Shaker Heights Broadband Assessment, Strategy, and Business Plan

Recommendations

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Contents

About the Report *

'This report presents information that the City and stakeholders needs to make an informed decision about strategic investments in modern broadband infrastructure. The goal is not to make this a technical document but to assist decision makers in placing the policy decisions in context.

A word about the report content and organization may be helpful at the outset. This subject area is a very challenging one for local government. The complex technical nature of the undertaking sometimes makes the policy issues hard to assess. This report attempts to assist in this regard by providing technical information which can be thought of as informational or educational, in the body of the report and in several appendices.

- The *Executive Summary* provides an overview of key findings and recommendations.
- *Options for the City* summarizes build out and cost options evaluated in the study.
- *Broadband, Fiber, and the Internet* provides an overview of why fiber is important to Shaker Heights.
- The *Cost of Broadband* provides an overview of the economic impact.
- The *Economic Impact* chapter describes the potential benefits of a community-owned fiber network.
- The *Needs Assessment* and *Service and Gap Analysis* sections discuss current and future bandwidth needs for Shaker Heights and identifies the kinds of uses that the network will support.
- The *Local Conditions* section summarizes information collected from interviews with City staff, businesses, and service providers.
- *Building and Operating Networks* provides an overview of the process of planning and operating a City broadband infrastructure.
- *Funding and Financial Analysis* and *Financial Models* discusses funding options and a summary of the four business cases developed as part of the study.
- The *Governance and Ownership* section describes a variety of business models and ownership models available and in common use and their advantages and disadvantages.
- The *Case Studies* section provides a review of other community projects.
- The *Appendices* contain maps and cost estimates developed as part of the work.

*The consultant's report was edited for grammatical & other minor errors.

Executive Summary

"Rather than wait for incumbent ISPs to build the network your cities want and need, you can take control of your own broadband futures."

"Rather than thinking of yourselves as taxers and regulators, which has been the traditional role, you can think of yourselves as facilitators of the kind of services you've been begging the incumbents to provide for years." Gigi Sohn, FCC Chief Counsel

This report describes a series of strategies and options to get improved and more affordable broadband services in the Shaker Heights. Increased affordability and availability of broadband delivered services has the potential to increase work from home opportunities in the city, help retain existing businesses, and improve Shaker Height's ability to attract and retain residents, including Millennials, young couples, and entrepreneurs.

While many residents and businesses have access to wireless or copper-based "little broadband" services with bandwidth in the range of 1-10 megabits/second, many other cities and towns in the country (more than 160, according to Broadband Communities magazine) have already made the leap to fiber-based "big broadband" with a minimum bandwidth of 100 megabits/second and many of those communities are now "Gigabit Cities" with a standard residential and business connection of 1,000 megabits (one Gigabit).

One might reasonably ask, "Why does anyone need a Gig of bandwidth?" The value of a Gig fiber connection is about the future, not the present. It is about preparing citizens, businesses, and the community to be able to compete for jobs and businesses over the next five to thirty years, with future-proof infrastructure that will support future needs.

Shaker Heights has a long and rich history of being on the forefront of community innovation and development, and at the beginning of the 20th Century, it was the new rail transportation system that helped create Shaker Heights. Today, Shaker Heights needs a 21st Century transportation system in the form of ubiquitous fiber infrastructure.

With the development of Internet technology, a single high performance fiber cable is able to deliver multiple services over a single broadband cable, rather than the multiple copper cables deployed to provide first telephone service (copper twisted pair) and TV (copper coaxial cable). It no longer makes sense to have multiple companies installing fully duplicated network cables in the same community; that approach only raises the cost of service for homeowners, businesses, schools, and local government.

As just one example, music was formerly a "heavy" product that required both a local and national road system to carry first vinyl records and then CDs from manufacturing plant to customers. Today, virtually all music is transported directly to buyers over the Internet-based digital road system. Software, formerly sold in stores, packaged in boxes, is now delivered via the digital road system. In the two week Christmas season (2015) Apple

Computer sold and delivered more than a billion dollars in software--all delivered via the Internet-based transport system.

Today, Shaker Heights needs a modern transportation system--a digital road system--both within the city and connected to other points in the state and the nation.

If Shaker Heights wants to stand still economically, then it can stay with its dominant copper-based telecom infrastructure, effectively freezing economic development where it is today. But if the community wants to grow economically, retain businesses, attract young people, attract entrepreneurs, and bring new businesses, Gigabit fiber becomes a critical part of a forward-thinking economic development strategy.

Communities across the country (more than 150, according to Broadband Communities magazine) are making investments in broadband infrastructure because the incumbent telephone and cable providers are bypassing their communities entirely or making limited fiber investments only in areas they perceive as the most profitable, leaving many other residential neighborhoods and business areas with inadequate service. We call this the "Balkanization" of communities, where one or more providers divides up the community with some areas with fiber and some without. An unpleasant by-product of fiber Balkanization is that it effectively creates new monopolies for service within the community--fiber may be available in a particular area, but with only a single provider offering fiber service, customers have neither a choice of providers nor competitive pricing.

In Shaker Heights, Time Warner, AT&T, Wide Open West, Everstream, and Lightower (previously Fibertech) offer services in the community, predominantly over copper-based cable. Shaker Heights does have some limited fiber. Everstream and Lightower have a very limited fiber footprint. Neither company is offering any residential/neighborhood fiber services, and Everstream has only a few businesses connected. Wide Open West (WOW) is offering some fiber services, largely in the eastern portion of Shaker Heights. Most businesses and residents are still getting Internet via copper infrastructure.

A single community-owned modern fiber-based infrastructure could be offered to these private sector services providers (and any other interested businesses) to sell their services to Shaker Heights residents and businesses. This approach is very similar to the way that community roads are used by the entire community for a variety of public and private purposes. This "open access" business model keeps the City government out of the telecommunications service business, creates new and expanded business opportunities for existing service providers, and can deliver better and less expensive broadband services to businesses, residents, schools, and City government.

Long Term Goals of a Fiber Initiative

Long Term Goals	Description
Encourage Public/Private Partnerships	Partnerships among the City, local schools, service providers, public safety agencies, and major businesses will assist with business attraction and lower telecom costs for all partners.
Create New Business Opportunities for Existing Service Providers	The City should provide only basic infrastructure and transport, and should not compete with existing providers by selling services to businesses and residents. This is best done by the private sector.
Fiber Should Support Economic Development	Broadband investments should be targeted to promote neighborhood revitalization, business growth and resident quality of life improvements.
Reduce Cost, Improve Quality of Government Services	City investments in basic broadband infrastructure will provide the City with the security of an affordable and resilient IT infrastructure over the long term while simultaneously improving departmental efficiency.
Reduce Costs for Businesses and Entrepreneurs	Modest investments in fiber and wireless infrastructure will reduce the cost services for entrepreneurs, business start ups, existing businesses, and work from home/business from home activities.

Encourage Public/Private Partnerships

The size of Shaker Heights and the diversity of public and private interests in the city will require a commitment to collaboration between the private sector and City government. From a network perspective, the entire city is a single market. Important and critical partners include:

- City government will benefit from having its own infrastructure independent of changes in private sector contracts and pricing changes.
- The K12 school system would be likely to migrate to a City-owned system over a period of years to stabilize network costs and develop a more resilient school network.
- Existing incumbent and competitive telecom service providers would benefit from the shared cost model, making it easier for them to offer more and better services in Shaker Heights.
- Businesses, institutions, and other stakeholders that have high bandwidth needs will also benefit from a City broadband initiative.

- The regional light rail system is interested in sharing right of way and making use of City-owned fiber.

By taking the time to develop partnerships:

- Costs are spread across a larger market area, making the long term financial sustainability much more likely.
- The larger market base will attract more providers and services, leading to even lower prices and a greater diversity of service offerings.
- The larger market base will also encourage more private investment, especially in creating new and diverse fiber routes in and out of the city.
- It will be possible to raise more funds more quickly and thereby build to more businesses, residents, and institutions more quickly.

Create New Business Opportunities for Existing Service Providers

Any local government investment in telecom and broadband infrastructure should be at the basic infrastructure layer of the network. Shaker Heights should avoid selling services to businesses and residents. Providing basic infrastructure will allow providers to reach new customers at much lower cost and allow them to offer improved services to their existing customers. An important goal of any local government investment should be to create new business opportunities for existing incumbent and competitive providers.

Build Fiber in Support of Community Development Goals

Shaker Heights needs more distribution and access fiber in neighborhoods, which is essential for maintaining the high quality of life in the city.

- Widespread fiber availability in Shaker Heights neighborhoods is critical to continue to attract residents to the city. In our work in other communities, we hear regularly from real estate agents that homes without fiber are more difficult to sell. Fiber to the home is needed to support work from home opportunities and to attract work from professionals to Shaker Heights.
- Fiber to the home is needed to support business from home ventures, especially small business start-ups and entrepreneurial ventures.
- Fiber is needed to every economic development area and corridor in the city, and open fiber is needed in the downtown core and in other commercial and retail areas of the city to reduce the cost of broadband services for businesses located in those parks.

Reduce Cost, Improve Quality of Government Services

A City-owned broadband infrastructure will give City government a stable and predictable cost structure. This would replace the current short term contracts that do not offer the

City any long term pricing stability as well improved redundancy for critical services. The Police Department would benefit from a long range plan to make fiber available to most community locations (e.g. fire and rescue, police stations). The City could also benefit from improved monitoring of public facilities like parks (real time video for crime prevention). There is keen interest in being able to access and make use of the security cameras in the K12 schools but the current school and City networks cannot support this application. Security cameras in City parks and recreation fields would also enhance public safety, but no infrastructure exists to support this service right now.

Fiber infrastructure could also be used to develop a wireless mesh system in various areas of the City. A wireless system would give police better and faster access to various public safety data systems from patrol cars and could help reduce or eliminate the use of costly cellular data service.

The City currently has very limited mapping (GIS) capabilities, and relies heavily on the County for GIS services. City staff would benefit if they had access to an online (Web-based) GIS system. These are relatively inexpensive, do not require desktop software, and are much easier to learn and to use than dedicated desktop GIS software.

Reduce Costs Businesses and Entrepreneurs

A shared, high performance network will reduce the cost of telephone, Internet, data back up, videoconferencing, and other business services through reduced cost of infrastructure and increased competition. Shaker Heights is competing for jobs and businesses with other communities in the Cleveland area and communities in other states that already have this kind of infrastructure in place--and most of those communities are aggressively promoting it as part of their economic development business attraction and retention strategies.

Competition from Other Localities

As we have described elsewhere in the report, many other regions, some close by, are well ahead of Shaker Heights in their plans to acquire 21st century broadband infrastructure.

- There are numerous other county and multi-county broadband networks that have been operating successfully for years. New Hampshire FastRoads is a community-owned Gigabit network providing open access services to 22 towns in rural New Hampshire.
- Kansas City, Kansas and Kansas City, Missouri have construction underway in their Google partnership, which will connect hundreds of government locations, thousands of businesses, and tens of thousands of homes.

- Danville, Virginia has been successfully operating a municipal open access network since 2007, and the project generates enough revenue to fund a steady expansion.
- The City of Eagan, Minnesota has built 17 miles of Gigabit fiber that passes most of the primary business and commercial areas of the city, and the network was a key factor in attracting a major data center to Eagan.
- More than 160 other communities in the United States have operating networks or have substantial network construction underway.

Short Term Goals

A variety of short term goals should be considered as next steps in this effort.

Short Term Goals	Description
Continue the Current Broadband Initiative	The current group of public and private stakeholders and interested parties should continue development of this initiative.
Commitment from Key Stakeholders to Support the Effort	Support from elected officials and key stakeholders like the K12 schools, the business community, and local nonprofits, is essential to success.
Consistent Message and Coordinated Public Awareness	If a decision to move forward is made by the City, stakeholders, and interested parties, a consistent message about the benefits and advantages will be critical to gain public support.
Develop a Common Fiber Overlay Plan and Open Ditch Policy	Conduit and handholes should be included where appropriate in all new public and private construction. Shared trenching should be vigorously pursued.
Coordinate Broadband Infrastructure Improvements with Public Safety Spending	Coordinate upgrades to public safety communications systems with planned fiber and wireless improvements to reduce the cost and improve the quality of public safety voice/data traffic.

Continue the Current Broadband Initiative

The current group of City officials, private sector business people, and institutional stakeholders should continue to meet regularly, identify key decision points, recommend an overall strategy, and adopt an action plan for next steps. A City-owned infrastructure with most day to day management and operational tasks outsourced to qualified private sector firms would be the most efficient approach and would limit the need for additional City staff.

Commitment from Key Stakeholders to Support the Effort

City support may consist of investments in conduit and other passive infrastructure that can be leased out on an open access basis, commitments to buy services once the network is constructed, and commitments to provide expedited rights-of-way and construction

permit processing. The commitment to buy services for City facilities and agencies is particularly important for financial sustainability and stability over time. As more private sector businesses are connected, government purchases of services have less financial impact on the enterprise, but early commitments from anchor tenant customers can ease financing (both for public and private ownership) and can help attract service providers.

During the planning stages of first phase of development, it is also important that local businesses consider the result of purchasing or renewing long term broadband and telecom service contracts with providers. Large "anchor tenant" customers for the new network can use their purchasing power to encourage local incumbent and competitive service providers to amend their contracts to allow a graceful transition to the new open network.

Consistent Message and Coordinated Public Awareness

Public support for the project will be important to the long term success of the effort. All parties involved in the effort must be able to address key talking points clearly, succinctly, and consistently to avoid confusion and negative rumors. Incumbents may embark on extremely negative and mis-leading public relations campaigns that seem to suggest a wide range of poor outcomes to such an effort. Citizens may assume that taxes will be increased to support the effort. A well-managed public awareness campaign that includes helping elected and appointed officials both understand and discuss key parts of the project will be very important.

Develop a Conduit Overlay Plan and Open Ditch Policy

A conduit overlay plan is an essential part of any next steps. The City should continue to develop its current work efforts to identify desired fiber routes and connected facilities, any road reconstruction or repairs, water or sewer expansion, and any other civic construction or utility work should be compared to the overlay plan to determine if the new work is on a desired conduit (and fiber) route. If it is, funds should be budgeted during the planning phase of the effort to include adding duct and fiber along that route.

The Public Works Department should update new project guidelines and checklists to encourage both public and private development projects to include conduit, duct, and handholes where appropriate, just as private developers routinely provide shared infrastructure like roads, sidewalks, water and sewer.

The Shaker Heights Public Works Department should be trained to install duct so that incremental build opportunities can be pursued at least cost.

Coordinate Broadband Infrastructure Improvements with Public Safety Spending

Public safety can benefit substantially from cost sharing with a community-owned network. Fiber can be reserved specifically for public safety use so that the Police Department has secure data transmission with no information co-mingled with

commercial and residential data. The public safety radio network can be enhanced by running fiber (over time) to all repeater towers, improving the quality of voice transmission and potentially reducing the overall number of towers and repeaters needed.

A Vision for the Broadband Initiative

The Shaker Heights broadband infrastructure initiative should have the following characteristics:

- **Scalable** - The initial design of the network will support a graceful expansion over time to be extended to all areas of the City. The long term goal of the project is to deliver high performance, affordable broadband services to any residence, business, or institution in the City that requests service, with Gigabit fiber as the standard minimum connection.
- **Affordable** - Shaker Heights will work with providers to ensure that a wide range of affordable services are available for businesses and families with limited resources.
- **Business-class ready** - Businesses in Shaker Heights should have as much bandwidth as they need to do in order to maintain and enhance services globally. Symmetric services should be available whenever a business needs that class of service. The network will deliver any amount of bandwidth needed by any business connected to the network, with any desired quality of service (QoS) required to make Shaker Heights businesses competitive in the world economy.
- **Redundancy and Resiliency** – The infrastructure will have a long term goal of developing a redundant "ring" architecture to minimize downtime from accidental fiber cuts and network equipment failures. Shaker Heights businesses, local government, schools and anchor tenants will have a high reliability network.
- **Equal access to all providers** – The infrastructure will be operated on an open access, wholesale business model with all business and residential services provided by qualified private sector providers. A single public wholesale price list will be used to determine the cost of provider use of the network.
- **Equal access to all residents and businesses over time** – The goal of Shaker Heights is to deliver high performance Gigabit fiber services to all residents and businesses as rapidly as possible consistent with fiscally conservative operations.
- **Competitive Marketplace** – The infrastructure will be operated as a multi-provider, multi-service network with a wide range of competitive price and service options available to customers.
- **Limited Government Involvement** - The City of Shaker Heights will own and manage the infrastructure, but it will function as a true public/private partnership with private sector service providers and partners.

