held a bachelor's degree or higher.

Most of Hudson's retail is located in concentrated areas. Most notable are two downtown blocks of historic buildings located on North Main Street, which is the original center of business in Hudson,

that continue commercial use by retail and office use. As an innovative means of local business support, in November 2002, Hudson was the first US community to launch a citywide gift card. The card was envisioned by the Hudson Chamber of Commerce to help stimulate local business and keep shopping dollars with the independent merchants in town.

Keeping with that tradition of local business support, on July 22, 2015, the city announced plans to become a municipal broadband service provider and serve gigabit connectivity over a fiber network. Launched shortly after in September 2015, business customers in select locations are signing on to the service with expansion to the downtown business corridors planned next through a phased citywide growth approach.

Development of the Initial Network

In January 2015, the city conducted a residential and business survey to determine the overall state of broadband in the community. Almost 1,000 residents and 133 businesses answered the survey that revealed that Internet services were lacking in coverage, speed, performance, and reliability.

Through the survey process, Hudson's small and medium business community reported many issues with their current broadband services, often citing poor reliability and performance as negatively affecting their ability to do business in the city. Many businesses wanted to upgrade to a better service but found that they could not afford to do so.

As an outcome of the survey and planning process, and through the 94-page "Broadband Needs Assessment and Business Plan," the City decided it would offer the service like it offers public power, water and other infrastructure.[27] Soon after, Hudson City Council approved the initial $800,000 capital expenditure to begin the deployment, and the City expects to spend another $1.5 million in 2016 on infrastructure.[28]

Like other communities that have recently decided to invest in municipal networks, Hudson's focus is only on Internet access and voice. The gigabit network, to be owned and operated by the City of Hudson, will be deployed incrementally by Hudson Public Power focusing on downtown and areas of high demand. Through the reinvestment of service fees from customers, the City plans to grow the network as a self-sustaining venture.

Development of Broadband Services

Hudson's municipal network is marketed under the name Velocity Broadband, and is one of the first cities in the Midwest to offer gigabit connectivity. The City is focused exclusively on Internet and voice, and is signing on business customers while the network is being deployed. The city has no definite plans to serve residents but once business services are in place, they will consider a residential service offering.

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[27] http://www.hudsonhubtimes.com/news%20local/2015/02/18/city-takes-next-step-toward-broadband-service
[28] http://www.hudsonhubtimes.com/news%20local/2015/06/07/city-invests-800-000-in-broadband-project

For now, the focus is on small and medium businesses. Hudson officials realize that connectivity is an essential service for economic development and they understand that businesses have no reservations about relocating to places where they can get the bandwidth they need.

The economic development director in Hudson says, "economic development is 80% retention, and Hudson businesses are unhappy with their current service. They want something like this."[29] And, they anticipate by offering these services, they will attract more businesses to Hudson, and more income tax, and retain more businesses."

Impact to the Community

While just launching at the time of this report's creation, impacts are too early to include here. A local public relations firm will be one of the beta testers as the network progresses. They upload and download large data files on a daily basis and their current 5 Mbps connection is inadequate. The CEO of the company says that their current Internet is constantly going down, and when that happens, staff must leave their offices to find other places in town with available Internet, such as coffee shops. Clearly, improved quality of broadband services will have an impact on this business, so similar business examples throughout Hudson taken in aggregate will have a substantial positive effect on the community.

[29] http://www.hudsonhubtimes.com/news%20local/2015/07/26/velocity-broadband-coming-to-hudson-as-city-utility

7. Municipal Retail Provider – Residential

7.1 Overview

Municipalities that provide end user services to residential and business customers are considered retail service providers. Most commonly, local governments offer triple-play services consisting of phone, television and Internet services. As a retail provider, the organization is responsible for a significant number of operational functions, including management of retails services, network operations, billing, provisioning, network construction and general management.

Municipalities that compete with broadband providers in business and residential markets must be effective in their sales and marketing efforts to gain sufficient market share to support investments needed to build and operate these networks. Retail providers must carefully develop their market strategy, product portfolio, rate structures, and service packages. The competitive and low margin nature of residential broadband services means that a provider must achieve a significant market share to operate profitably. Residential broadband is a volume business and without sufficient market share, providers are challenged at covering their high costs of operating, investing in network expansion, maintaining reserves, and covering debt service.

Perhaps the most important decision when evaluating a retail business case is whether the municipality should provide linear television services. Television is the "glue" that holds the triple-play service bundle together, and without television, many networks fail to achieve strong market share above 30%. However, the business case to carry television services results in a break-even in many cases that does not generally provide contribution margin to the business like Internet and phone services do.

In fact, the cost to provide television services are staggering, including several million dollars for headend equipment, significant monthly per subscriber costs for content, and high ongoing operations and management costs. Moreover, the television delivery model is evolving with more online content and "over the top" programming. The current model is expected to significantly change within 3-5 years, posing significant technology risk to new municipal providers who choose to invest in the equipment necessary to provide these services. Therefore, municipalities that enter the retail market must be very careful to plan their market strategy correctly, especially in today's changing technology environment.