Broadband Infrastructure as a Utility

Governments build and manage roads, but don't own or manage the businesses that use those roads to deliver goods and services. In an open access "digital road system," multiple providers use the shared infrastructure to offer their service competitively to customers. This approach provides true competitive pricing between competing service providers, and little or no government regulation is required.

The tremendous versatility of the Internet and the underlying technology bases now allows services that used to require their own, separate (analog) road system (voice telephony and TV services) to be delivered alongside other services like Internet access on a single, integrated digital road system.

If we managed overnight package delivery the way we manage telecom, UPS and Fedex would only deliver packages to residences and businesses where each delivery firm had built a private road for their exclusive use. We recognize immediately the limitations of such a business model–few of us would have overnight package delivery to our homes because the small number of packages delivered would not justify the expense of building a private paved road.

Before the rise of the automobile, most roads were built largely by the private sector. After cars became important to commerce and economic development, communities began building and maintaining roads because it became an economic development imperative to have a modern transportation system in communities.

Before the rise of the Internet, digital networks were built largely by the private sector. As broadband has become critical to commerce and economic development, communities with digital roads are more competitive globally.

A UTILITY COMPARISON		
SHARED ROADS	SHARED AIRPORTS	SHARED TELECOM
Historically, roads have been built and maintained by the community for the use of all, especially private firms that want to use them to deliver goods and services.	Airports are built and maintained by a community or region as an economic and community development asset. Both public and private users benefit from the shared use of a single, well-designed airport	Duct and fiber may be installed and maintained by the community and/or a neutral owner/operator for the use of all, including private firms that want to use them to deliver goods and services.
Access to the community road system is provided by parking lots and driveways, built by property owners, developers and builders.	Airport assets like departure gates, ticket areas, and runways provide access to the airline services.	In the digital road system, access across private property to the community–wide network in the public right of way is provided by duct and fiber built by property owners and/or developers and builders.

A UTILITY COMPARISON		
SHARED ROADS	SHARED AIRPORTS	SHARED TELECOM
The local government uses roads only to deliver government services. Local government does not offer services like overnight package delivery.	While the local government or a consortium of local governments typically own the airport facility, the local governments do not offer flight services.	Local government uses the digital transport system only to deliver government services. Government does not offer services like Internet access or Voice over IP.
Private sector businesses use roads so that their own cars and trucks can deliver goods and services to customers. Because businesses do not have to build and maintain roads, all businesses benefit directly by being able to reach more customers at less expense.	Private sector airlines are able to offer competitively priced airfares because of the shared cost of the airport terminal facilities. Each airline does not build its own airport (which would sharply increase the cost of airfare).	Private sector businesses use the digital transport system to deliver goods and services to customers. Because businesses do not have to build and maintain a digital road system, all service providers benefit directly by being able to reach more customers at less expense.
There are no road connection fees, and anyone may connect to the road system for free. Governments pay for the cost of maintaining roads largely from those that use the roads . Fees are proportional to use, from taxes on tires and gasoline.	Businesses and citizens do not pay a fee to access the airport facility. The cost of maintaining the airport facility is paid by the airlines, which bundle that cost into the price of airfare. Fees are proportional to actual use by flying customers. Airlines benefit because they do not have to build, own, and operate the airport directly. Those costs are shared across all users.	Any qualified service provider may connect to the digital road system for a nominal fee and begin to offer services, without any significant capital expense. Network capital and operating costs are recovered by charging service providers a small fee that is based on a percentage of their income from services offered over the system.

Business Model Options

There are three business/ownership models that we are considering as part of the study. These models are:

- Private Sector Only
- Municipal Retail
- Wholesale Multi-Service

Customer aggregation is a key advantage to a shared, community-owned telecommunications infrastructure. By building fiber to homes and businesses, the community maximizes the market potential for private providers who want to sell services. For Shaker Heights, the early focus should be tied to economic development and residential neighborhood enhancement goals. Infrastructure investments should be supporting areas where business and jobs growth is most likely to occur, as this will also help ensure financial sustainability for the network. As the revenue increases from leasing network services, the revenue that exceeds operating costs and debt can be used to expand into more neighborhoods. Residential fiber build outs can occur

over time as the network expands. The community investment allows these businesses to reach more customers than any single company could reach on its own. Some of the outcomes of this approach are:

- More customers -- When the network capacity is shared among several providers, each provider has a much lower cost of infrastructure needed to enter a market. In smaller towns and regions, this is a critical difference. Community investments allow more companies to profitably offer services in smaller markets than a firm could do on its own.
- Lower costs -- When a provider can reach more customers via a shared broadband system, lower costs of service usually results. Typical reductions in cost in open access systems are usually on the order of 15%, and are frequently much more than that. It is not unusual to see the cost of telephone service decline by 40% or more.

Recommendation

Shaker Heights should pursue the wholesale open access approach.

The marketing, sales, and technical support related to retail sales is better done by the private sector. Service providers who choose to use the network to deliver their services would be responsible for identifying customers, obtaining service contracts, and providing first tier technical support.

By only having a handful of wholesale only customers (i.e. service providers), the City's role is well-defined and limited. Virtually all network operations, network management, routine technical maintenance, and emergency repairs can be outsourced to qualified private sector companies.

The City would have a limited public awareness role to ensure that residents and businesses are aware of the new network option, and would have to provide some oversight of service providers.

Services aggregation occurs when communities build open networks, meaning that any qualified service provider can offer services using the community digital roadway. In this business model, there are usually several service providers competing for customers in each category of services (e.g. voice telephone service, TV, Internet access).

- More choice-- A natural outcome of more services is more choice for purchasers of services. Instead of a single monopoly provider of telephone or television, customers can pick and choose among a variety of service plans at various price points.
- More competition -- When more services are available, there is more competition for customers. Subsequently, service providers must sell services for the lowest possible price, and also creates incentives to provide excellent service to customers. Compare this to a monopoly environment where there is no competition and hence little pressure for a company to provide good service--customers have no other service options.

- More services -- When there is a wider choice of services on the shared system, there is more opportunity to use more services. This is, in part, what makes open service provider networks financially sound investments for communities: Open systems create a bigger market for telecom services, and thereby creates more revenue flowing through a community revenue sharing plan.

Features	Private Sector Only	Municipal Retail	Wholesale Multi-Service Network
Basic Concept	Three separate services (voice, video, data) with little or no sharing of network.	Only three services (voice, video, data) with little or no sharing of network.	Very high efficiency achieved by sharing a single high performance network. All providers share network capacity.
Government Involvement	No government involvement. Private sector decides where and when to offer services. Some areas get little or no service.	Government competes directory with the private sector. Government decides what services are offered.	Government does not compete with private sector. Government provides high performance digital road system that benefits all public and private users. Buyers have rich set of choices.
Governance	Owned by a private company. Community must accept whatever services are offered.	Owned and operated by local government. Limited triple play services sold directly by local government.	May be owned by local government or by a community enterprise like a broadband authority or coop. Wide variety of services sold by private sector companies.
Competition	Little or none in most areas. Cartel-like pricing keeps prices high.	Government picks providers of each service. No incentive to lower prices.	Level playing field creates robust competition. Service providers drive down costs and provide great service to get customers.
Service Options	Limited. Providers can offer triple play at most.	Limited. Government resells triple play services.	Unlimited. Low cost of market entry and high level of service automation attracts service providers and encourages innovation.
Revenue	Limited by low returns on the individual services.	Limited by low returns on the triple play services.	Unlimited. Revenue directly linked to demand. Revenue increases with demand.
Service Area Expansion	Limited to high density population areas. Rural areas and smaller cities are at a structural disadvantage.	Limited by triple play approach, which keeps funds for expansion low.	Unlimited. Expansion completely supported by revenue sharing or use fees. Open services network can provide become financially sustainable relatively quickly.
Risks	Some areas do not get adequate service or affordable pricing.	Government officials must predict business technology needs years in advance.	More complex network management required, but reduces costs sharply for service providers, which encourages competition.

The Public/Private Partnership

Because virtually any modern broadband network (and most older telecom networks) use public right of way for a large portion of network distribution, ALL business models are

"public/private partnerships." The notion of the public/private partnership is not a distinct business model, but rather exists along a continuum, with minimal public involvement on one end (i.e. only use of public right of way) to full public ownership on the other end.

Private Sector Only

The "leave it to the private sector" model has obvious shortcomings, which is why so many communities are now beginning to consider telecom as essential public infrastructure. Private sector firms have a primary responsibility to preserve and enhance shareholder value. They do not make operational and service area deployment decisions based on community and economic development needs. For many communities, this has meant that broadband services have lagged well behind the rest of the world and places those communities at a competitive disadvantage when trying to attract or retain businesses.

The private sector model requires overbuilding, which means that each service provider must build its own network end to end to serve customers. This leads to completely duplicated networks, which increases costs and makes it more difficult for these firms to make a business case for enhanced services in many areas. This business model is a fundamental weakness, because these private networks are not only expensive, but typically underutilized. Residential networks are only used heavily in late afternoon and evenings, and are virtually unused overnight and during the work day. Business networks that are only used heavily during work hours typically have very low utilization for the other two-thirds of the day. School and education networks are used only 8 to 12 hours per day, and are empty the rest of the time.

Community broadband projects can overcome this fundamental weakness and substantially reduce the operating cost of networks by using a shared model, rather than a private model.

Municipal Retail

Also known as Muni (Municipal) Triple Play. Local government builds the network and sells services in direct competition with the private sector, offering only traditional "triple play" voice, video, and broadband. Muni triple play systems are usually closed systems that offer little choice to customers. Muni triple play systems compete directly with the private sector, and tend to have very low take rates. Opponents of community broadband often cite the low take rates of muni triple play projects to "prove" that community broadband is a poor investment. But the low take rates only show that muni triple play business models are not financially viable over the long term.

The two key issues with this model are:

- It requires local government officials and leaders to sign long term contracts (typically 5 to nine years) with the providers whose services will be resold over the network. This means that those local leaders must have a high degree of confidence that they can accurately predict, seven to nine years out, what level and quality of services the businesses and residents of the community will require. While contracts can be renegotiated as needs change, prices are likely to rise during that renegotiation.

- This model situates the local government in direct competition with incumbent providers. This not only tends to keep take rates low, which threatens financial viability, but adoption of this model also encourages lawsuits from the incumbents (Bristol, Virginia, Lafayette, Louisiana, Geneva, Illinois, and Monticello, Minnesota are examples of communities that were sued after selecting the muni retail model).

Wholesale Multi-Service Approach

Local government and/or an independent entity firmly vested in the long term interests of the community builds and manages the infrastructure and provides access to service providers on a wholesale basis. In turn, service providers offer business, residential, and government/institutional customers retail services. In this model, the private sector offers all services to their own private sector customers directly. Government manages the infrastructure but does not compete with private sector providers.

Wholesale Option One

In this first option, community/City investments are limited primarily to passive infrastructure (i.e. no network electronics). This is often called the "dark fiber" model, but passive infrastructure can and may include conduit, handholes, cabinets and shelters, and splice closures. This approach is an option that should be considered carefully, especially for residential neighborhood projects.

For smaller communities with limited resources and/or a very small market, passive infrastructure only is an excellent approach. The advantages include:

- Reduced capital costs by eliminating network electronics. Providers lease fiber strands and provide their own network electronics to "light" the fiber.
- Reduced operational costs. By limiting the infrastructure investment to passive components, there is little to no day to day operational responsibilities. Emergency break-fix repairs and routine repairs and maintenance work can be performed on an as-needed basis by qualified private sector companies.
- Reduced management and administrative oversight. While fiber strand and asset management tasks, billing, and financial management are still required, these are of limited scope.

Disadvantages of this model include:

- Revenue opportunities are limited to leasing fiber strands and small amounts of revenue derived from leasing cabinet or shelter space.
- The fiber strand leasing model does not always scale up well for large area deployment, as it requires predicting how much fiber is going to be needed well in advance of actually market demand. This is not always an easy task. Fiber cable is much less expensive than it was ten years ago, but the initial fiber strand mapping work prior to construction has to be done very carefully.

- It is possible to end up with limited competition because the cost of network equipment shifts the marketing advantage to the first provider who signs up a customer, often for very long periods of time.

Wholesale Option Two

The providers buy wholesale transport (i.e. raw bandwidth with no services--called a Layer 2 circuit) from the network, and then add their own services (e.g. Internet, voice, TV, etc.) on that circuit to their customers. Services are provisioned individually for each subscriber. This approach limits the initial investment required of a new service provider that wants to enter the market--thereby encouraging more competition and lower prices. Advantages of this model include:

- Higher revenue potential by leasing capacity on the network rather than fiber strands.
- Lower cost of entry to the market for smaller providers, which increases competition and helps reduce service costs for businesses and residents.
- Greater long term control over expansion since the network owner is providing a complete end to end network, including electronics.

Disadvantages include:

- Higher operational costs since the network owner must provide 24/7/365 network monitoring and support. While this can often be outsourced to a qualified private sector firm, this increases the expense of the network (note that the higher revenue potential can and usually does provide sufficient revenue to cover expenses).
- Increased administrative and management oversight due to the more complex end to end network.

Issues to consider with this approach include:

- The Layer 2 provisioning approach allocates one or more circuits to each customer of each provider. Troubleshooting technical problems requires excellent network operations with NOC (Network Operations Center) staff able to sort out whether the problem is caused by customer equipment, service provider equipment, or the network itself.
- Service providers require regular market and price incentives to ensure that take rate targets are met.
- The network has to maintain a regular public awareness marketing effort to ensure that businesses and residents are aware that the community-owned network offers new price and service options.

A lesson learned from communities that have implemented community broadband networks is that with both wholesale options (dark fiber, end to end network), it is essential to ensure that a sufficient number of service providers are prepared to sell services on the network--a minimum of two is desirable during the first year of operations.

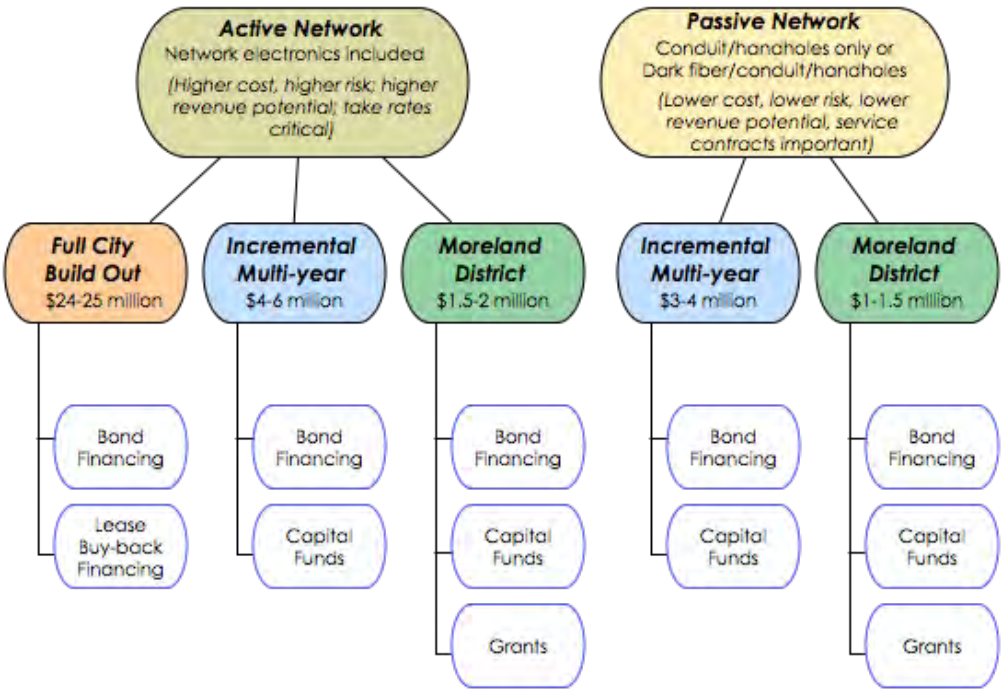
Options for the City

In the course of this study, several different infrastructure and funding options were identified. The diagram below summarizes how these options and opportunities are connected.

There are two fundamental infrastructure options: a passive network and an active network. A **passive network** includes only conduit (plastic pipe), handholes (where conduit is terminated to allow access to homes and businesses), and sometime dark fiber cable. An **active network** includes all of the passive network infrastructure (i.e. conduit, handholes, dark fiber) along with all of the network electronics needed to provide service. An active network is often referred to as a "lit network," meaning that the network electronics are sending laser light over the fiber to deliver services like Internet, phone, and TV.

Three different build out scenarios were evaluated, including a **full city-wide network build out**, an **incremental multi-year build out**, and a **small build out** focused on the Moreland District and adjacent business/commercial areas.

Several funding options were identified and could be applied across some or all of the build out options, including **bond funds**, a l**ease-buy back** financing strategy, City **capital funds**, and **grants**. The costs below represent construction costs only.



Active Network

The City would build a complete end to end network, with all the electronic equipment needed between the central service provider meet point and individual customers, including the Customer Premises Equipment (CPE) that would be installed in the home or business. If the City chooses the active network approach, day to day operations and maintenance could and should be outsourced to a qualified network management firm. But the City would still have the ultimate responsibility for financial and management oversight. We would expect that at least one full time employee would be required to ensure efficient and effective City oversight, for both the limited or the full build out option. The City would have to promote awareness of the network and work closely with providers to ensure that take rates meet the business plan targets (about 40%).

Passive Network

Conduit/Handholes Only Option

The City would install only passive (no electronics) infrastructure and lease conduit space to interested providers, who would install their own fiber and electronics. This approach imposes very little day to day management on the City, and maintenance/repairs would be limited. Revenue would also be less than the Active Network option, but with correspondingly less operational costs. The cost of this approach would be about 65% of the cost of an active network. Break-even for this model would likely occur in year six.

Dark Fiber/conduit/Handholes option

The City would install only passive (no electronics) infrastructure. This would include conduit, handholes, and dark (unlit, no electronics) fiber cable. The City would lease dark fiber strands to interested service providers. Like the conduit/handholes only option, day to day management would be very limited, and maintenance and repairs could be outsourced. Management of fiber strands represents a larger task than management of conduit space, but the two are similar (and could be outsourced if needed). Revenue would be higher for leasing fiber strands, but the cost would be close to the cost of an active network (about 90%). However, operational costs would be much lower. Break even for this model would be similar to the active network model, or about year seven.

Potential to Attract Providers

Both the active network option and the passive options are likely to be attractive to service providers. Both strategies make it easier and less expensive for providers to both acquire new customers and to deliver enhanced services to existing customers. Both Everstream and Wide Open West have indicated they would be interested in using City-built infrastructure if the pricing is right; both companies expressed a preference for dark fiber

over conduit only (their costs to connect customers would be much lower). And other Cleveland areas providers may also be interested.

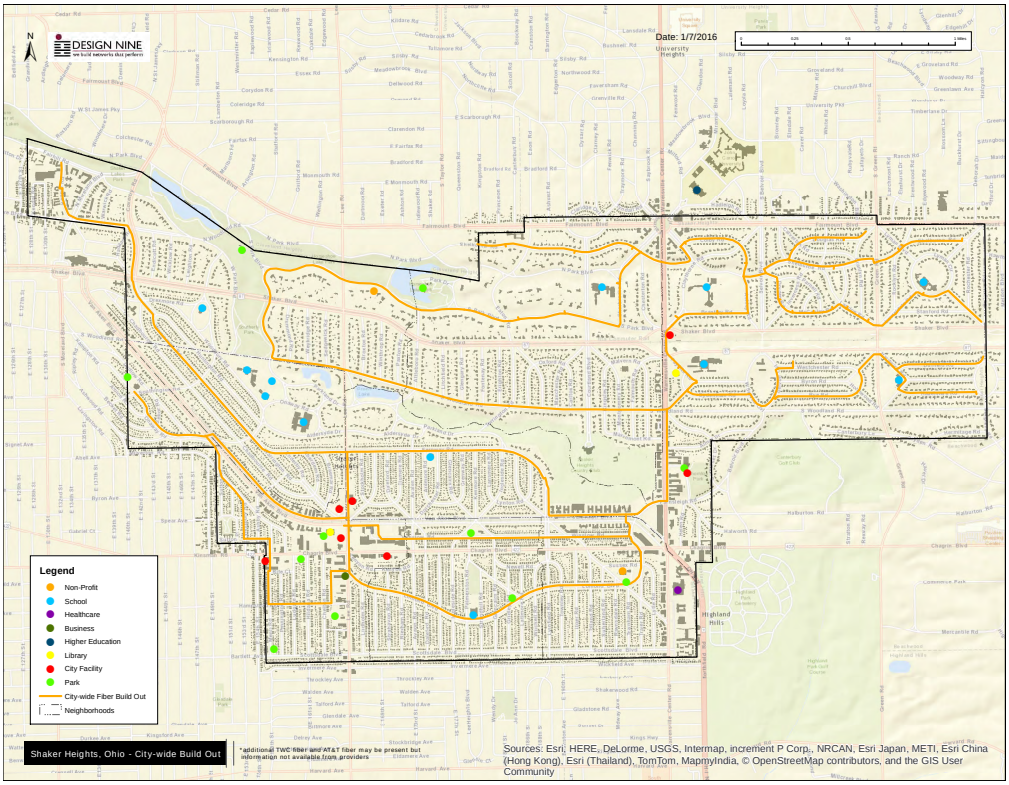
Build Out Options

Four options were evaluated for Shaker Heights. The two city-wide build outs would include fiber to most homes and businesses, but the financing arrangement would be different in each one (i.e. city bonding vs. a lease-buy back agreement). The Incremental build out and the Moreland option both represent significantly smaller initial expenditures, and both options could be expanded over time to include more areas of the city.

City-wide Build Out (Bonding)

The City would undertake a full build out of fiber connectivity throughout the City's residential neighborhoods, schools, health care facilities, and business/commercial districts and connect all City facilities. Cost is estimated at approximately $25 million for initial construction and operations, and bond debt payments (including principal and interest) are estimated at approximately $1 million/year for the first ten years. No operational subsidies are projected. In this model, the projected break-even point would occur in year seven.

75/25% Underground Fiber to the Premise
Full Buildout in 2 years w/ 40% residential take rate in year 5
Bonding for CAPEX at 4% APR over 30 year term with 4% closing costs on bond



City-wide Build Out (Lease Buy Back)

The City would sign an agreement with a firm specializing in lease-buy networks. The selected firm would underwrite the full cost of a city-wide build out of fiber connectivity throughout the City's residential neighborhoods, schools, health care facilities, and business/commercial districts and connect all City facilities. The network would be leased the network to the City for twenty to thirty years. At the end of the lease period, the City would own the network, if it so chooses. Lease payments are graduated to increase as take rates increase, resulting in estimated variable lease payments from $1,000,000 in the first several years to an estimated $2,750,000 in year 10. No operational subsidies are projected.

75/25% Underground Fiber to the Premise
Full Buildout in 2 years w/ 40% residential take rate in year 5
Assumes builder financing and lease payments to builder @ approximately 5.2% over 20

Incremental Build Out

The City would undertake an incremental build out of fiber connectivity throughout the City's residential neighborhoods, schools, health care facilities, and business/commercial districts. The first phase of the build out would target the Lee/Chagrin and Van Aken commercial/retail areas and the neighborhoods in between and connect these City facilities : Stephanie Tubbs Jones Community, Shaker Heights Police Department, City Hall, Shaker Heights Fire House, Public Works, Fire Station 2 and Thornton Park.Cost is estimated at approximately $4 million for initial construction, and debt payments are estimated at approximately $250,000/year (principal plus interest) for the first ten years. An operational subsidy of about $1.1 million is projected.

75/25% Underground Fiber to the Premise - Incremental Multi-year Network
Take rate begins at 25% and grows to 40% by year 5.
Assumes $4M via bond @ 4% over 30 years and $1.1M in subsidy

Moreland Area Build Out

The City would undertake a limited build out of fiber connectivity in the Moreland neighborhood and nearby Lee and Chagrin business areas and connect these City facilities: Stephanie Tubbs Jones Community, Shaker Heights Police Department, City Hall, Shaker Heights Fire House, Public Works . Cost is estimated at approximately $1.95 million for initial construction and operations, and debt payments are estimated at approximately $750,000 for the first ten years. An operating subsidy of about $1,975,000 is estimated.

75/25% Underground Fiber to the Premise - Moreland Project
Take rate begins at 25% and grows to 40% by year 5.
Assumes: $1.95M via bond @ 4% over 30 years and $1.975M subsidy

Current City Conditions

The City of Shaker Heights is not currently installing any conduit pipe suitable for the insertion of fiber-optic cable beneath the roadways.

The city does not have a "dig once" policy but should develop one to reduce the amount of street rehabilitation due to various companies installing utilities without any coordination or joint trenching.

The mission critical IT and communications service requirements for the Shaker Heights Police Department are real-time access to cameras in police cars and body cameras on police personnel. Access to security cameras in schools is also an important priority. Faster and more reliable networking services allow for the application of license plate cameras and generally improve public safety. The department also participates in remote arraignments and video arraignments which require broadband connectivity. The department would like to be able to use wireless cameras to monitor city parks and other public facilities.

The Police Department would also like to be able to access video surveillance cameras in the K12 schools, but currently lacks the bandwidth to support large numbers of real time video feeds. The department would also like to have a wireless "hot spot" network in the City so that patrol cars could access the City data network without returning to the police building. A citywide fiber network would facilitate these uses.

The City has 24 strands of fiber between City Hall and the Police/Court Building. Most City buildings have 1 fiber strand: fire stations 1 and 2, Public Works, Community Center, and the Thornton Park Recreation Center. The City's current bandwidth is provided by TimeWarner Communications and is adequate for current applications. The City pays $945/month for 11 miles of dark fiber and $575 per month for Internet service of 61.5 Megabit download/11.5 Megabit upload. It is important to note that future needs like those envisioned by the Police Department will require more bandwidth, not only between City buildings but to parks and to the K12 schools.

The cost of two point-to-point T1 circuits is $208 each per month to the Police Department and these circuits are provided by AT&T. The City contracts for 2 PRI (voice telephone) circuits at $465 per month each and pays a total of $1,300 per month for other trunks that could be eliminated by a fiber network that provides VoIP and other services.

Traffic control may be added to the municipal network. The current traffic system uses 8 phone lines that could be eliminated ($400 per month for measured service) and about $40 per month per intersection. Dialing into traffic control box often malfunctions and the city would benefit from putting that application on a reliable fiber connection. Another benefit of City-owned broadband infrastructure would be improved traffic management.

The Shaker Heights Fire Department relies on many critical IT and communications services to perform its functions. The department receives all calls for dispatch in Cleveland Heights. Each truck has a computer with Verizon unlimited data service plan.

Response times get sent back from the trucks to the station. The trucks are also required to access building and construction data over city network. This provides serious technical challenges. The Fire Department has historically had a heavy reliance on its own IT

capability. Every building in the City was monitored by alarms through wiring that the Fire Department installed itself. This function was discontinued around 1990.

Rescue squads transmit constant patient health data to hospital, so the department is interested about future developments in telemedicine.

The Fire Department is now updating its records management system. It is also configuring a wireless inspection system tied through Verizon cards. This system has proven to be complicated to install & manage. All fire trucks currently contain 4G modems.

Economic development and housing quality track together. The "creative class" wants broadband access. While Shaker Heights has historically been the community of choice for lawyers and doctors and other professionals, the City needs to be sure that it continues to offer modern amenities that will attract the next generation. Affluent residents have many choices of where to live and any potential resident who has experienced an effective broadband service will not choose to live in a community without it.

Th e educational profile of most residents skews to professional occupations. Th ese are people whose positions allow them to telework. Th ey are free to make life style choices. This is the segment of the population we need to continue to attract to the City.

Shaker Heights has always been a desirable residential community among professionals. However, with limited new development space available the tax rate for individual home owners is high. Improved, affordable high-speed broadband could be the catalyst to the City's economic development and encourage the migration to mixed residential/ commercial development which could revitalize and repurpose existing properties.

One of the City's areas of focus is the revitalization and development of the southern Moreland neighborhood. The City needs to add and promote features to help draw residents to this region of the City which was hard hit by the foreclosure crisis . Potential broadband providers have said that a high housing density is more critical than low income risk when selecting where they locate. Moreland's high density may ultimately give the neighborhood an advantage.

A new fiber-optic broadband network may need to include some wireless hot spots as part of the installation. Wireless should also be added to the public park system. Currently residents cluster around the library when it's closed so that they can receive the library's wireless signal.

Public/Private Partnership Opportunities

Because virtually any modern broadband network (and most older telecom networks) use public right of way for a large portion of network distribution, ALL business models are "public/private partnerships." The notion of the public/private partnership is not a distinct business model, but rather exists along a continuum, with minimal public involvement on one end (i.e. only use of public right of way) to full public ownership on the other end.

Service Providers

Service providers are a natural partner in an open access network. No matter what option the City chooses (e.g. conduit only, dark fiber only, active network), service providers will be able to use the new infrastructure and would become the City's primary customers. While in many respects a community broadband network shares many similarities with other public utilities (e.g. roads, water, sewer) there is one fundamental difference. Other public utilities like water and sewer have a captive audience and the utility is able to operate as a monopoly–meaning the customer base can be taken for granted. Early discussions with service providers have been positive, with at least two providers making requests for additional information about the effort.

A community broadband network is a public/private enterprise, and service providers are the primary customers of the network. Service providers cannot be taken for granted. Instead, a fair fee structure, a high quality network, excellent maintenance and operations processes, and organizational flexibility will be required to recruit and retain service providers.

Projects that are not successful in attracting service providers will fail. Affordable lease rates for tower space and/or fiber connections will attract service providers. Other open access projects (Danville, The Wired Road, FastRoads, Utopia) have not had any difficulty getting service providers to use the infrastructure.

Lease-Buy Firms

If the City chooses the lease-buy option then the selected firm immediately becomes a long term partner with the City. Th is firm would be responsible for designing and constructing the network, operating the network, and selling services to customers in the city.

Schools and Libraries

Both the schools and the libraries in Shaker Heights are reasonably well-served with their current broadband services, but as bandwidth needs increase, both institutions could become partners on the network.

Electric Utility

Electric utilities are natural partners in any municipal broadband venture. The fiber infrastructure can easily support both automated meter reading (AMR) and Advanced Metering Infrastructure (AMI). The latter application is becoming more common, and is being used in both industrial and residential settings to control the power use of large appliances and industrial equipment, typically during peak use hours when the utility may have to buy power at higher spot prices. There are other applications that can be valuable to the electric utility. Chattanooga's fiber to the premises (FTTx) initiative has enabled millions in savings for the city-owned electric service. When power outages occurs from events like ice storms or tree damage, the utility is able to use the fiber network to very accurately pinpoint where the outage occurs, enabling a more rapid repair of the electric network at less cost. First Energy was not responsive despite repeated calls to the designated Shaker Heights representative.

Infrastructure Recommendations and Next Steps

- The City should evaluate the findings and recommendations in this report and determine if it wants to move this initiative forward at this time. The City has to answer the question, "Is this worth doing?" This has to be answered in part by linking broader community and economic development goals to the potential of the broadband infrastructure to support those goals.
- If the City does want to move the initiative forward, the level of funding that the City is comfortable committing will determine next steps. Th e City has several fund-ing options, including bonding, using City cash reserves, and applying for grant funds--and the City may be able to combine these sources to create a "basket" of funds for the effort. Th e City could alternatively pursue a lease-buy agreement. Th ere are other funding options available to the City, but many of these would require a special assessment on property owners or other kinds of user fees to help pay for con-struction. Th ese were not considered to be viable alternatives at this time.
- If the City wants to pursue the lease-buy back option, then it will be necessary to ob-tain written offers from one or more firms offering the lease-buy option. Th ese offers should be specific and should clearly identify both the infrastructure commitment and the total financial obligation to be assumed by the City.
- If the City chooses to pursue a full build out on its own, then a determination would have to be made about how to bond: a stand-alone bond for the telecom infrastructure only or including the telecom cost as part of a larger bond offering (e.g. including water, sewer, or other improvements).