7.2 Services and Rates

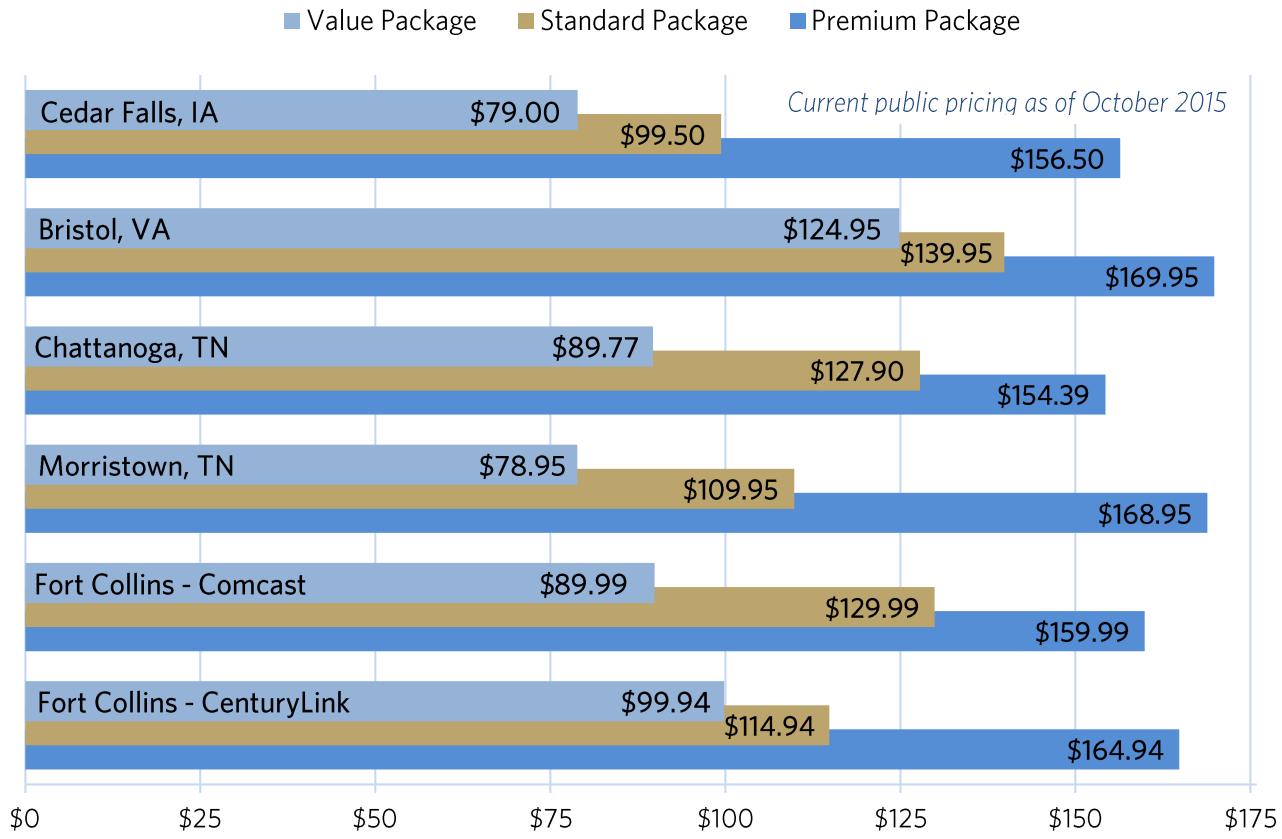
Municipal retail providers have used deployed FTTH to compete on speed, quality and sometimes price to win market share. Municipal retail providers that provide residential services in most cases also serve business, community anchors, and wholesale customers in their markets. This enables them to make greater use of their resources to serve more customers. Figure 15 provides a comparison of five municipal retail providers.

Figure 15: Municipal Retail Provider Service Portfolios

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA	Longmont, CO
Residential					
Internet	✓	✓	✓	✓	✓
Telephone	✓	✓	✓	✓	✓
Television	✓	✓	✓	✓	
Home Security			✓		
Other			✓		
Commercial					
Internet	✓	✓	✓	✓	✓
Telephone	✓	✓	✓	✓	✓
Data	✓	✓	✓	✓	
Wholesale					
Data	✓	✓	✓	✓	
Dark Fiber	✓		✓	✓	
Community Anchor					
Internet	✓	✓	✓	✓	✓
Telephone	✓	✓	✓	✓	✓
Data	✓	✓	✓	✓	✓
Dark Fiber	✓	✓	✓	✓	
Other		✓	✓		

In many cases, municipal retail providers maintain pricing similar to the existing market but offer improved quality of services to their subscribers, more bandwidth and better customer service. Figure 16 illustrates how monthly rates for triple-play services in Fort Collins compare against the municipal retail providers analyzed in this study. As indicated by the chart, rates for the common triple-play packages from Fort Collins' two dominant providers, CenturyLink and Comcast are similar to rates from municipal retail providers.

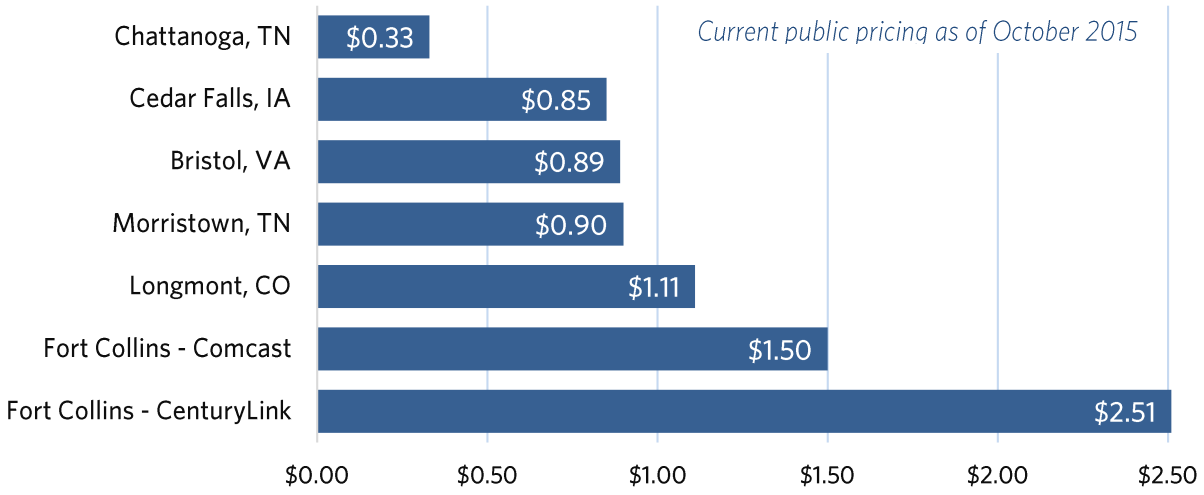
Figure 16: Triple-Play Price Benchmarking – Fort Collins Compared with Municipal Retail Providers



The key differentiator for municipal retail providers is the robustness of their Internet service. Figure 17 illustrates the "cost per megabit" that residents pay for Internet service from CenturyLink and Comcast in Fort Collins compared with what residents pay from municipal retail providers in other markets. Cost per megabit is an important gauge that describes the cost that a resident pays for each megabit of Internet service per month for a residential Internet connection. Since each provider offers unique speeds and prices, this measure allows one to compare costs for Internet services across multiple providers by simply dividing the price of an Internet connection by its speed.

As shown in the chart, the cost per megabit that residents pay in Fort Collins from CenturyLink and Comcast is considerably higher than in markets with municipal broadband providers. Effectively, in these markets residents get "more for their money," as the cost per megabit is significantly lower. The lower the cost per megabit, the more Internet bandwidth residents get for each dollar spent.

Figure 17: Cost Per Megabit Benchmarking – Fort Collins Compared with Municipal Retail Providers



7.3 Market Penetration

Municipal retail providers have been known to achieve high residential penetrations in the markets they serve, in many cases over 50%. Figure 18 illustrates market penetration for five municipal retail providers. In most cases, these providers have achieved their residential uptake over a period of 6-7 years. Commercial market penetration has varied considerably among residential retail providers, in part because in these markets, there are additional options for commercial services whereas the options for residential services were limited to one or two. Figures for the City of Longmont are estimated as they are currently progressing through Phase 2 of their FTTH deployment.

Figure 18: Market Penetration Benchmarking – Municipal Retail Providers

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA	Longmont, CO
Residential					
Homes Passed	14,500	140,000	16,800	15,000	4,000
Residential Subscribers	5,600	70,000	12,700	13,000	500
Residential Take Rate	39%	50%	76%	87%	13%
Years to Achieve Penetration	6 years	7 years	6 Years	7 years	2 Years
Commercial					
Commercial Premises Passed	3,200	14,000	2,800	2,500	500
Commercial Subscribers	750	4,500	2,100	1,100	N/A
Commercial Take Rate	23%	32%	75%	44%	N/A
Years to Achieve Penetration	8 Years	10 Years	6 Years	6 Years	N/A

These providers have experienced strong uptake of their services, which they attribute to a combination of leading edge pricing, competitive pricing and high-quality local customer service. All

five providers reiterated the importance of local service to keeping their existing customers and winning new customers. They attributed their electric utility heritage as a key aspect that allowed them to provide high levels of customer service to their customers. Figure 19 provides a quick community profile of each municipal provider.

Figure 19: Community Profiles in Municipal Retail Provider Markets

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA	Longmont, CO
Population	29,324	173,778	17,341	40,566	90,237
Square Mileage	20.9	137.15	13.2	28.9	26.19
Households	11,412	79,607	17,000	14,608	33,551
Median Household Income	$33,216	$38,064	$32,221	$50,546	$58,698

7.4 Organizational Profiles

All five municipal retail providers studied in this report also maintained municipal electric utilities as part of their municipal organization. The presence of a municipal electric utility creates an environment that fosters the development of broadband services for a number of reasons, including:

- Operational expertise managing a critical service for the community
- Subject matter expertise in fiber-optics, in cases where municipal electric utilities maintain their own fiber-optic plants for SCADA communications
- Ownership of pole lines, infrastructure and facilities throughout the service area
- Ownership of vehicles and equipment needed to maintain fiber-optic networks
- Business process expertise managing sales, marketing, billing, accounting and reporting
- Access to capital markets and funding programs generally beyond municipality without a municipal electric utility
- Resource and cost allocation techniques that enable the sharing of resources between municipal electric and communications utilities

In all cases, municipal retail providers in this report maintained sizable electric utilities and in each case, an initial fiber network was built to support the electric utility's needs prior to deploying any broadband services. In these cases, the electric utilities built their own fiber networks to support substation communications needs, which catalyzed their expansion to provide broadband communication services.

Figure 20: Organizational Profiles of Municipal Retail Providers

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA	Longmont, CO
City-Owned Utilities					
Electric	✓	✓	✓	✓	✓
Water/Sewer	✓	✓	✓	✓	✓
Gas				✓	

7.5 Financial Profiles

All five municipal retail providers studied in this report utilized some type of bonding vehicle to finance the initial municipal retail FTTH network. In the case of Chattanooga and Bristol Virginia Utilities, federal Department of Energy (Smart Grid) and Department of Commerce (Broadband Technology Opportunities Program) grants provided supplementary funding for portions of their broadband deployments and are not included in numbers provided in Figure 21 below. In these cases, each utility financed the construction of the outside plant fiber optic network, headend equipment and related capital assets through bonds.

Figure 21: Funding Sources for Municipal Retail Providers

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA	Longmont, CO
Investment	$20,000,000	$161,000,000	$32,000,000	$15,450,000	$45,300,00
Funding Source	GO Bond	Rev. Bond	Rev. Bond	GO & Rev. Bond	Rev. Bond
Term of Debt	N/A	20 Years	25 Years	15 Years	20 Years
Interest Rate	N/A	4.0%	3.67%	3.0%	3%-5%

Revenues and expenses for four of the five municipal retail providers are provided in Figure 22. The City of Longmont, CO was not included in this analysis because the municipality is still in its "launch phase" and has not published financial results to date. Also, 2014 CAFRs from the City of Longmont, CO did not provide financial information that was relevant to use in the analysis.

The four municipal retail providers can be considered mature operating utilities that have been providing FTTH services for at least 5 years. The revenues represented are for the most current fiscal year and represent a steady "run rate" for each utility. Municipal retail providers generate the majority of their revenues from residential services. For the four providers below, each generates about 70% of gross revenues from residential services consisting of voice, video and data. The remaining revenues are generated through providing services to businesses, community anchors (schools, hospitals, and others) and wholesale services to other providers.

Costs vary considerably between these providers, which is also generally true for municipal retail providers. Therefore, it becomes difficult to set benchmarks consistently as each provider has a cost structure that differs from its peers. Municipal retail providers also account for their expenses using

methodologies that vary from state to state, which is partly due to their statutory reporting requirements and partly due to how they structure their enterprise funds internally. Therefore, we do not advise that Fort Collins rely on the performance of other municipal retail providers (or other types of municipal providers) to forecast its own expected performance. Rather, the numbers represented in these analyses should be used as a guide to understanding how other municipal providers have performed in their specific environments anecdotally, rather than quantitatively.