- If the City moves forward, further conversations with the providers that have expressed an interest in using the planned City infrastructure will be important. Both Everstream and Wide Open West have already built fiber facilities in Shaker Heights. To the extent that it is practical, the City should try to determine how to best make new investments that work with existing fiber from Everstream and WOW. It would be counter-productive to substantially duplicate existing private sector facilities, and there may be some opportunities to arrange fiber swaps and/or fiber sharing.
- If the City does move forward with a broadband initiative, it will be important to explain to citizens and businesses the linkage between the broadband initiative and the City's broader community development and economic development goals that would be supported by a City fiber infrastructure initiative.

Broadband, Fiber, and the Internet

What is Broadband?

There is much confusion about the "true" definition of broadband. If the goal is to enhance neighborhood and business access to broadband, there can be no upper limit on the definition of broadband. Saying that broadband (as an example) is 5 megabits/second of bandwidth or 10 megabits/second is to immediately tell businesses in the city that there will be structural limits on their ability to do business in the future–it is dictating the size of truck that can be used to deliver goods and services. Here is the only appropriate definition of broadband:

Broadband is whatever amount of bandwidth is needed to support the residents and business' ability to participate in the global economy.

Broadband is a community and economic development issue, not a technology issue. The essential question is not, "What system should we buy?" or "Is wireless better or cheaper than fiber?" Instead, the question is:

"What do Shaker Heights businesses and residents need to be able to compete globally over the next thirty years?"

In short, Shaker Heights today has "little broadband" in the form of DSL and cable modem service, along with a very limited amount of "big broadband" in the form of fiber to a few businesses and institutions.

If the City chooses to make investments in broadband and telecommunications infrastructure, it is absolutely critical that those investments are able to scale gracefully to meet business and economic development needs for decades. This drives the solution towards a Gigabit fiber solution. Wireless is able to provide basic Internet access needs, but is not able to support advanced video and multimedia services. Some off the shelf business videoconferencing systems in use today require a minimum of 50 megabits of bandwidth--beyond the capabilities of any affordable wireless system (cellular data networks are approaching this level of bandwidth at off-peak times, but with punishingly expensive bandwidth caps). Two key concepts that should drive community investments in telecom are:

"Broadband" is not the Internet

Bandwidth is not a fixed number

Broadband and "the Internet" are often used interchangeably, but this has led to much confusion. Broadband refers to the network delivery system--the infrastructure, while "the Internet" is just one of many services that can be carried over that broadband infrastructure. The challenge for Shaker Heights is to ensure that businesses and homes have a broadband network with sufficient bandwidth to deliver all the services that will be needed and expected within the next three to four years, including but not limited to "the Internet."

Why fiber?

Fiber optic technology has been deployed by telecommunications companies since the seventies. Properly installed and maintained, fiber cable has a life span of forty plus years. Despite regular improvements in wireless technology, fiber continues to be the technology of choice for delivering broadband services (e.g. Internet, telephone, TV, etc.) to homes and businesses.

Fiber is a "future proof" infrastructure investment with a useful minimum life of thirty to forty years when installed properly. The capacity of fiber has been and will continue to be expanded regularly without incurring additional construction costs (by changing the equipment). This is in contrast to other community infrastructure systems like water and sewer that require massive and expensive upgrades to the water or sewer lines once the capacity of those lines has been reached.

We are now seeing even small and medium-sized businesses asking for fiber connections. Without ubiquitous fiber infrastructure, Shaker Heights will not be economically competitive. Communities that already worry about losing too many young people to other areas have much more to worry about. Fiber is the only transmission system that will be able to deliver all the services businesses and residents will expect and demand in just a few years. Communities that choose to delay fiber infrastructure investments will be at a severe disadvantage in the next several years when trying to attract and retain businesses and workers.

From an economic development perspective, fiber is the only technology that offers both very high bandwidth capacity and high security. If Shaker Heights wants to attract and retain Millennials, professional services firms, and work/business from home residents, and businesses developing cutting edge, proprietary systems and data, fiber is the only viable business class infrastructure.

- Increases in the amount of bandwidth being used by business and residents continues to increase faster than wireless technology improvements.
- Fiber and wireless are complementary technologies, not competing technologies. Over the past several years, there has been a massive increase in the number of cellular wireless towers that are connected by fiber. This is necessary because only fiber can provide the bandwidth needed to meet the needs of cellular users connected to those towers.
- Wireless performs best as a mobility service, enabling convenient access to broadband services when away from home or the office.
- While wireless systems appear to have a lower initial cost, a comparison of the Total Life Cycle (TLC) costs of wireless and fiber networks for fixed access from homes and businesses shows that fiber is a better long term solution financially.
- In both business and residential uses, the amount of bandwidth being used has been very consistently doubling every two years since the mid-nineties.

- If wireless technologies were able to keep up with the constant increases in bandwidth use, cellular companies and cable companies would not be imposing data caps and over-use charges, which are intended specifically to discourage network use.

The Wireless Broadband Debate

We do not subscribe to the wireless vs. fiber debate. We believe both wireless and fiber systems are required in Shaker Heights. Virtually everyone, within a few years, will have a very capable wireless device that supports phone service, email, Web browsing, gaming, TV, music and a host of other services. Residents and businesspeople already expect these devices to work everywhere; this means communities need a well-designed wireless network of towers, antennas, and related systems, including fiber backhaul. A fiber connection is needed to get the wireless signals onto the Internet from local wireless access points; fiber can be used to dramatically improve wireless performance by providing a very fast connection from the wireless radios to the rest of the network). Wireless systems work best when supported by a fiber backbone to carry traffic to and from its destinations. Fiber and wireless systems are complementary, not competitive.

Wireless is often touted as a broadband panacea. Across the country, many communities have tried offering some kind of wireless system. These municipal wireless systems often lack sustainable business plans, and we do not know of a single city-funded wireless project that has been sustainable beyond offering limited free WiFi in public areas like parks and shopping areas. Philadelphia's early and well known WiFi project found that more access points were needed than originally anticipated, and the private firm that promised to operate and maintain the network pulled out, forcing the City government to take over an expensive system that was not able to deliver the connectivity that residents expected.

Current broadband wireless systems lack the capacity to handle high bandwidth services like video when more than a few people are using the same access point. While prices for broadband wireless networks (e.g. WiFi, WiMax) have slowly declined, when costs are calculated over a reasonable life cycle, wireless systems are relatively expensive. Wireless systems are inherently less secure than cable based systems, and we never recommend that a business uses a wireless connection for its primary access unless no other alternative exists. The primary future use of wireless will be for cellular mobile access to services, rather than fixed point access. In underserved areas, properly designed wireless systems are an excellent first step, but are not a complete solution over the long term. Over time, wireless to the home will have to be replaced with fiber connections to meet demand, but wireless will remain important for mobile access to broadband (e.g. access to the Internet and email from mobile phones and laptops).

The Cost of Broadband

Over the next thirty years, the businesses, residents, and institutions of Shaker Heights will spend over 749 million dollars on telecommunications services--in today's dollars, unadjusted for inflation and unadjusted for price increases. Some analysts believe that the average household bill for services delivered via broadband may double in the next ten years, which would make the thirty year projection easily exceed one billion dollars. Currently, there exists a substantial opportunity to capture more of these funds and direct them towards greater job creation and business opportunities for the city.

Numerous studies indicate that demand for bandwidth is doubling every two years, Indeed, the New Hampshire FastRoads community-owned fiber network is finding that their 50 meg residential Internet service is extremely popular...in rural and remote New Hampshire.

The health and appeal of Shaker Heights neighborhoods and the economic future in Shaker Heights is going to be dependent in part upon the availability of affordable high speed broadband services--at the bandwidths that will be needed to conduct business in the future ("big" broadband), not at today's "little" broadband speeds. Businesses large and small are already heavy users of the Internet, and their bandwidth needs will increase dramatically as two business trends accelerate: telecommuting and the necessary connectivity for high-speed broadband.

- Business travel costs are increasing rapidly as the cost of fossil fuel increases. Both the cost of ordinary commuting to the workplace is increasing as well as the cost of out of town business travel by air. Businesses are already investing heavily in HD quality business videoconferencing systems, and will make more use of them to reduce travel costs. These HD quality business videoconferencing systems require dramatic increases in bandwidth that are not affordable or in most cases not even available in certain areas of the city.
- In many states and the federal government, the employment commission encourages businesses to allow employees to work from home to help with work-life balance and reduce overhead costs in the office, but the broadband infrastructure must be in place. High performance broadband could have positive effects: it could enable more people to work from home, it could enable more home-based businesses, and it could attract more businesses to the city.

More and more workers and business people are working from home, either on a part time or a full time basis. New work from home job opportunities are growing rapidly, but most of those jobs require a wired Internet and a wired phone connection to qualify. Many corporate and business employees will be seeking permission to work more from home (e.g. one or two days per week) to reduce travel costs. Some major businesses in other parts of the U.S. are already actively planning to have 20% of their workforce work full time from

home to reduce employee travel costs and office energy costs. Telework initiatives are becoming more widespread throughout many states, where corporate employees working from home require high bandwidth services to be connected to the office network and to use corporate videoconferencing systems. These corporate network services will require 35-50 megabit connections within five years.

For the city, business retention and new business attraction can only be accomplished if the business and commercial areas of the city and city neighborhoods have the right telecommunications infrastructure that will enable businesses and residents to have access to ***affordable***, high performance broadband services.

The table below provides an estimate of current and future costs of telecom services in Shaker Heights (TV, Internet, phone) over the next thirty years, without any increases in costs due to inflation or price increases for services. The use data for households is based on national use averages.

City of Shaker Heights 30 Year Estimated Telecom Expenditures			
	Households still on dial-up	Households with "little" broadband cable modem/DSL/wireless	Households with no Internet
Total households	11,141		
Total businesses	800		
Household Percentage	6%	84%	10%
Number of households	668	9,360	1,114
Average monthly telecom expenditures	Local phone: $25 Long distance: $25 Cable/satellite TV: $65 Dial up Internet: $20	Local phone: $25 Long distance: $25 Cable/satellite TV: $75 Broadband Internet: $45	Local phone: $25 Long distance: $25 Cable/satellite TV: $65
Annual cost/household	$1,620	$2,040	$1,380
30 year expenditure	$32,487,156	$572,804,711	$46,123,740
Total residential expenditures	$651,415,607		
Total expenditures	$749,127,948		

When local governments undertake a study of broadband infrastructure, a key question should be:

"What is the benefit if government invests in broadband infrastructure?"

And the inverse question should also be asked:

"What happens if we don't make strategic broadband investments?"

OUTCOMES OF STRATEGIC LOCAL GOVERNMENT INVESTMENT	OUTCOMES OF LEAVING IT ENTIRELY TO THE PRIVATE SECTOR
Increased competitiveness with other cities and regions that have made broadband investments and have driven down the cost of Internet and voice services for businesses and residents.	Slower economic growth, and more difficulty attracting new residents to the community.
Better prepared to attract businesses and jobs to the area.	The city is at an economic disadvantage without a strategy to ensure than affordable high speed broadband is in place as a business attraction and business retention tool.
Cities and counties that have made investments have seen the cost of telecom services sharply reduced, keeping more money in the community and freeing up business funds for expansion and jobs creation.	Residents and businesses will continue to pay more for voice, TV, Internet, and other broadband services.
A long term strategy of "fiber everywhere" gives the city better educational opportunities and improved access to jobs. Fiber service in the city will also attract entrepreneurs and business people who want to work from home.	The city may see less population growth, loss of younger workers and families, and diminished educational opportunities.
Aggregation of the marketplace for telecom services via shared community infrastructure attracts more providers and helps keep prices for broadband services lower.	Private sector providers will continue to "Balkanize" the city, with higher prices and more limited bandwidth options because of limited competition.

Economic Impact and Benefits

Other communities across the United States are already actively pursuing new and innovative public/private partnerships to improve the access and affordability of telecom services delivered via broadband. The Fiber To The Home Council maintains statistics on the growth of residential fiber in the United States. About 13 million premises have been connected with fiber, but that represents only about 12% of American homes. The deployment of fiber is highly dependent upon location, so some densely populated urban areas, primarily on the East Coast, are getting fiber much more rapidly than other areas of the country.

Communities that have affordable broadband are enjoying a faster rate of economic growth than communities that lack broadband, based on a CMU/MIT study (Measuring the Economic Impact of Broadband Deployment, Sirbu and Gillett, 2006).

A more recent study (2014) by David Sosa of the Analysis Group found that the availability of next-generation broadband speeds provided by Gigabit fiber substantially improves a community's gross domestic product. The study examined 55 cities in nine states and discovered an economic boost in all 14 communities where gigabit service was

widely available. Those 14 cities displayed per capita GDP about 1.1 percent higher than the other 41 communities with limited or no access to gigabit broadband, equating to about $1.4 billion in additional GDP. The report stated, "Next-generation broadband is likely to have a substantial impact on economic output and, consequently, consumer welfare."

In Kansas City, the site of Google's first fiber initiative, KCnext President Ryan Weber said that Google and AT&T plans to offer Gigabit fiber in the city will result in several perks. Weber noted that competition is a very good thing when it comes to providing utilities like fiber:

"When businesses relocate to an area, that is now a big part of the conversation — access to fiber. They want to make sure there are a number of carriers because for some tech companies, they have two carriers coming into their office."

A Brookings Institution study (Crandall, Lehr, and Litan) in 2009 found that for every 1% increase in the availability of broadband in a community, the level of employment increases correspondingly by .3% annually. The study also found that as the level of Internet users increased in a community, there was a corresponding increase in economic growth, with a 10% increase in Internet use yielding a 1.3% increase in the economy.

A new digital divide is emerging, with fiber as a differentiator. Communities ***and neighborhoods*** with affordable broadband infrastructure and the ability (i.e. fiber) to expand capacity as demand grows over the next seven to ten years should enjoy a measurable economic development advantage over communities that lack such infrastructure.

Broadband is not a silver bullet for Shaker Heights. Broadband investments need to be tied to a wider set of community and economic development strategies that help make communities engaging and interesting places to locate and run businesses, and to make communities a vibrant and safe place to live. Communities that have made broadband investments without taking the time to identify a broader set of goals and expected outcomes have usually been disappointed when broadband investments have not had much of an impact. However, it is clear that broadband investments are critical for economic viability.

- In 2008, U.S. industries invested over $455 billion dollars in telecom and technology investment, including over $60 billion in broadband.
- A 2011 report from the McKinsey Global Institute studied the Internet's growing impact on the economy. The report found that the Internet accounted for 21% of GDP growth in the last five years for mature countries, and this number is only expected to climb higher.
- $8 trillion dollars is exchanged through e-commerce annually.

City investments in infrastructure will accelerate the availability of broadband options within the community, especially in the business and retail sector. It is important to note that the City government would not sell services to the public and would not compete with

private sector firms. Instead, private sector firms, including existing telecom providers, would use the new infrastructure to compete with each other. Service providers using the network would pay a small portion of revenue to the network for the use of the infrastructure.

Commuting costs due to energy increases will encourage more work from home and business from home activities. Traffic and commuting patterns will change, and these shifts in commuting patterns may suggest different budgeting strategies for community infrastructure improvements and investments. As fuel prices continue to fluctuate, a slow but steady increase in the number of home-based jobs and businesses is being driven by the corresponding increase in the cost of commuting. But home-based workers and businesses will require more than the current residential broadband services; business class broadband will become increasingly important as city neighborhoods transition to daytime business districts.

Residents and businesses are increasingly content creators, not just content consumers. This shift in locus of content development also means that both residential neighborhoods and existing commercial areas of the city require much higher performance networks with symmetric bandwidth to accommodate content creation.

Demographic changes must be considered; if the city wants to attract and retain young people, consider the following data from a Fiber To The Home Council report (March, 2013):

- Among young people under 35, 54% of males are "very interested" in advanced broadband services, and 44% of females are "very interested" in advanced broadband services. In this age group, over 65% are "very interested" in working from home.
- In the over 54 age group, one third of men and women are interested in advanced broadband services, and over half want to use HD video calls.
- 11% of fiber to the home users have a home-based business.
- Fiber service is ranked as the number one factor influencing a home purchase if the buyer already has fiber at their current residence. Fiber is ranked as the number two home buying factor if they do not have fiber service now.
- Fiber connected homes are perceived as being worth $5,000 to $6,000 more than an equivalent home without fiber.
- Because of the increase in home-based businesses due to fiber availability, fiber can create as much as $1.1 million in new business revenue to the community for every 1,000 homes passed by fiber.