Figure 22: Profit & Loss Statements from Municipal Retail Providers (Most Recent Year)

	Morristown, TN	Chattanooga, TN	Bristol, VA	Cedar Falls, IA
Gross Revenues				
Residential	$6,103,352	$67,002,000	$19,500,000	
Commercial	$1,525,838	$24,169,000	$6,600,000	
Community Anchor			$2,200,000	
Interfund Allocations	$921,003			
Other Revenue	$386,742	$8,712,000		$3,966
Cable System Revenue				$7,913,921
Data Service revenue				$5,975,439
Access Revenue				$236,407
Private Line Revenue				$179,980
Total Gross Revenue	**$8,936,935**	**$99,883,000**	**$28,300,000**	**$14,309,713**
Operating Expenses				
Cost of Services	$6,181,982	$34,555,000	$15,000,000	
Maintenance	$238,941	$31,168,000		$8,009,105
Sales, General & Administrative		$2,207,000	$4,800,000	$2,999,629
Depreciation	$372,067	$15,073,000		$2,190,992
Interfund Transfers	$962,339			
Taxes	$87,683			
Total Operating Expenses	**$7,843,012**	**$83,003,000**	**$19,800,000**	**$13,199,726**
Operating Income	**$1,093,923**	**$16,880,000**	**$8,500,000**	**$1,109,987**
Non-Operating Expenses				
Debt Service	$32,011		$1,470,000	
Other Income/Expense				$(515,320)
Interest & Misc. Income	$(1,699)			$(270,294)
Interest Expense	$32,416	$1,697,000		$502,144
Non-Operating Expenses	**$62,728**	**$1,697,000**	**$1,470,000**	**$(283,470)**
Net Income	**$1,031,195**	**$15,183,000**	**$7,030,000**	**$1,393,457**

7.6 Municipal Retail Provider Considerations for Fort Collins

Organizational & Operational	• Requires experienced staff and management with prior broadband experience • Should be approached as "starting a new business" in a new industry • Organizational culture focused on service is critical • Presence of an electric utility is important for business and operational competence
Competitive Environment	• Superior products only sell if the benefits can be demonstrated – focus on the benefits not the technology • Marketing and sales are key to achieving uptake and profitability • Competition will use any legal tactics to protect their turf against a new market entrant • Marketing and sales plan must be developed, tracked, managed and adjusted as the environment changes
Political Environment	• Requires strong commitment from officials to back financing • Must have a positive reputation in the community • Expectations should be set early on and managed through deployment • Should consider expectations for universal service and lifeline programs; bridging the digital divide is a key aspect of municipal retail providers • Total financial commitment and total control • High risk/high reward business model
Funding Environment	• Funding can be phased, but to achieve scale funding to cover a large market share is required, 40% market share is a general figure for "break even" of FTTH networks • Electric utility funding capacity can provide better rates without hitting taxpayer pockets • Consider separate funding instruments for long-term capital assets vs. equipment • Consider operating fund requirements for the first 3-5 years, operating costs generally run 50% - 60% of gross revenues
Community Benefits	• Community is in significant control of services provided • Dollars stay local within the community • Future-proof community needs and scale to meet future demand • 21st century amenity that attracts creative class

7.7 Municipal Retail Provider Case Studies (Residential)

7.7.1 Bristol, Virginia

Community Overview

The City of Bristol lies in rural southwest Virginia. Beginning in the 1980s, this rural community of 17,000 residents began to suffer an economic downturn due to legacy industries of coal, tobacco and textiles becoming less viable on the national and world stage. This led to concerns from community leaders and the local economic development commission on how Bristol would revitalize its business and industrial base.

The City of Bristol and its surrounding communities have relied on Bristol Virginia Utilities (now BVU Authority) to provide electric, water and wastewater services since 1947. Beginning in 2001, BVU realized that in order to economically and effectively manage their electric grid, it needed a better way to communicate with the electric power substations, and the best way to provide that service was to deploy a fiber-optic network for high-speed, reliable communications.

Development of the Initial Network

By 2003, BVU had built a robust fiber-optic network to provide this platform for its electric substations. The City and BVU soon realized that connecting municipal sites and departments to this network could significantly reduce costs. They were correct and after bringing the City sites online, the City effectively saved $1.5M over the next three years for taxpayers in the community. This strategy not only reduced costs but also protected the City from future cost increases. As the City's online services grew, so did its needs for bandwidth. BVU's network provided ample capacity to accommodate this growth without increasing cost to the City.

By design, BVU's fiber-optic network passed many of the industrial parks and business areas within the city, and local leaders determined that its network could provide enhanced benefits to economic development in an effort to revitalize the community. In 2005, BVU launched a program to take its network commercial. In order to effectively provide a portfolio of services, BVU recruited service providers to use extra capacity on the network to provide their products and services to businesses. After exhaustive searches, no viable service providers were willing to enter the market and make the required investments to service such a rural area.

Development of Broadband Services

The City of Bristol and BVU made an important decision to begin providing services directly to businesses and residents within the community. BVU now provides triple-play services to customers of Bristol and surrounding areas. As a municipal-owned provider, BVU is responsive to the needs of its constituents and has positioned its community for the future.

Impact to the Community

- Reduced government spending by $1.5M in the first 3 years
- Lowered and stabilized business and residential Internet costs by about 20%
- Reduced education spending by about $750,000 in the first 5 years
- Independent study showed that the business and residential community saved almost $10M due to rate reductions the first 5 years
- Energized the economy by adding over 1250 jobs, and retaining about 700 jobs
- Nearly $50M in new private investment, which increased annual payrolls by $37M dollars
- One of the first communities to offer 1 Gigabit to business and residents
- Network serves nearly 12,000 residential and 2,500 business customers
- Achieved almost 70% market penetration in the city's footprint
- Provides fiber backhaul for Verizon cell towers, enhancing mobility speeds in the region
- Provides transport for multiple service providers, supporting their wholesale needs
- Reinvestment of proceeds back into the network and economic development opportunities for the entire community
- Received BTOP and VTC grants of almost $33M to extend the current fiber backbone through 8 more counties, based on success of the current network
- Connected schools, healthcare, public safety and community support to significantly reduce taxpayer spending in the region

Challenges

The biggest challenges that BVU faced in launching OptiNet were overcoming outdated Virginia state laws related to municipalities offering telecom services, and legal and regulatory issues raised by local incumbents. One of the biggest hurdles was a State of Virginia statute that prohibited municipal entities from offering telecom services. Because OptiNet is government owned, BVU could not legally provide telephone, Internet, or video services in Virginia. To overcome this obstacle, the utility filed a complaint against the state, pointing out that a more recent federal statute – the Telecommunications Act of 1996 – made the state law invalid. The Virginia General Assembly agreed in 2002 by overwhelmingly passing legislation that reversed the previous ruling.

That same year, as BVU was ready to roll out its suite of services, the incumbent cable operator in Bristol entered an injunction against BVU, claiming the utility wasn't legally authorized to provide cable television (CATV) services. The courts ruled in favor of the cable operator, and BVU was forced to seek a legislative change to its charter and a separate legislation that would allow it to provide the services. In 2003, the Virginia General Assembly once again came to the rescue, passing Senate Bill 875, which reversed the decision.[30]

[30] Broadband Communities Magazine. http://www.bbpmag.com/2008issues/aug08/AugSep08_MuniSnapshot.pdf

7.7.2 Ashland, Oregon

Community Overview

The City of Ashland, Oregon rises to an elevation of 1,949 feet nestled in the foothills of the Siskiyou and Cascade ranges, about 15 miles north of the California border on Interstate 5, and about 12 miles south of Medford and about 300 miles south of Portland. Ashland is home to around 20,000 people and 9,400 households, with a total area of about 6.6 square miles, leading to a population density of 3,047 people per square mile. About 21% of the population and 13% of families have incomes below the poverty line. Out of the total population, about 30% of those under the age of 18 and 3.5% of those 65 and older live below the poverty line.

The largest employer is Southern Oregon University (SOU), with a faculty and staff of over 750. Typical of smaller towns, health services (400 employees), and schools (300 employees), are the major employers, while businesses related to outdoor recreation, transportation, technology and light manufacturing are also important employers. However, income from tourism is important to Ashland's economy, and leads the way for a significant number of restaurants, galleries and retailers that cater to the nearly 400,000 visitors that attend the Oregon Shakespeare Festival.

A municipal network commonly cited as a failure is the Ashland Fiber Network (AFN) in Oregon. As a pioneer in the municipal network movement in the late 1990s, Ashland certainly made a number of mistakes, which communities across the country have learned from. However, Ashland itself has learned from those early challenges, fixed many of the problems, restructured its business plan, and the network has now gone on to certainly benefit the city.[31]

Development of the Initial Network

The City of Ashland's Electric Department originally presented its case to create Ashland Fiber Network in the mid-1990s. The proposal responded to the regulatory, market, and public environments of the period. The 1990s were an exciting time of growth and experimentation with high-technology industries taking hold, stock markets at historically high levels, capital markets flush with low-interest money, the Federal government prioritizing telecommunications services through the Federal Telecommunications Act of 1996, and deregulation of energy markets setting an unknown future for public utilities providers. In that time of innovation, Ashland presented the creation of AFN as an opportunity. A telecommunications utility could meet the new demands for communications services in Ashland while diversifying and bolstering the City's electric business. Electric rates were also pledged in support of the effort.

Ashland's City Council approved the Electric Department's plan to build a fiber optic ring in February 1997 and an AFN Implementation Team was formed. The AFN business plan was presented by the Electric Department to Ashland's City Council in late-1998 and was approved. That plan intended for

[31] http://www.ashland.or.us/Files/Proposed%20AFN%20Business%20Plan.pdf

Ashland Fiber Network to be self-supporting through revenues, with initial construction debt repaid by operating revenues within a ten-year period.

The AFN project experienced financial problems quickly after launch. Charter Communications purchased a local provider and rebuilt their network in Ashland to create an equal alternative. Price competition ensued and AFN construction costs went significantly over budget. The utility failed to generate positive revenues from inception and a critical moment for AFN came in 2004, when the City determined that AFN would never be able to pay its business and intra-fund loans. $15.5 million in bonds were issued to consolidate AFN-related debt and to provide a degree of financial certainty.

AFN continued to struggle to define its business and identity over the ensuing years. Various managers all brought their own strategies and organizational structures to attempt to make AFN viable. Restructurings included staff moves, separating AFN from Ashland's Electric Department, investing in new products to sell that did not materialize, contracting out operation of AFN's cable television business line in late-2006, refocusing on providing wholesale Internet service and even crossing resources between AFN and the internal City technology division. That lack of long-term clarity has contributed to the mixed results and weak financial performance that exists today.

Development of Broadband Services

Today, Ashland Fiber Network is a decade old and operates primarily as an Internet service wholesaler. Its revenues have not met operating and debt expenses, and capital reinvestments into the AFN infrastructure have been nominal at best. Though on a performance basis, AFN has shown a strong record of meeting standard operating measures, it is not yet positioned to offer the new services that customers demand in terms of planning, resources, contracts and projects.

AFN struggled during the period when its cost pressures were much lower and net revenues could have been much higher. Internet service provision continues to transform into a commodity, with characteristically low margins and limited growth potential. Indeed, Internet-based entertainment and communications services carry more value than the infrastructure those services operate on.

Impact to the Community

AFN borrowed its startup funds from the Ashland Electric Utility. After years of city departments covering AFN shortfalls, in August 2004 the City took out $15.5 million in bonds with an annual debt payment of $1.43 million. In October 2005, the City adopted a surcharge of $7.50 on all electric bills to subsidize AFN – a surcharge that was later rescinded after protests from citizens. In December 2005, $500,000 was given from the electric department to help AFN pay its debt.