World class broadband infrastructure will be necessary to maintain the city's attractiveness as a great place to live.

Business Attraction

Chattanooga and Kansas City have both reported that the "big broadband" Gigabit fiber available has brought new businesses. Many of these new businesses are owned by entrepreneurs that deliberately moved to one of the two cities to take advantage of the high performance networks and the associated low cost of connectivity.

A near term effort to deploy fiber widely in Shaker Heights would give the city an edge in business attraction, but as more communities make similar investments, this opportunity will degrade over time.

Business Retention

If fiber services from a wider range of providers was more widely available in Shaker Heights, the cost of typical businesses services like Internet and telephone will likely decline. When the Wired Road project in southwest Virginia began offering competitive services from private sector providers, prices for Internet and phone declined by as much as 60%, and many businesses found they were able to dramatically increase the amount of bandwidth they were purchasing for Internet access while simultaneously paying less. Efforts to reduce the cost of telecommunications for businesses will become more important to business retention efforts as other communities, especially those nearby, roll out Gigabit service connections and competitive pricing.

Economic Growth

There are generalized benefits for improved availability and affordability of broadband services.

- A analysis by Canadian firm SNG found that every dollar spent on broadband infrastructure created a tenfold return to the community in increased economic activity.
- A study (http://www.aestudies.com/library/econdev.pdf) of Lake County, Florida, where the local government opened its fiber for business use found a 100% increase in economic activity over time.
- Several other comprehensive studies have found a minimum of 1% higher annual economic growth in communities with affordable high speed broadband infrastructure. Over a period of years, this translates into a permanent and significant increase in economic activity compared to communities that lack such infrastructure.

Broadband is Green

Broadband brings a variety of energy-saving "green" benefits:

- Reduced use of paper for some services and applications (e.g. reading newspapers and magazine on tablets, rather than the higher carbon footprint of home delivery of paper version).
- Email reduces the amount of fuel needed to deliver paper mail.
- Online shopping is more efficient in terms of delivery costs (one UPS truck can deliver packages more efficiently than individual consumers each driving a private car to the store).
- Concentrating computing resources in the high efficiency "data cloud" can reduce the amount of electricity needed by businesses and users.

Job Creation and Retention

As businesses inevitably rely more on dependable access to telecommunications to sustain their trade, they are also seeking fast and affordable networks as well. In many cases, cable and DSL companies are monopolies within a community. Unsurprisingly, these companies are able to provide unreliable and slow networks, since customers have no other choice but to purchase their products. As a result, numerous communities have taken the issue into their own hands and built their own networks. Communities are able to control the connections and the reliability of the services. Ultimately, affordable access to reliable internet services is a catalyst for economic growth and job creation.

- Chanute, Kansas (Chanute Municipal Network): One of the reasons why Spirit AeroSystems chose Chanute for their new manufacturing facility is because of their leading broadband infrastructure. As a result, the plant created over 100 new jobs.
- Bristol, Virginia (Optinet): This community has a publicly owned network that attracted companies like CGI and Northrup Grumman. These companies not only created 700 jobs, but also paid twice the average wage in the community due to the convenience of the network.
- Springfield, Missouri (SpringNet): When a carrier failed to meet the demands of Springfield, SpringNet was created and ultimately served to provide the necessary connectivity to create over 400 jobs to the community.
- Chattanooga, Tennessee (EPB Fiber): According to an academic study, the first ten years of the EPB fiber network will produce over 3,600 new jobs correlated with the City's high speed Internet, phone, and television services.
- Palm Coast, Florida was able to retain the city's largest employer (over 500 jobs) because the city-owned open access fiber network sharply reduced the cost of Internet access within the City.

Public Savings

When local governments build their own networks, they experience striking savings and greater reliability. How? Since the local governments own the network, they have the leverage to determine the future costs and when these price hikes would occur. Community anchor institutions like schools, libraries, and government facilities typically reap in the greatest savings because they are no longer contracted to sign a lease to join a network. The City of Shaker Heights currently spends about $47,960 per year for Internet and dark fiber connections from Time Warner. This amount could be substantially reduced if there was more competition in the City for Internet and City building connections.

- Martin County, Florida: Once the initial capital investment in the fiber asset is paid off, Martin County School District will save nearly $340,000 per year. In other words, the school district will only pay an estimated $6,000 per year for a gigabit connection to 26 locations.
- Bristol, Virginia: One study concluded that Bristol schools have saved $1 million from 2003-2008 just by self-provisioning phone services. This results in nearly $10 million in savings for the community.

- Martinsville, Virginia: Similarly to Bristol, Virginia, Martinsville saves between $130,000 and $150,000 annually because they do not need to lease telephone lines.
- Medina County, Ohio: When data needs were fulfilled by Time Warner Cable, Highland Public Schools spent $100,000 per year for the company's services. However, the county saved $82,000 in 2012 when it switched over to the Medina County municipal network since the cost was only $18,000 per year.
- The city of Wilmington, North Carolina uses its fiber network to turn the lights off at sports parks at night. Cameras have been placed at every sports and recreation field, along with remote control light switches. A single city employee can quickly check the cameras to see if anyone is still at a field, and if not, a couple of mouse clicks turn off the lights. The city expects to save $800,000 per year on electricity costs.

Needs Assessment

Bandwidth needs for the past decade have been growing by 25% to 50% per year, and show no sign of slowing. As computers and associated hardware (e.g. video cameras, audio equipment, VoIP phones) become more powerful and less expensive, new applications and services are continually emerging that drive demand for more bandwidth. The table below indicates the likely growth in bandwidth, based on current uses, emerging high end equipment, and research lab/university/government networks already deployed and in use. Lightpaths refer to placing multiple wavelengths (paths) of light on a single fiber. High end commercial equipment already in production is routinely placing 20+ lightpaths on a single fiber, with each lightpath capable of carrying data at gigabit speeds. This technology will move down to ordinary business and residential network equipment over the next ten to fifteen years. Current fiber being installed will require only a relatively inexpensive equipment upgrade to increase carrying capacity over the same fibers.

From a report by the Information Technology and Innovation Foundation, listed below are the bandwidth requirements for services already commonly in use and for emerging services like telepresence business videoconferencing.

Application/Service	Upstream Bandwidth Requirement	Downstream Bandwidth Requirement	Total Combined Bandwidth Required
Medium resolution videoconferencing	1.2 megabits	1.2 megabits	2.4 megabits
Streaming video (720p)		1.2 megabits	1.7 megabits
Standard definition TV		4 megabits	4.25 megabits
Basic HD videoconferencing (720p)	1.2 to 4 megabits	1.2 to 4 megabits	2 to 8 megabits
Telepresence high resolution HD videoconferencing	5 megabits	5 megabits	10 megabits for 2 attendees, 15 meg for 3 attendees
Video home security service	10 megabits		2.5 to 5 megabits
HD digital television (1080p)		15 megabits	5 to 10 megabits
Telepresence very high resolution HD videoconferencing (1080p)	15 megabits	15 megabits	30 megabits for 2 attendees, 45 megabits for 3 attendees
4K digital television	1 megabit	19 megabits	20 megabits

Note that the business videoconferencing services all require symmetric bandwidth. This is a critically important issue, as current incumbent "little broadband" services like DSL and cable modem systems do not offer symmetric bandwidth (where the upstream and downstream bandwidth is equal). Using this information we can project what Shaker Heights homes and businesses will need in the coming years.

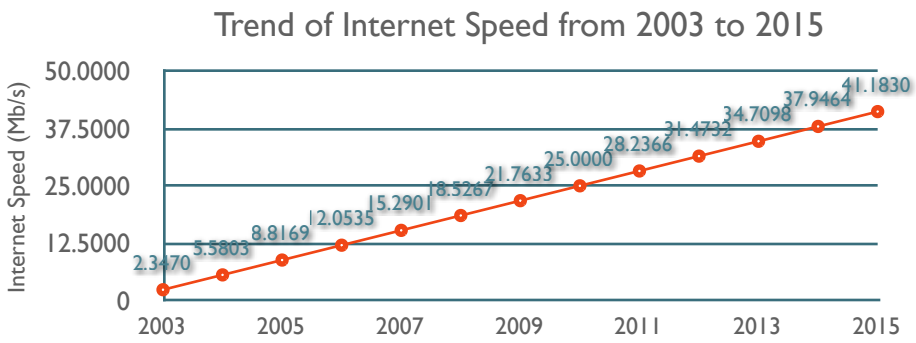
	Next 2-4 years	Next decade	Twenty years
Small business needs (1-9 employees)	10-25 megabits of symmetric bandwidth and 5-10 megabits of Internet access	100 megabits of symmetric bandwidth and 20-40 megabits of Internet access	Gigabit+ symmetric bandwidth and 50 to 100 megabits of Internet access
Medium-sized business needs (10-100 employees)	50-100 megabits of symmetric bandwidth and 10-20 megabits of Internet access	Gigabit symmetric bandwidth and 50 to 100 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 100+ megabits of Internet access
Large business needs (100-1000+ employees)	Gigabit+ symmetric bandwidth and 100+ megabits of Internet access	Multiple gigabit symmetric connections and 250 to 500 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 1 Gigabit+ of Internet access
Residential needs	25-50 megabits of symmetric bandwidth and 4-8 megabits of Internet access	100 megabits of symmetric bandwidth and 20-30 megabits of Internet access	A Gigabit symmetric circuit and/or lightpaths, with 50 to 100 megabits of Internet access

Trends in Broadband Use

Although the U.S. once led the way in the World Wide Web, the U.S. has now fallen to the 27th place among developed nations for broadband usage according to a report conducted by the OECD (Organization for Economic Co-operation and Development) in 2012.

In addition, limited choices often force U.S. consumers to purchase slower bandwidth speeds at a higher cost as compared to other nations. However, increasing bandwidth speed at an affordable price point will be necessary to compete in a global economy. The speed of the bandwidth can have a significant impact at the local, state, federal, and international level in regards to the standard of living and economic development.

The Internet-enabled local and regional networks service the purpose of maintaining and creating jobs, facilitating telemedicine, improving education, ensuring public safety, and providing public services. Just within the past decade, the key purposes of the Internet were intended for basic use to hop onto the web. However, the Internet is now used for both play and for work.



The steadily increasing use of the Web and other Internet-based services is creating the need for more bandwidth both at home and in business. Broadband bandwidth has increased from 300 Kb/s in 2003 to 25 Mb/s in 2010 according to a report conducted by Cisco. Despite the fact that global IP traffic has increased eightfold over the past 5 years, and will increase fourfold over the next five years, most U.S. Internet connections are not sufficient enough to support interactive home-based medical monitoring, multi-media distance learning, or to send and receive data to run a home-based business as denoted by the Cisco Visual Networking Index.

In other words, the U.S. is average on the playing field of first generation broadband measures. The U.S. is an even weaker performer on providing reasonable prices for high and next-generation speeds. This translates into a significant concern if business users of broadband want to compete globally for business concerns and enjoy the same connectivity capabilities as their competitors in a worldwide marketplace. Various predictions are forecasting steady future growth as the number of Internet-connected devices increases and users make more sophisticated use of those devices and the services available on those devices.

- FTTH users work more from home, reducing traffic congestion
- 9% of home-based businesses report fiber is critical to success (Shaker Heights has hundreds of home-based businesses)
- Older users want telepresence, telemedicine
- Younger residents want collaboration tools, work from home
- More than 20 million homes now have fiber passing them (about 30% take rate)
- 82% of home buyers who already have fiber will not buy a home without it
- 68% of buyers who don't have fiber now want it (only 62% rate green space as most important)
- 49% would cancel fiber service last if forced to cut living costs

- By 2017, average global broadband speed will grow 3.5-fold, from 11.3 Mbps (2012) to 39 Mbps (2017) -- Shaker Heights can't rely on antiquated copper networks to support future bandwidth needs.
- Annual global IP traffic will reach the zettabyte threshold (966 exabytes or nearly 1 zettabyte) by the end of 2015. (A zettabyte is a measure of storage capacity. 1 zettabyte is approximately equal to a thousand exabytes or a billion terabytes.)
- The OECD (Organization for Economic Co-operation and Development) predicts that 2022, the average household with two teenage children will own roughly 50 Internet-connected devices, up from approximately 10 in 2014. This trend has been dubbed the "Internet of Things."
- Seventy-eight percent (78%) of the data used by smartphones is accessed via WiFi rather than cellular networks, indicating that ubiquitous wireless access in downtown areas can be important to attracting shoppers and visitors.
- The "terabyte club" will reach 6 million by 2015. In 2015, there will be 6 million Internet households worldwide generating over a terabyte per month in Internet traffic, up from just a few hundred thousand in 2010. There will be over 20 million households generating half a terabyte per month in 2015.
- Global IP traffic has increased eightfold over the past 5 years, and will increase fourfold over the next 5 years. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 32 percent from 2010 to 2015.
- A growing amount of Internet traffic is originating with non-PC devices. In 2010, only 3 percent of Internet traffic originated with non-PC devices, but by 2015 the non-PC share of Internet traffic will grow to 15 percent. PC-originated traffic will grow at a CAGR of 33 percent, while TVs, tablets, smartphones, and machine-to-machine (M2M) modules will have growth rates of 101 percent, 216 percent, 144 percent, and 258 percent, respectively.
- Globally, video will be 73 percent of all Internet traffic (both business and consumer) by 2017, up from 60 percent in 2012. The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be in the range of 80 and 90 percent of global consumer traffic by 2017. -- the City of Shaker Heights needs broadband infrastructure that will support current and future video uses, especially high-def business videoconferencing.
- Busy-hour traffic is growing more rapidly than average traffic. Busy-hour traffic will increase fivefold by 2015, while average traffic will increase fourfold. During an average hour in 2015, the traffic will be equivalent to 200 million people streaming high-definition video continuously. During the busy hour in 2015, the traffic will be equivalent to 500 million people streaming high-definition video continuously.

- Internet video is now 40 percent of consumer Internet traffic, and will reach 62 percent by the end of 2015, not including the amount of video exchanged through P2P file sharing. The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be approximately 90 percent of global consumer traffic by 2015.
- The highest quality IP-based video streams today require six to twelve megabits/second, but the emerging Ultra HD, designed to support the new 4K TVs, will require fifteen to twenty megabits/second--per channel. If there are two people in a home watching two different channels at the same time, the base bandwidth requirement just to watch TV will be on the order of 40 megabits/second.
- Globally, mobile data traffic will increase 13-fold between 2012 and 2017. Mobile data traffic will grow at a Compound Annual Growth Rate (CAGR) of 66 percent between 2012 and 2017, reaching 11.2 exabytes per month by 2017. -- Fiber-enabled data backhaul services are critical to ensuring that mobile phone and data networks have enough capacity to support demand.
- Business IP traffic will grow at a CAGR of 24 percent from 2010 to 2015. Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 2.7 between 2010 and 2015.
- Business video conferencing will grow sixfold over the forecast period. Business videoconferencing traffic is growing significantly faster than overall business IP traffic, at a CAGR of 41 percent from 2010-2015.

Next Generation Connectivity

"Next generation" is the term used to describe future planning for the next step in network connectivity and infrastructure. There seems to be an emphasis on deploying fiber-to-the-home (FTTH). But why? By pulling fiber deeper into the neighborhood and providing greater access to connectivity, this allows the infrastructure to be in place to accommodate future communication needs, capacities, and innovations. Because of the U.S. demographic bulge that occurred during the baby boom after World War II caused exurban migration, the U.S. is currently the only country where fiber is being deployed in largely suburban areas with single family homes. In countries like Japan and Korea, fiber to the apartment is widely available, in part because the cost of delivering fiber to a high rise apartment building that might have 500 subscribers is much lower than the build cost of fiber to 500 single family homes in a sub-division.

Next generation broadband reaps substantial benefits; there are several key benefits of "Next-Generation Broadband":

- Dramatically faster file transfer speeds for both uploads and downloads
- The ability to transmit streaming video, transforming the Internet into a far more visual medium

- Means to engage in true-real time collaboration
- The ability to use many applications simultaneously
- Ability to maintain more flexible work schedules by being able to work from home on a part time or full time basis
- The ability to obtain health-related services for an occasional illness and/or long term medical services for chronic illnesses.

Clearly, consumers have a strong interest in a visual medium from when and wherever they are. YouTube is the second most popular search engine after Google, which demonstrates the need to support the infrastructure to transmit streaming video.