Between 2005 and 2007, AFN did not contribute anything to its debt service and between 2008 and 2010 it contributed $356,000, with $700,000 in 2011, and $409,000 in 2012. Property taxes now help cover part of AFN's debt. Thus, residents who were not offered system access or who chose not to use it were still required to subsidize the network through higher property taxes.

Challenges

The existence of a municipal network does not assure universal service because there is no guarantee that the network will be built out to reach all residents in a given geographic area. The challenge is related to the cost to build the infrastructure to certain areas that may be prohibitive because of terrain or density of population. This can be seen in the case of the AFN.

In fact, about 1,300 Ashland households did not receive AFN services because it was too costly to build the infrastructure to service certain areas. In declining to provide service to hard-to-reach areas, AFN engaged in the same business practices as private firms, essentially avoiding high-cost areas. However, unlike a private firm, when a municipal network declines to serve all households in its area, property owners who do not have access must still pay for the system in the form of higher taxes.

7.7.3 Morristown, Tennessee

Community Overview

Morristown is the seat of Hamblen County, Tennessee, and has a population of 29,304 across the city's 27.9 square miles, giving it a population density of 1,044 people per square mile. There are 11,020 households in Morristown, with a median household income of $33,217, and per capita income at $17,690. About 26.2% of the population is below the poverty line. It is the principal city of the Morristown Metropolitan Statistical Area, which encompasses all of Grainger, Hamblen and Jefferson counties. The Morristown MSA is part of the Knoxville Combined Statistical Area.

Public schools in Morristown are operated by Hamblen County Department of Education. There are four middle schools and two high schools. The main campus of Walters State Community College is located in Morristown, with King University and Tusculum College having satellite campuses.

In the post-WWII years, the community evolved from an agricultural economy to a manufacturing based economy, producing such a wide range of products as textiles and furniture to automotive parts and high tech plastics. Located on Interstate 81 at the crossroads of US highways 25E and 11E, and less than 8 miles from Interstate 40, with access to major railways, Morristown has now grown into an industrial and manufacturing center for east Tennessee, with 70% of the utility's electricity serving industrial and large commercial customers.

Morristown serves as the hub of the Lakeway Area for employment, manufacturing, healthcare and educational services. Tourism is a sizeable industry as well, anchored by Cherokee Lake, which has 463 miles of shoreline in Hamblen County that attracts 2.5 million visitors annually, and is within an hour of the Great Smoky Mountains National Park, which attracts over 10 million annual visitors.

Development of the Initial Network

Among the first three or four utilities in the nation to develop their own fiber to the home broadband system, the desire to deploy the network was actually born out of the desire to provide better television service. In 2004, a new mayor and some new council members responded to the call from the public to do something about the incumbent cable TV provider, which had consistently increased

rates and had terrible customer service. The city tried to negotiate with Charter without success to hold down rates, so they asked the utility to enter the business.

Besides cable TV rates, there was concern to improve broadband capabilities to support existing businesses and recruit new industry. After some surveys of customer interest, Morristown filed a business plan with the state comptroller, and asked for a referendum to be sure the citizens supported borrowing the money to enter the business. The results were overwhelmingly in favor of the Morristown Utility Systems (MUS) proceeding with the plan.

At the time of Morristown's initial deployment in 2004, fiber-to-the-home was not a common practice, and leadership was not comfortable with the investment. However, once they realized that fiber was a way to secure the network investment for the future, it was an easy decision. The decision has certainly paid off, as nearly a decade later the upgrade to gigabit capability did not have to touch the fiber network – the electronics were simply changed on either end.

From a municipal perspective, MUS connects all county libraries, and several of the hospitals, for which it is also developing a new traffic control system in conjunction with the county fire and police departments and the 911 system. All of the Board of Education schools are connected, except for a couple in the county that are not served by MUS, along with two local colleges. All of those organizations are connected with either gigabit or 100 Mbps connections.

Development of Broadband Services

Morristown Utility System (MUS) FiberNet started signing up customers in May 2006, and by late 2008 already had a take rate of 33%. In July 2015 over 44% of homes passed, and an even greater percentage of businesses. In fact, 100% of Morristown households have access to broadband Internet. Out of the four service providers that Morristown has for broadband, 80% of residents have availability to choose from at least two of those providers.[32]

The leadership of MUS believes that the most important thing they can do is provide superior customer service, so a local call center was established, with technical support, right on Main Street in downtown. With that, response times have been minimized, whether customer equipment needs replacing or a new business is opening, they can react to customers needs quickly.

For business, speed and reliability of Internet are critical. Regarding speed, MUS's perspective is not to sell a customer more bandwidth than they need just to drive profit. Most businesses start out with 4Mbps of guaranteed symmetrical bandwidth, while most commercial service providers start at 12Mbps. Morristown's gigabit speeds are available should a customer need it, but MUS is not going to sell a gigabit of service simply for the sake of profit grabbing.

For the electric side, MUS uses the network to deploy real-time advanced metering services. This allows MUS to automate demand response, which lowers our wholesale power bills, provides better

[32] http://www.musfiber.net

services, and reduces operational costs, by remote disconnect, where trucks aren't dispatched as much. Meters can be checked in a matter of seconds, so the network is really redefining the way MUS provides services and conducts its business.

FiberNet's strong financial performance resulted in MUS becoming cash flow positive just two years after launch, and net income positive after five years. Both of these key milestones were reached significantly quicker than initially projected. In terms of revenue, FiberNet generated $8.6 million during 2013 and $8.9 million during 2014. FiberNet's solid financials have translated into a 35% increase in MUS's payments in lieu of taxes to the City, which now amount to $350,000 per year, up from $150,000 in 2010.

Impact to the Community

Morristown businesses and residents are saving $3.4 million annually thanks to MUS FiberNet's introduction of lower prices in the local broadband market. MUS thinks that if the FiberNet service wasn't available in Morristown, cable and Internet rates would be much higher. Therefore, MUS thinks they act as the salt that prevents the incumbents from taking advantage of the city residents and businesses. Apparently this approach is working because incumbents have not raised cable TV prices since MUS entered the business, and because of MUS pressure, the incumbents have improved their services and their systems. Moreover, it's a win for the community to the tune of $3.4 million every year, which can be spent locally rather than being siphoned out of the community to corporate shareholders.

MUS FiberNet's impact on economic development has been positive. Oddello Industries, a contract furniture manufacturer that relies on FiberNet for its communications, recently announced a $4 million expansion in Morristown, resulting in 228 new jobs. Oddello CEO, Tom Roberts, cited "reliable utilities" among the reasons for investing in Morristown to grow its Morristown presence from 35 to 415 employees in just the past year. Molecular Pathology Laboratory Network (MPLN), a global leader in personalized laboratory medicine, decided to locate its primary backup facility in Morristown, in part because of the FiberNet connectivity available to the company. As a global provider of diagnostics to hospitals, medical labs and physician groups, MPLN required ultra-reliable data replication and disaster recovery services, which FiberNet enabled.

The president of the Chamber of Commerce says, "When site selectors look for something, this is the nugget that sets us apart. You see about six or seven utilities in the state doing this and they knew it was a risk. A lot are unsuccessful at it so that really justifies the commitment our utilities have made here. I think a lot of people in the community are pleased with their broadband offers and the affordability we have because of healthy competition."[33]

In looking at cost savings for Morristown's city government, MUS points to $840,000 in total savings from a smart meter program - a combination of lower annual power consumption and operational efficiencies. The fiber, as an electric asset, enabled the utility to receive $4 million in grants from the

[33] http://www.wbir.com/story/news/2015/05/06/municipal-internet-as-utility/26964309

Tennessee Valley Authority for smart grid development. These developments have further provided a path to lower rates through better technology. Another $20,000 in annual savings is due to the county not having to pay out-of-town contractors to maintain the network because the required expertise can now be found locally thanks to MUS's dedicated network specialists.

Challenges

Although there are many benefits that outweigh the challenges, MUS admits that broadband and telecommunications is a tough business for a small community, due primarily to the economies of scale. The extra challenge for Morristown leaders was to gain the political will to be successful, to battle the telecom lobby and the Tennessee legislature, and to make some good business decisions with vendors. MUS leadership says it takes determination because it is not an easy business.

8. Public-Private Partnerships

Public-private partnerships (P3s) are an emerging business model that provides an innovative solution to an ongoing municipal broadband issue: how does a local government invest in municipal broadband without operating a broadband network? Public-private partnerships come in many forms and are a very early stage business model that is still taking shape today.

Generally, P3s bring a local government and one or more private organizations into a partnership to plan, fund, build and maintain a broadband network within the municipality's jurisdiction. In many cases, P3s are still in development as there are very few cases of networks today permanently using this model. However, there are a number of P3s that are in various stages of negotiation and even a few that are preparing to build broadband networks.

Typically, P3s use the policies, capabilities and funding of local governments to build fiber infrastructure in concert with broadband provider capabilities to implement and operate broadband networks. At the highest level, most P3s use the credit capacity of local governments to finance the construction of fiber networks at a rate lower than broadband providers' cost of capital.

Although advocates of P3s claim P3s do not require public organizations to contribute capital, the reality is that without public organizations "having skin in the game" the likelihood of attracting a private partner that will assume nearly all of the risk in the project is low. However, Google Fiber has proven that it is possible; the City of Kansas City made significant incentives available that many cities may not be in a position to offer,34 either from a statutory or organizational perspective.

When a local government brings public funding to a P3, it reduces the financial barrier to entry for the provider and creates a more feasible business case to operate in the area. These arrangements also allow local governments to maintain ownership of long-term community assets and significant control in the negotiation of how broadband services are provided to their community.

The "tricky part" in P3s is to find the right alignment between the public and private partner. Each organization must align on a number of aspects of the P3 to make it successful, including:

- Who has rights to access the network and is the P3 exclusive or non-exclusive?
- What are the public and private partners' goals and how are they incentivized?
- What roles and responsibilities does the public and private partner have in the P3?
- What assets are financed through the public and private partner?
- What revenue model is used by the public and private partner to recoup their investment?
- What requirements must the private partner meet, in terms of service availability, speed, price, locations and timeframes?
- How will the partners determine future build outs and who pays for them?

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[34] http://www.wsj.com/articles/SB10000872396390443862604578030671101065746

8.1 Public-Private Partnership Case Studies

8.1.1 Westminster, Maryland

The City of Westminster, MD recently developed a P3 with Ting Internet that will bring together the two organizations and build a fiber to the home network to approximately 9,000 homes and 500 businesses. The City recently approved a budget of $650,000 to build out fiber to the home infrastructure in a "pilot" program to reach a subset of the entire community.

Since the City had no desire to operate the network or provide retail services, it recruited Ting Internet to become the operator and deliver all retail services to the community. In the partnership, the City will build and own all fiber infrastructure while Ting will simply operate the network. The City will collect revenues from Ting for lease of the fiber to recoup its initial investment in the network. Based on the success of the initial pilot, the City and Ting may continue the build out of the network to the remainder of the community. Ting will maintain exclusivity on the network for the first two years, after which time the network will be open to other competitive providers in addition to Ting.

Ting provides only Internet services as of today but plans to offer a competitive television service and voice service to customers in the future. Ting's rates in Westminster follow:

- Residential Gigabit Internet (1000 Mbps Up / 1000 Mbps Down) - $89/month
- Residential Basic Internet (5 Mbps Up / 5 Mbps Down) - $19/month
- Business Gigabit Internet (1000 Mbps Up / 1000 Mbps Down) - $139/month

8.1.2 MoBroadband & Sho-Me Technologies

Prior to NTIA's Broadband Technology Opportunities Program (BTOP), south-central Missouri relied on copper-based broadband access and needed significantly higher speeds to enable distance learning, telehealth and public safety applications. NTIA provided a $26.6 million grant to Sho-Me Technologies to deploy a 1,494-mile network connecting 101 anchor institutions across 30 counties. The origins of the project date back to 1997 when Sho-Me Power Electric Cooperative, a public entity, created a technology subsidiary, Sho-Me Technologies, to leverage its existing internal advanced optical communications network to offer high quality, high bandwidth connections to both internal and external customers, particularly rural communities.