In addition to video streaming, true-real time collaboration also provides an effective way for people to interact from wherever they are. People can engage in a two-way, real-time collaboration, so that fruitful, visual conversations can be held between friends, family, business associates from the state, country, or internationally.

Because of fiber networks, employees have the capabilities of working from their home. Findings suggest that if all Americans had fiber to the home, this would lead to a 5 percent reduction in gasoline use, a 4 percent reduction in carbon dioxide emissions, $5 billion in lower road expenditures, and 1.5 billion commute hours recaptured.

Significance of Big Bandwidth for the Future

According to a report from the World Bank on information and communications technologies, for every ten additional broadband subscribers out of 100 inhabitants are correlated in high income countries with GDP growth increases of 1.21%.

Prosperity

As suggested from the statistic above, the Internet generates growth. In more than a handful of countries, GDP growth doubled to over 21% due to the Internet. Although some jobs have been eliminated due to the emergence of the Internet, nearly 1.2 million jobs have been created over the past 15 years from the Internet. The McKinsey's global SME survey suggests that 2.6 jobs were created for every one destroyed.

Health Care Delivery

According to "The 2008 State New Economy Index" healthcare can be significantly improved in the future through greater use of information technology and connectivity to the web. Healthcare costs can potentially be cut by $80 billion annually. The cost of health care continues to rise annually. For instance, health care as a share of U.S. GDP almost doubled from 8.8 percent to 15.3 percent in 2005, and ten years later, costs continue to rise.

Some insurance companies (e.g. Anthem/Blue Cross) are now (2015) offering online access to health care professionals (i.e. doctors and nurses) for routine medical illnesses (e.g. fevers, flu, colds, sore throats, etc). Users of this service have to have robust Internet access

and a Web cam. Prescriptions are sent directly to the customer's drug store at any time of day or night.

Electronic prescribing has become common. Electronic prescribing cuts medical transaction costs by eliminating the need for confirmation phone calls and faxes and reduces the chance of health risks due to prescription delays.

Government and Civic Life

The term E-Government refers to networked information technologies online to serve constituents. The Internet cuts costs for many state governments from reducing the paper trail to expediting services through the Web like renewing drivers' licenses and paying taxes. Furthermore, E-government will become a setting for online based discussions between constituents and bureaucrats. This allows for greater transparency in hopes of garnering a better perception of how government functions. More local and state governments and the federal government are attempting to involve constituents through webinars, blogs, wikis, and videos.

Education

Students benefit greatly through the use of computers and Internet. Nearly every public school in America has access to the Internet. In 2007, there were 180,000 more instructional computers in the schools than in 2006. Students who attend schools without access to computers and the Internet may be ill prepared for the work place. The prevailing use of information technologies in not only the United States, but also globally, is a clear indicator that future prosperity is in the hands of students who are able to understand and use the pertinent tools.

Use Trends and Service Needs Analysis

Mark Peterson, a Professor of Community and Economic Development at the University of Arkansas who studies the impact of broadband access and affordability on rural communities, wrote recently, "Broadband connectivity is not the infrastructure of the future, it is the infrastructure of the present." Shaker Heights faces a challenge in economic development infrastructure with primarily "little broadband" (i.e. DSL, wireless, and cable services) when many communities, regions, and countries have already made the decision to focus resources on the development of "big broadband," which is typically fiber with a minimum capacity of 100 megabits or Gigabit to the premises.

- A third of IBM employees work from home at least part time, and the company has reported annual savings of $110 million.
- Australia's government is converting the entire telecommunications infrastructure for the country to an open access system by buying a major portion of Telstra assets. Telstra, which is currently the country's primary incumbent telecom provider, will become a service provider on the new open network.

- In a 2013 report to the Fiber To The Home Council, Render Research and Consulting reported that fiber to the premises adds $5000 to $6000 to the sales price of the house.
- Fiber to the home users say they are able to work from home more often, averaging 7.3 workdays per month, reducing their carbon footprint and decreasing wear and tear (and maintenance) on roads.
- About 13% of homes in the U.S. had been passed by fiber by 2012.
- Nationally, less than 10% of homes have no access to any kind of broadband service, but in the city, more than 13% of homes still have no broadband access, or nearly 50% higher than the national average.

In its March, 2009 report, the ITIF (Information Technology & Innovation Foundation) listed some of the next generation services and applications enabled by high performance, affordable broadband. The table on the next page lists these and other services that all represent broadband-enabled applications and services that must be available in Shaker Heights if it is to remain economically viable.

Residential and Business	Videoconferencing
	IP TV (Internet Protocol TV)
	HD streaming video
	Ultra hi-def (BluRay) video streaming
	Video on demand (e.g. Netflix)
	Place-shifted video
	Cloud computing services
	Online and cloud-based gaming
	Smart homes, buildings, and appliances, including smart electric meters, AMR (automated meter reading), and AMI (advanced metering infrastructure)
	Remote computer aided design (CAD)
	Work from home jobs
	Business from home
	3D graphic rendering and CGI server farms
	Remote network management and managed services
	Virtual collaboration spaces (e.g. enhanced GoToMeeting, Webex style services)

Public Safety	Intelligent transportation applications (smart road systems)
	Public safety and first responder networks
	Emergency dispatch and coordination
	Webcast agency meetings (e.g. virtual meetings)
	Online training for first responders, fire, and rescue
Society	Broadcast of local sports events
	Videoconferencing of community and town hall meetings for wider participation
	Wider availability of nonprofit and community organization services
Health Care	Teleconsultations
	Telepathology
	Telesurgery
	Remote patient monitoring
	Remote diagnosis
	Remote medical imaging
	Grid computing for medical research
Education and Research	Distance education
	Virtual classrooms
	Remote instrumentation
	Multi-campus collaboration
	Digital content repositories and distribution (digital libraries)
	Data visualization
	Virtual laboratories
	Grid computing for academic research

- When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. As we noted in the previous section, "broadband" is not a service--it is a delivery medium. If we think about broadband using a roads analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband road system, and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

- By 2012, Americans were watching more than 10 billion videos per month over the Internet. In 2015 it is estimated that more than one million video minutes are traveling across the Internet every second.

- This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of 1 megabit to 3 megabits for most residential users, 3 megabits to 5 megabits for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth is possible, but as the DSL bandwidth goes up, the distance it can be delivered goes down.

- Current wireless offerings are in the range of 1/2 megabit to 3 megabits, and WiMax services are only be able to deliver 4-8 megabits to individual customers. Some wireless providers are rolling out 10-15 megabit services, but wireless does not scale up well with respect to cost. As bandwidth increases, the cost of the equipment also increases, and even a 15 megabit service is well short of the FCC projections of the need for 50 megabits of bandwidth in the near term. Wireless performance and capacity is heavily dependent upon backhaul (the local connection to the provider's core network); if this connection is also wireless, the bandwidth available at the access point is shared among all users, even if the rated capacity of an individual connection is 15 megabits. In other words, if the backhaul capacity is 100 megabits, and twenty local users are sharing that capacity, actual bandwidth available to any single user may be much lower than 15 megabits. If all the users are trying to watch video at the same time (not uncommon in early evening), performance can suffer drastically.

- Across the U.S., current average bandwidth for cable modem services is typically 10 to 20 megabits, with cable companies promising "up to..." twenty or thirty megabits. It is important to note that cable providers make heavy use of the phrase "up to" in their advertising, and it is not unusual to see ads promoting cable modem speeds of "up to 30 megabits." However, that amount of bandwidth is shared among many users (often 200 or more) in a neighborhood, which results in much lower average speeds, and during peak use times in residential areas, the actual bandwidth available to a single household may be less than one megabit.

The challenge for Shaker Heights is to ensure that the businesses, residents, and institutions in the community have a telecommunications infrastructure in place that will be able to handle the 50x bandwidth increase projected by the FCC (which is based on many years of real world data).

At a recent broadband conference, a talk by a DirecTV official provided additional insight into residential bandwidth needs. The DirecTV speaker noted that one of their biggest complaints is that the company does not have enough HD format programming. He went on to note that a single channel of "standard" HD content uses 10 megabits of bandwidth when delivered via IP-TV, and a live event like a race or sporting event (e.g. football) requires 15 megabits of bandwidth. The new HD 4K video standard requires 19 megabits per channel--far beyond the ability of existing wireless and copper-based broadband services to deliver with any quality (or at all).

DirecTV is already delivering video programming to end users using Internet-based IP-TV formats, and noted that many buildings and homes do not have the internal cabling to support the IP-TV bandwidth needs. He also indicated that their early IP-TV users cannot tell the difference between IP-TV delivery of video and traditional cable/satellite delivery.

In 1993, the year that the Blacksburg Electronic Village began offering the first residential Internet access in the world, the average connection speed was 14,400 bits per second. At the end of 2007, the average bandwidth to the home is fifty times that for DSL service (768,000 bits per second), and over 70 times that for the typical cable modem connection (about 1,000,000 bits per second). DSL speeds have flattened out because DSL capacity has flattened out, not because demand has diminished.

Distance learning, entertainment, and video conferencing are three major applications of internet video. Distance learning from home with live video feeds will require high performance 2+ megabit connections in the near term (next 2-4 years), and over the next 4 to 7 years, there will be many distance learning courses that will incorporate live HD two-way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Distance learning could be an important home-based application for workforce training and retraining. Some Idaho community colleges offer "hybrid courses" where a student attends several class sessions at the college and the remaining sessions online from their home, the library, or another location.

Massive Open Online Courses (MOOCs) are now being offered by many colleges and universities, and provide an important and affordable way to obtain certifications and/or college credit in virtually any topic. But many of these classes rely heavily on video to deliver course content, and so an excellent Internet connection is a requirement.

Entertainment will also drive bandwidth demand from the home, and the popularity of video sites like YouTube and Netflix provide a good indication of the long term demand for video in many forms, including:

- Live feeds (e.g. live TV shows, sports coverage, and live news reports).
- Video on demand (TV shows available for viewing at any time, rather than at scheduled times).
- Movies on demand (instead of going to the video store).
- Two way video conversations (family, friends).
- Video stored on home computers and distributed across the Internet (e.g. videos of grandchildren, family activities).
- Local video content streamed live or from a server (e.g. high school football games, other sporting events, council meetings, other civic activities).

Most homes in Shaker Heights have multiple TVs, meaning that a minimum of 25 megabits of bandwidth is required just to have both televisions on and tuned to two different channels. If a third person in the home is attending an evening distance learning course that uses HD video, the total bandwidth need would be more than 40 megabits.

Another source of increased demand, alluded to above, is multi-tasking. Surfing the Web while watching TV is becoming commonplace. With the proliferation of smart-phones, tablets, and laptop computers, the amount of potential users is also increasing. A recent study collected data showing that the average U.S. household has an average of 10 Internet-enabled devices:

> *"U.S. homes now have more than half a billion devices connected to the Internet, according to a study by the NPD Group. Furthermore, the overall number of connected devices per household, according to a 2014 OECD study, is 10. This is more than three times the average number of people per household. The proliferation of connected devices is primarily fueled by tablet sales...."*

Service and Gap Analysis

Business Bandwidth Needs

The table below shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The cost of fuel is already affecting business travel decisions, and more and more businesses will invest in HD quality business videoconference systems to reduce the need for travel. These HD systems require substantial bandwidth; a two way HD video conference requires 20-25 megabits during the conference, and a three way conference requires 30-35 megabits during the conference. As more workers try to reduce the cost of driving to and from work by working part or full time from home, the business location must provide network access (Virtual Private Network, or VPN) to the employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 megabits of bandwidth during normal work hours.

	Large Business		Small Business		Home Based Worker		Business From Home	
Description	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		A single employee working at home for his/her company.		A home business with one or two employees working at home.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	20	1.28	5	0.32	1	0.064	1	0.064
TV		0		0		0		0
HDTV		0		0		0		0
Credit Card Validation	4	4	1	1		0		0
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	20	30	7	10.5	1	1.5	1	1.5
VPN Connection	5	25		0	1	5		0
Data Backup	5	7.5	1	1.5	1	1.5	1	1.5
Web Hosting	1	2		0		0		0
Workforce Training (online classes)	2	20	1	10	0	0	1	10
HD Videoconferencing	10	100	2	20	1	10	1	10
Telecommuting workers	5	15	2	6	0	0	0	0
Totals		**205.0**		**49.6**		**18.3**		**23.3**
5 years from now (megabits)	**615**		**149**		**55**		**70**	
10 years from now (megabits)	**1845**		**446**		**165**		**210**	

Residential Bandwidth Needs

The table below depicts the bandwidth needed for typical residential services which are available now or will be available in the near future. In a next generation network all services will be delivered over a single network infrastructure which will require an access network that can support providing most services to most consumers simultaneously. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their "advertised" bandwidth today's cable and DSL networks would grind to a halt.

In fact, they already are; some cable providers have begun to receive heavy criticism for undocumented manipulation of data traffic. Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded when compared to the same channel delivered by satellite.

	Residential Daytime		Early Evening		Evening and Late Night		Snow Day	
Description	Intermittent Television and Internet use across a small percentage of households.		Increased video, voice and Internet use as children arrive home from school and employees from work.		Peak television and Internet use. Multiple TV's are on, phone and computer being used.		On top of typical daytime traffic children are home from school, and many employees are home working.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	1	0.064	1	0.064	1	0.064	1	0.064
Standard Definition TV	1	2.5	1	2.5	1	2.5	1	2.5
HD TV	1	4	2	8	2	8	3	12
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	1	1.5	1	1.5	2	3	3	4.5
Online Gaming		0.25		0.5		1		1
VPN Connection	0	0	1	2	1	2	2	4
Data Backup		0	1	5	1	5	1	0
Telehealth (subscriber)	1	4	1	4	1	4	0	0
Distance Learning / Workforce Training		0	1	10	1	10	2	20
HD Videoconferencing		0		0		0	1	14
Totals		**12.6**		**33.8**		**35.8**		**58.3**
5 years from now (megabits)	**38**		**101**		**107**		**175**	
10 years from now (megabits)	**113**		**304**		**322**		**525**	

The table above is designed to show bandwidth consumption in several scenarios. Network design requires a system than can meet peak demand across the entire network, meaning the network must be able to deliver peak bandwidth demand to a majority of households at the same time. Super Bowl Sunday is a typical example of a day when a majority of households may be watching a video at the same time. Political debates, season finales of popular shows, and even a typical Saturday afternoon during football season may see many households trying to access multiple channels of video simultaneously. This table shows the severe gap between current DSL, wireless, and cable modem options in the City of Shaker Heights and projected future demand.

Shaker Heights Schools

There are several private schools in Shaker Heights. Repeated telephone and email requests for information on their current and future broadband needs were not returned.

The Shaker Heights public schools have all but one facility serviced by Time Warner fiber. he schools currently pay a monthly maintenance fee of about $3,300/month to Time Warner. The Time Warner contract was renewed in 2015 and will expire in 2019; the schools expect to continue renewing that contract. A 10 Gig connection between City Hall and the high school provides the Internet gateway for the school system. The schools currently have a package of 500 Meg of Internet purchased from the North Coast Council. The schools have a 50% eRate subsidy which helps offset the cost of these services. The schools have ongoing conversations with the Shaker Heights Police Department and would like to be able to eventually provide the Police Department with improved access to the hundreds of security cameras already installed in the schools. This is a long term project that will require some hardware upgrades. The cameras could generate very large data traffic increases to the Police Department, which does not currently have enough bandwidth to handle that. Improved redundancy for the school network is desirable, especially to improve the reliability of the increased use of online testing, but the cost of additional fiber routes would be a primary consideration.

Service Provider Information

Everstream (formerly OneCommunity)

Everstream has some fiber infrastructure in Shaker Heights already, and its fiber facilities are mapped in the Appendix of this report. Everstream was part of the OneCommunity network, but was recently sold to a group of private investors. Everstream indicated a willingness to use City infrastructure, and expresses a preference for dark fiber. Everstream is also working with Lakewood, Ohio, which is described in more detail in the Case Studies section.

Wide Open West

Wide Open West (WOW) was responsive to our inquiries and readily provided a map of their fiber facilities in Shaker Heights. The company has built a fiber network concentrated around the edges of the city and has more fiber on the eastern side of Shaker Heights. WOW indicated interest in the City effort and indicated that if the City did build infrastructure that WOW would consider making use of it.