Sho-Me collaborated with the State of Missouri to develop the project's network design and identify the unserved and underserved areas to target its network build. The project forms an integral part of the MoBroadband Now initiative, launched in 2009. For its BTOP award, Sho-Me Technologies contributed 954 miles of existing fiber, valued at $8.8 million, and $2.6 million in cash.

This project reflects a private-sector-led model capitalizing on the expertise and resources of an electric cooperative. Sho-Me Power Electric Cooperative created Sho-Me Technologies as a subsidiary in order to expand and leverage its advanced networks to offer high bandwidth solutions. Sho-Me Technologies expanded broadband and fostered Smart Grid applications in partnership with

electric co-ops for more efficient, secure energy use. The company also improved student education by connecting K-12 schools; improved government services limited by budget cuts and strengthened public safety services by connecting regional law enforcement databases. In addition, by offering last mile broadband providers low interconnection pricing, Sho-Me's middle-mile network enabled them to extend enhanced broadband services to customers at affordable prices.[35]

8.1.3 Davenport, Iowa

Magellan Advisors recently completed a broadband feasibility study that determined the City of Davenport's options to expand broadband services to the community. Using a combination of smart public policy and existing public infrastructure, the feasibility study assessed a range of options that the City could pursue directly and those that the City should pursue in potential partnership with private broadband providers.

A regional competitive fiber provider that was looking to expand into new markets had previously approached the City. Although the competitive fiber provider had expressed interest in using the City's fiber and conduit resources, the City believed that it should solicit interest from a range of providers and evaluate them side by side to determine how each would propose to partner with the City and the benefits that would be achieved by each provider's solution.

Rather than move forward with a municipal option directly, the City and Magellan believed that it was important to first determine the level of private sector interest that competitive providers would propose for Davenport. The premise was to first evaluate how private sector companies would deliver solutions to achieve the City's broadband goals before committing the City to a municipal option. As one of the largest cities in Iowa with a population of 102,000, The City and Magellan believed that the large market size could create interest for existing and new competitive providers if the City developed the right incentive packages to bring them to the table.

The public procurement approach also allowed the City give all interested broadband providers a chance to address Davenport's goals for broadband. This approach allowed the City to follow its public procurement and non-discrimination rules and protect itself from potential claims that the City was favoring any particular provider.

Magellan developed and managed the competitive RFI that was released publicly in early 2014 to solicit interest from competitive providers interested in building a fiber network to cover 100% of the community. The RFI detailed the City's infrastructure and policies that could incentivize providers to build a citywide fiber-to-the-home network to serve residents and businesses. The City and Magellan structured the RFI to evaluate a variety of factors to compare providers, including:

- Total costs for deployment and pricing packages for residents and businesses
- Types of services, broadband performance standards, customer service levels

[35] http://www2.ntia.doc.gov/files/ntia_ppp_010515.pdf

- Time to market, phasing and coverage of the entire community
- Reasonableness of the business model used with the City
- Financial pro-forma analysis and risk analysis

The RFI was published in April 2015, and the procurement was open for a 60-day period to allow all potential respondents time to develop customized proposals. When the RFI closed in June, eleven responses were received from competitive providers across the country and several within the Midwest region. The City and Magellan have recently short-listed respondents and have begun negotiations to determine how each potential firm would create a partnership with the City.

9. Glossary of Terms

3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
AMI – Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second (Bps), kilobits per second (Kbps), and Megabits per second (Mbps).
Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system, which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable Internet).
CAI – Community Anchor Institutions	The NTIA defines CAIs as "Schools, libraries, medical and healthcare providers, public safety entities, community colleges and other institutions of higher education, and other community support organizations and entities." Universities, colleges, community colleges, social service providers, public safety entities, government, and municipal offices are all community anchor institutions.
CLEC – Competitive Local Exchange Carrier	Wireline service provider authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services by: 1) building or rebuilding telecommunications facilities of their own, 2) leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.
Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel.

Demarcation Point ("demarc")	The point at which the public switched telephone network ends and connects with the customer's on-premises wiring.
Dial-Up	A technology that provides customers with access to the Internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the Internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
Downstream	Data flowing from the Internet to a computer (browsing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver "always on" broadband Internet service.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Columbia, and U.S. territories.
FTTP – Fiber to the premise (or FTTB – Fiber to the building)	A fiber-optic system that connects directly from the carrier network to the user premises.
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), it is a more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – Internet Service Provider	A company providing Internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
ITS – Intelligent Traffic System	Advanced applications that, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.
LAN – Local Area Network	A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless Internet connection.
LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long distance service. Calls within a LATA typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
MPLS – Multiprotocol Label Switching	A mechanism in high-performance telecommunications networks that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared by many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a venture funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P^3.
QOS – Quality of Service	Refers to a broad collection of networking technologies and techniques to provide guarantees on a network to deliver predictable results reflected in Service Level Agreements. Elements of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic.

RF – Radio Frequency	A rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennae.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as "REA" or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer-controlled systems that monitor and control industrial processes that exist in the physical world.
SNMP – Simple Network Management Protocol	An Internet-standard protocol for managing devices on IP networks.
SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Steaming	Streamed data is any information/data that is delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.
T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.
Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flowing from your computer to the Internet (sending email, uploading a file).
UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission that manages the E-Rate program.
VLAN – Virtual Local Area Network	In computer networking, a single network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network.

VoIP – Voice over Internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using Internet Protocol.
VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of dedicated connections, encryption, or a combination of the two.
WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
Wi-Fi	Wi-Fi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards."
WiMax	WiMax is a wireless technology that provides high-throughput broadband connections over long distances. WiMax can be used for a number of applications, including “last mile” broadband connections, hotspot and cellular backhaul, and high-speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless Internet	1) Internet applications and access using mobile devices such as cell phones and palm devices. 2) Broadband Internet service provided via wireless connection, such as satellite or tower transmitters.
Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.