Time Warner

Time Warner currently provides service to most City buildings, and also provides service to the Shaker Heights public schools. The company was vague about future plans for residential and business customers. The company did not respond to repeated requests for a map of fiber routes connecting the City schools and City of Shaker Heights facilities.

AT&T

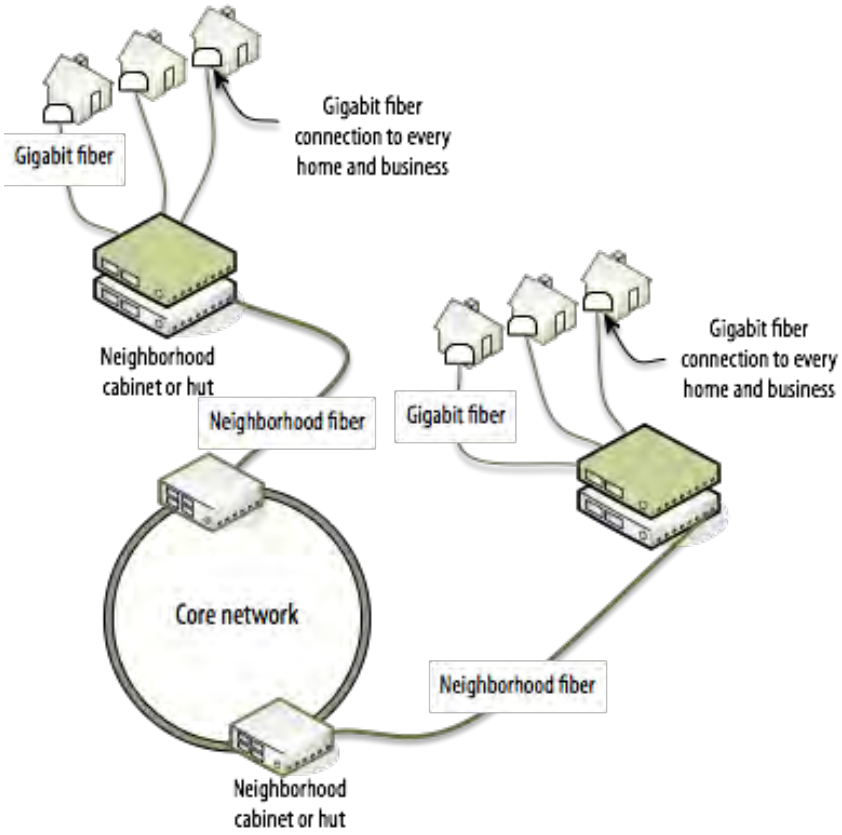
AT&T was the least responsive company. Numerous phone calls and text messages were unreturned. The company declined to provide any specificity about future plans. In late fall (2015) the company did announce its new "GigaPower" initiative to bring improved services to 38 additional urban markets, including Cleveland. However, no timeline or deployment schedule has been provided by the company, and GigaPower(tm) appears to a relabeled version of AT&T's U-Verse product, which is fiber to the neighborhood and existing copper twisted pair to the premises.

Lightower (formerly Fibertech)

Fibertech, a Cleveland area competitive fiber provider, was recently purchased by Lightower, which has large amounts of fiber in the northeast but has been expanding its footprint. Lightower does have a very small amount of fiber terminated in Shaker Heights. The company expressed interest in a Shaker Heights fiber initiative and could potentially be a provider on a City-owned network.

Building and Operating Networks

An Overview of a Modern Network



The diagram above provides an overview of a modern fiber broadband network. For Shaker Heights, conduit and fiber can be deployed in phases (along with network electronics if the active network option is chosen) to create a very high performance network capable of delivering affordable Gigabit and 10Gig connections in a series of redundant rings throughout the city . Additionally, even higher capacity circuits, including 100Gig and Gigabit wavelengths can be utilized to maximize the existing fiber strands to add even more capacity to the core portion of the network.

Core Network

The core network is often referred to as the "backbone" network. It is a high capacity route or set of routes throughout the community that provides transport between neighborhoods, business districts, and other major facilities. A core network is generally part of what is called "middle mile."

Ideally, the core network is designed as a redundant fiber ring, which provides both capacity and gives the network the ability to continue operating even if the fiber is cut or damaged in one location. A fully redundant ring can be expensive to construct, so the "ring" feature

may be a long term design goal. In Shaker Heights, one or two initial rings could be built to serve the Lee/Chagrin/Van Aken business areas, and additional rings could be added over two or three years of development to create a highly resilient local network. If a full City build out is chosen, then multiple rings would be included as part of the city-wide network design.

Distribution Network

Distribution networks are connected to the core network, and provide primary network paths through a neighborhood or business district. Fiber-based distribution networks generally are built along most streets and roads, and can be aerial fiber (mounted on utility poles) or underground fiber (installed in underground duct or fiber cable that is buried directly without duct). The distribution network connects the core network (the network backbone) with the individual connections within a neighborhood or business district that connect to home and businesses. This portion of the network can be fiber-based or wireless, but fiber will be required over the long term to support video services and other kinds of high bandwidth applications like telemedicine, Internet Protocol television (IP TV), business videoconferencing, and other emerging services.

Access Network

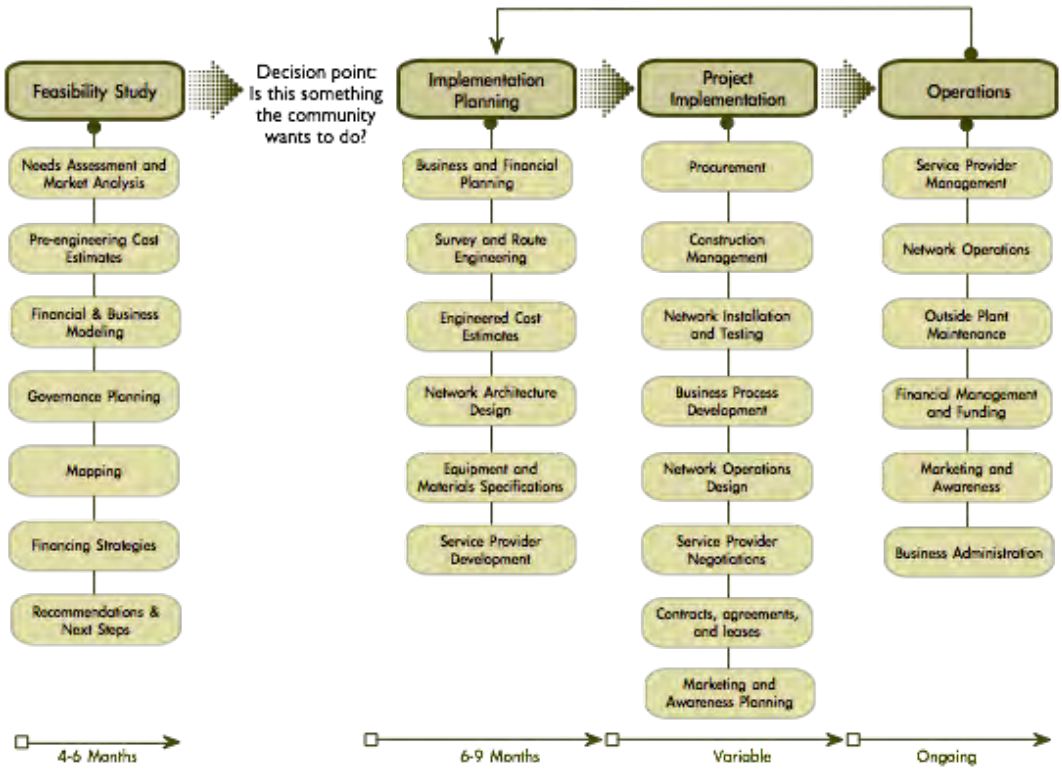
The access network is what is commonly called "the last mile," although "the first mile" might be more appropriate, since customers should be a primary consideration when designing a network. The access network is a direct fiber link between a fiber switch located within a neighborhood or business district and the customer premises. Network subscribers have to have Customer Premises Equipment (CPE) to get a network connection, and this is simply a small box that looks like a hub or switch. In a fiber network, the fiber cable is connected to one port, and one or more copper Ethernet RJ45 ports allow users to connect computers, phones, and TV set top boxes to it.

Construction and Operations Overview

For Shaker Heights, the decision to move ahead and develop a successful community-owned open access wholesale network will require attention in several areas including the technical (network equipment selection), engineering and construction, and business and financial planning. It is important to note that the business and financial planning are critical elements that will in large part determine the long term success of the effort. This section provides an overview of the key task areas and activities.

The illustration below shows the sequence of key phases and activities in the course of a network project. On the pages following this diagram is more detailed information about

the individual tasks and activities that will lead to successful completion of a fully operational network, including the business processes required.



A successful project requires a plan that ensures the right resources are available at the appropriate times during the various phases of development. Some resources must be identified and procured during the planning phase, some during the implementation and construction phases, and some during the operations phase.

- **Financial Planning** – Financial planning includes the development of short term and long term budget estimates and pro formas. These materials form the basis of developing a funding plan, as well as providing a solid base for ongoing evaluation of the success of the enterprise.

- **Business Model** – The business model selected determines the kind and type of revenue that will be generated by the project, and also affects the kind and type of expenses that are incurred. For community-owned infrastructure, there are two basic models. A "retail" network has business and/or residential customers buying services directly from the local government, which creates direct competition with local private sector providers. The alternative is the "wholesale" model, in which the community-owned infrastructure is leased out to private sector providers on a wholesale basis--the local government sells no retail services and does not compete with the private sector. Based on discussions with the Shaker Heights Administration, only a wholesale model is being contemplated.

- **Legal Counsel** – Whether the retail or wholesale business model is chosen, there is a short term and long term need for legal counsel familiar with telecom and broadband business agreements and contracts. Well written contracts with service providers protect the network and create a fair and equitable "level playing field" for competitive providers.

- **Engineering** – Whether fiber cable is hung on utility poles or placed underground in conduit, prior to construction, the routes must be surveyed and engineered drawings must be developed to meet DOT (Dept. of Transportation) requirements and to provide contractors with the information needed to construct the network to industry and state technical requirements. In the lease buy back model, the builder undertakes this role.

- **Network Design** – The logical design of the network must be matched to the business model, as the architecture of the network may vary according to a retail or wholesale model. The network design must also meet the requirements of large and small businesses, and for large businesses with extensive broadband and data needs, the network must be capable of meeting both current needs and future growth. In the lease buy back model, the builder undertakes this role.

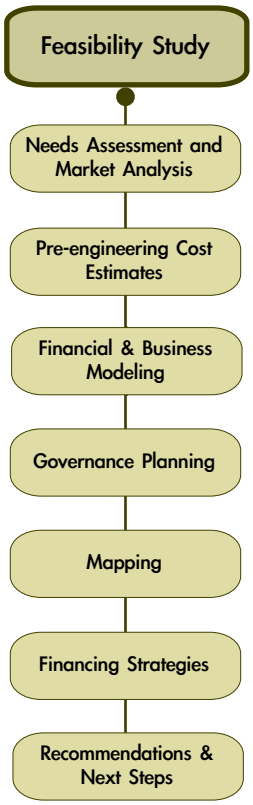
- **Equipment** – Once a network design is complete, an evaluation of equipment vendors must take place, ideally via a bidding process to ensure that the selected equipment will meet all of the business and technical requirements of the network, at the best possible price. A Total Cost of Ownership (TCO) evaluation should be completed to ensure that the right initial price is balanced with the longer term costs of extended warranties and technical support. The least expensive purchase price for equipment may be more expensive over time than equipment from a vendor with a higher initial equipment cost but lower support and warranty fees. In the lease buy back model, the builder typically selects the equipment provider.

- **Build Out** – While fiber construction is generally much less expensive than other typical community projects like water and sewer development, care must be taken to select contractors with the appropriate experience installing fiber in both aerial and underground designs. The cost of construction can vary widely, so the development of very specific bid documents that include the right engineering information as well as a carefully structured proposal response on pricing is needed to ensure the community obtains the right contractor at the right price. In the lease buy back model, the builder undertakes this role.

Early Phase Planning

This report represents the activities of the early phase planning. The current planning effort by Design Nine includes this work. The work includes:

- Needs Assessment and Market Analysis – An evaluation of current assets and projections of future needs, based on local business and economic conditions.
- Pre-engineering Cost Estimates – Pre-engineering cost estimates of potential network projects provide a baseline for understanding the costs of getting started, provide necessary inputs to the financial pro forma development, and also inform funding strategies.
- Financial and Business Modeling – A ten year financial pro forma, using inputs from the business requirements analysis and the cost estimates, provides an early test of the financial sustainability of the project and provides a long term road map for financial management.
- Governance Planning (Management and Operations Overview) – Before making a commitment to move to implementation planning, it is necessary to have a basic understanding of the key operations and management tasks related to operating the enterprise.
- Mapping – Mapping of current assets, areas and business locations of needs, economic growth areas, and key customers and stakeholders informs the development of the network architecture and the financial pro forma.
- Funding Strategies – Before moving to the next steps, it is vital to understand where the planning, engineering, and initial construction funds will come from. There are many options available.



- Next Steps – A list of key activities and milestones needed to move the project ahead.

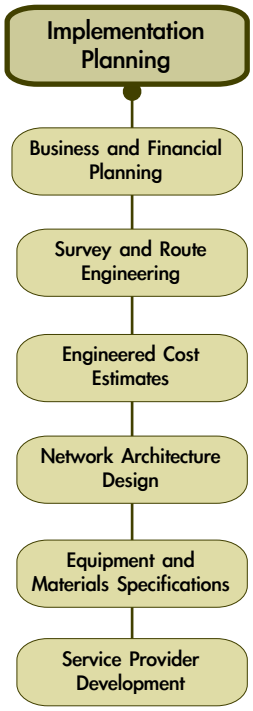
Implementation Planning Phase

This phase produces the equipment and construction specifications needed to bid out the work of constructing the network. In the lease-buy back model, the leasing firm would perform these functions. If the City is going to own the infrastructure (i.e. full or partial build out), this work is typically performed by a consulting firm with experience designing and managing the construction of community-owned networks.

- Business and Financial Planning – This work is typically performed by a qualified consulting firm, which would develop a detailed business and financial plan. This includes planning how the business front office and back office will be run.
- Survey and Route Engineering – An on the ground survey is needed to complete a final route design. This work is performed by an engineering firm that also has the responsibility to produce the engineered design and obtain required permitting. The field

survey confirms that the final route can be built to the necessary standards and regulations.

- Engineered Cost Estimates – If the engineering firm will not perform the build, the full drawing set is attached to the construction bid documents and becomes the basis for the awarded construction contract.
- Network Architecture Design (Detailed) – Final analysis of vendor equipment is performed and selection is made.
- Equipment and Materials Specifications – The Engineering firm also completes a detailed list of all equipment required for the construction.
- Service Provider Development – In an open access network, service providers have to be recruited and formally signed to a contract to become a provider on the network. Providers usually need "coaching" because they are typically unfamiliar with open access networks and need help understanding the unique business opportunities they represent for private sector companies.

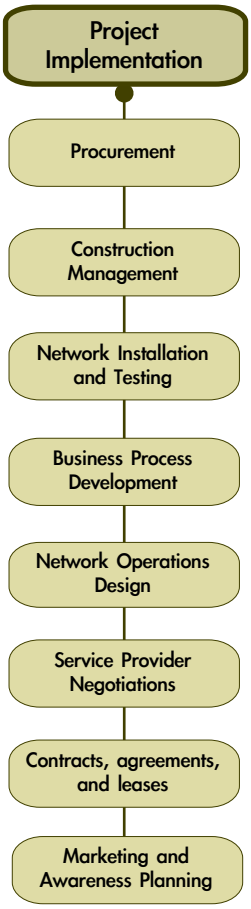


Construction Phase

The documents produced in the Implementation Phase are used to bid out the construction work and to procure the network equipment needed to produce an operational network. Like the Implementation Phase, if City has chosen the lease-buy back model, the leasing firm performs these functions. Otherwise, the City would hire a firm qualified to manage the build out (e.g. conduit/handholes, active network) to manage the construction.

- Procurement – At the beginning of the construction phase the City or the leasing firm will bid out the project construction.
- Construction Management – The construction work is bid out and an award is made to a qualified contractor with the best price. It is common to negotiate the final cost of this work once a firm has been selected.
- Network Equipment Installation – Network equipment is ordered from a vendor that meets the technical specifications. Equipment must be tested, installed in cabinets or shelters, powered up, and connected to the fiber cable.
- Business Process Development – During the construction phase, business and operational decisions must be made to produce a set of business processes that will guide the day to day operations of the network. In the leasing model, this is the responsibility of the leasing company. Otherwise the consulting firm hired by the City would assist with the development of the work processes.

- Service Provider Negotiations – Negotiations with qualified service providers continues.
- Contracts, Agreements, and Leases – The construction phase will generate the need for a variety of legal documents. Some will be related directly to the construction (e.g. an easement agreement to have conduit cross property). Typically, an experienced telecom attorney will be needed to develop service provider agreements. Other contracts could be handled by the City attorney or outsourced to a qualified attorney.
- Marketing and Public Awareness – As the network is constructed, a modest but ongoing public awareness and publicity effort is required to ensure that business customers, schools, local government agencies and other potential users of the network are aware of the project and the possibility of reducing costs and obtaining more and better services. Under the lease-buy back model, the leasing firm would be responsible for this effort. If the City owns the infrastructure, the City will have to lead this effort, but some of the work could be outsourced to a local marketing firm.



Transitioning to Operations

Under the lease-buy back model, operations would be handled entirely by the leasing firm.

Under the other models, the City would typically outsource operations and management of the network, and the items below describe the primary responsibilities. As construction is approaching completion the City may need to hire appropriate firms to monitor and maintain the network. The kind, type, and cost of this work would depend upon whether the City chooses the active or passive network approach. The companies responsible for the maintenance of the network will need to be under contract on day one. Different companies will have different requirements for assuming operational responsibility, but all should be under contract at least one month before the first customer comes online.

- Network Monitoring – The Network Operator will need about a month before the first customer is brought online. This time will be spent configuring monitoring equipment, configuring alerts, setting up internal processes, and bringing staff up to speed on the new environment.
- Outside Plant Maintenance – As soon as the contractor completes construction the City will be responsible for maintaining the network, but would sub-contract this responsibility to a qualified private sector firm. Some responsibilities such as utility locating,

fiber repairs, and maintenance of generators, HVAC systems, and other assets will begin before the network is under full operations.

- Service Providers – As the City signs on service providers they will need time to bring their connections into the colocation (meet me) facility, install equipment, and configure their network for the new services. If construction is involved this process could take several months.

Funding and Financing Analysis

The funding approach undertaken by the city will depend in part on the scope of the build out. Regardless of the source of funds for the initial capital expenditure, revenue from the network will be used to repay the cost of the initial investment. With an open access business model, there are two basic ways to generate revenue: connection fees and transport fees.

- With the **connection fee model**, connected residential customers pay a monthly connection fee that is designed to cover the operational costs and the principal and interest payments on the debt or the lease payments. Service providers pay only a very small amount to have their services delivered over the network.

- With the **transport fee model**, there is no connection fee, but service providers pay a wholesale "transport fee" to have their services carried over the network, with a per circuit (per customer) monthly transport charge.

It is important to note that the bulk of a Shaker Heights investment in broadband infrastructure will be in passive infrastructure that will have a conservative life span of thirty years or more (i.e. fiber cable). These types of infrastructure investments create hard assets that have tangible value and can then be leveraged for additional borrowing. The demand for services and the associated fees paid for those services will provide the revenue that will pay back loans or lease payments over time. There is ample time for the project to recoup not only the initial capital investment, but also to receive regular income from the project.

The financing of community-owned telecommunications infrastructure faces several challenges with respect to funding.

- Not all local governments are willing to commit to making loan guarantees from other funding sources like property taxes, because the idea of community-owned telecom infrastructure has a limited track record and therefore a higher perceived risk.

- Similarly, citizens are not always willing to commit to the possibility of higher taxes that may be needed to support a telecom infrastructure initiative, for many of the same reasons that local governments are still reluctant to make such commitments: perceived risk and a lack of history for such projects.

- Finally, banks and investors are also more skeptical of community telecom projects because of the relative newness of the phenomenon. By comparison, there are decades of data on the financial performance of water and sewer systems, so the perceived risk is lower. We do see this beginning to change, and projects both in Montana (Bozeman) and New Hampshire have received some financing from local banks.

Somewhat paradoxically, the cost of such a community digital road system is lower when there is a day one commitment to build to any residence or business that requests service.

This maximizes the potential marketplace of buyers and attracts more sellers to offer services because of the larger potential market. This is so because:

- Service providers are reluctant to make a commitment to offer services on a network without knowing the total size of the market. A larger market, even if it takes several years to develop, is more attractive.
- Funding agencies and investors that may provide loans and grants to a community network project want to know how the funds will be repaid and/or that grants will contribute to a financially sustainable project. Knowing that the size of the customer base is the maximum possible for a service area helps reduce the perceived risk for providing loans and grants.

There are a wide variety of financing options available, and Shaker Heights may use more than one source of funding, depending on the scope of the build out and where in the project timeline the funds are needed. There are two general categories of funding strategies:

- User/customer funding approaches – Sources of revenue and equity that come from directly or indirectly charging users (e.g. businesses, residents, and institutions) fees that represent one time equity contributions and/or recurring fees.
- General funding strategies – There are a variety of sources that may be used to provide loans, grants, guarantees, tax credits, and other types of equity and loans.

User/Customer Funding

Funding Source	Description	Notes
Revenue Share	Service providers pay a share of per customer monthly revenue directly to the network owner.	Network owner has only a small number of monthly bills--one for each provider. Revenue is somewhat unpredictable, particularly in the first year or two.
Connection Fee	Business and residential customers pay the network owner a one time connection fee (either in a lump sum or monthly payment over several years).	Not all customers may be willing to pay a full connection fee. The amount of the connection fee may have to vary depending upon how recurring charges are collected (i.e. monthly use fee or revenue share).

Funding Source	Description	Notes
Use Fee	Business and residential customers pay the network owner a flat monthly use fee instead of an indirectly paid revenue share.	Service providers pay nothing for transport, and in this model, their prices are correspondingly lower. The network owner must bill each connected customer monthly. The use fee provides the network owner with a predictable revenue stream that will improve bonding potential.
Purchase Commitments	Customers make a binding or non-binding commitment to buy one or more services (or spend a certain minimum amount for services) from providers on the network.	Very useful for determining where to build first. Binding commitments can help strengthen bond offerings.
Take or Pay	Business and residential customers in a community agree to buy services from providers on the network or pay a fee.	If voter approval can be obtained, helps get high take rates and provides predictable funding to help support revenue bonding efforts.
Electric Utility Partner	The electric utility agrees to use the network for meter reading and energy conservation.	Achieves immediate 100% take rate for electric service. Fees paid to network owner are small, but predictable and include all connected customers.

Revenue Share Model

In the revenue share model, any company that chooses to use the community network infrastructure for commerce would pay a share of revenue that reflects a fair value for access to that infrastructure. This percentage of revenue varies with the anticipated operating costs, debt load, and type of service being delivered, but typically ranges between 10% and 35%. Numerous projects in Europe and the United States have successfully implemented this model, and attracting service providers has not been an issue since the providers benefit by having little or no capital costs to acquire new customers.

All existing telecom providers, including incumbents, are invited to use the system to sell services both to existing customers and also to reach new customers with new services that were not possible to deliver using older, copper-based technology. Incumbents indicate that they cannot offer higher performance services in some business areas and neighborhoods in Shaker Heights (and in many other U.S. cities) because of the high cost of infrastructure upgrades. This is true, because the current telecom business model of each company building, maintaining, and managing its own infrastructure (called overbuilding) is expensive–much more expensive than building a single common digital road system that is shared by many companies.

Connection Fees

Tap fees, pass by fees, and connection fees are already commonly used by local governments for utilities like water and sewer. The revenue share model can be strengthened from additional sources of revenue, including one time pass by fees, connection fees and sweat equity contributions.

- Pass By Fees – Pass by fees could be assessed once the fiber passes by the property, just as some communities assess a pass by fee when municipal water or sewer is placed in the road or street–and the fee is assessed whether or not the premise is connected, on the basis that the value of the property has been increased when municipal water or sewer service passes by. At least one study has indicated that properties with fiber connections have a higher value by $5,000 to $7,000 than similar properties without fiber access.
- One Time Connection Fees – A one time connection fee can be assessed to property owners (e.g. residents and businesses) when the fiber drop from the street to the premise is installed. This is similar to the kinds of connection fees that are typically charged when a property is connected to a municipal water or sewer system. The fee is used to offset the cost of the fiber drop and the Customer Premise Equipment (CPE) needed to provide the operational access to the network. The connection fee can be modest (e.g. $100) or it can be a larger percentage of the actual cost of the connection. Fiber CPE may range from $250 to $350 and a fiber drop may cost from $200 for a premise very close to the distribution fiber passing along the property to $1,000 or more if the premise is hundreds of feet from the road. One variant would be to charge a minimum connection fee for up to some distance from the road (e.g. $100 for up to 75' and $2 for each additional foot).
- Sweat Equity Contributions – The cost of the drop fiber (from the road to the residence) can be substantial if the house is some distance from the road, and a portion of the cost of fiber in some neighborhoods can be attributed to these longer distances.

Danville, Virginia, which began operating its community open access network in late 2007, recently made the decision to use monthly connections fees ($8.80/ month per premise) to help offset the cost of network equipment needed to accelerate their build out to more homes and businesses. This approach also enabled them to lower the fees charged to service providers using the network, which should attract more providers and enable nDanville to offer a wider range of services to customers.

There is already some data that indicates that residential property values increase by as much as $5,000 to $7,000 if fiber broadband services are available, so pass by fees can be justified on the basis of increased property values accruing to the property owner. Given the novelty of this approach, pass by fees may need more time to become an accepted finance approach, but tap fees (for installing the fiber cable from the street or pedestal to the side of the home or business) may be easier

to use, especially for businesses that may need improved broadband access. Tap fees have the potential of reducing the take rate in the early phases of deployment, but as the value of the network becomes established, it is likely that there will be much less resistance to paying a connection fee.

The Utopia project in Utah (an open access, open services community-owned network) reports that in one community, they were successful getting 1,600 residents to pay $3,000 each to get connected to the network. In other words, users financed $4,800,000 of network build. Brigham City, Utah is building a $5.5 million network with a $700,000 investment by charging residents for connections. They are financing the payments–residents pay $25/month for up to 20 years ($6,000). So if residents choose the long term payment plan, they pay a portion of the interest incurred on the funds borrowed by the project. Brigham City apparently has enough interest that they are telling residents if you don't sign up to pay for a connection, you go to the bottom of the list and will be hooked up last.

The Wired Road project in southwest Virginia is also having some success using pass by and tap fees to finance network connections. Some businesses are paying as much as $3,000 to get a fiber connection to their place of business because the pay back is less than ten months–in other words, their Internet costs drop by more than $300/month when using a Wired Road service provider.

Use Fee Model

The use fee is a monthly (recurring) fee charged directly to connected users by the network owner as an alternative to the revenue share, which is an indirect charge (the revenue share is paid to providers by customers, and the provider, in turn, pays the network owner). The primary advantage of the monthly use fee is that it provides the network owner with a predictable stream of revenue that does not depend on the less predictable ability of service providers to attract and retain customers. The connected user pays the use fee as long as any service from any provider is being used. Use fee customers will pay lower rates to providers for the actual service because the provider does not have to mark up the service costs to cover the revenue share portion.

Use fees may have to be adjusted based on what services are available on the network. For example, a use fee of $25 works well for customers buying a triple play package of TV, Internet, and phone from a provider. But a use fee of $25 for a customer buying only a package of Internet artificially inflates the cost of that service.

Split Fee Model

The Split Fee model would offer customers one of two options:

Buy services using the revenue share model, whereby the network owner collects fees from the service provider supplying the service or services to the customer. In this case, residential and business customers make no payments to the network

owner and the network bills only the service provider for the appropriate revenue share amounts.

Customers agree to the connection fee/use fee model. In this case, customers still buy services directly from providers, but would pay a lower rate for those services because the provider pays no revenue share to the network owner. Business and residential customers would pay a one time connection fee (either a one time payment or billed in monthly increments over a period of years) and a monthly use fee as long they are taking one or more services from the providers on the network. The network owner bills these customers directly for the monthly use fee and for the connection fee.

The split fee model gives the network owner the ability to raise capital early and directly from users of the network, in the form of the one time or "easy pay" connection fee. The network also has the benefit of the predictable monthly income from the use fee, which investors will value more highly than the less predictable revenue share fees paid by providers to the network.

Split Fee Model	
Revenue Share Customers	Connection/Use Fee Customers
Services are purchased directly from providers.	Services are purchased directly from providers.
Providers bill their own customers directly.	Providers bill their own customers directly, but at a lower rate because providers do NOT pay a revenue share to the network owner.
The network owner bills providers for the appropriate revenue share for each customer monthly.	The network owner bills customers for the appropriate connection fee and monthly use fee.
Providers pay the network owner the revenue share fee.	Providers pay no per customer fees to the network owner.
Customers of services pay nothing to the network owner.	Customers pay providers for the cost of subscribed services and pay the network owner the appropriate fees.

As an example, if Shaker Heights set the one time connection fee at $3,000, and 10% of potential subscribers in the area committed to that form of payment, that would represent as many as 1,138 subscribers contributing approximately $3,414,000 in equity funding to the project.

The split fee model does require more accounting and bookkeeping, but the potential to raise funds locally offsets the cost of doing so. Of critical importance will be selecting network management software that can track which customers are paying via revenue share and which customers are paying connection/use fees.

Purchase Commitments

While purchase commitments (intent to buy services from providers on the network) are not a direct source of funds, communities that are able to achieve high levels of purchase commitments can use them to strengthen the attractiveness of a revenue bond offering, which could help reduce the interest rate charged for bonds. These purchase commitments can be binding or non-binding. Binding commitments would contractually obligate the property owner to buy some minimum amount of services (e.g. $25, $40) from one or more providers on the network. Non-binding commitments would simply provide an indicator that the property owner intends to buy some amount of services from providers on the network. The former–binding commitments–are much more valuable from a funding perspective, since lenders can more easily predict what kind of revenue is going to be generated from customers.

Purchase commitments can also be used for another, though related, purpose, which is to identify where to build first. For example, in a multi-neighborhood project, the City leadership might indicate that the first neighborhoods to get infrastructure will be those that can obtain a minimum of 35% purchase commitments. By using this market-driven approach, the City would have a good indication that the capital expense it is undertaking in the community will generate enough revenue to cover operating costs and debt payments. If only a 5% or 10% purchase commitment is obtained from residents and businesses in a particular neighborhood, that area would be placed lower on the build out list (but not excluded).

Take or Pay Model

The "take or pay" model has been used by local governments to help finance infrastructure projects like water and sewer. In this approach, property owners agree to buy the service (e.g. water, sewer, fiber services) or pay a monthly or annual fee in lieu of service. The monthly fee in lieu of service is used to help pay for the cost of the infrastructure. Take or pay is based on the principle that the new infrastructure provides both a common good for the community and increases property values. It is not a tax, since it is not

Recommendation

Based on what we have learned about Shaker Heights, we can make the following recommendations about funding.

Few communities have chosen to raise taxes to fund community broadband projects, and this does not appear to be a viable option for the City.

Shaker Heights could use long term municipal bonds to fund the construction of the network. Because Shaker Heights has no track record of building and managing telecom infrastructure, a bond offering would have to be developed carefully, with an extensive financial analysis as part of the bond package.

A municipal lease-buy back approach would move the capital expense to the lessor with the City committing to a long term lease payment obligation (the lease term is typically 20-30 years, and at the

assessed on property owners that use the services delivered by the community infrastructure.

Take or pay could be a vehicle for raising equity for construction as well as a means for supporting the issuance of revenue bonds. If a round of bond funding is to be spent in communities that have approved the take or pay approach, investors will view the bonds favorably because they know that there will be two reliable streams of revenue: revenue from those customers that buy services on the network, and all other households and businesses will be paying an established and predictable fee.

Electric Utility Partner

Electric utilities can be valuable sources of funding for community broadband efforts. If the utility is willing to use the fiber network for Automated Meter Reading (AMR) and energy conservation efforts like Advanced Metering Infrastructure (e.g. remote turn on/turn off of major appliances like air conditioners and water heaters), the broadband project can achieve a 100% take rate in the utility service area. Even though the fee paid by the utility for each electric subscriber may only be a few dollars a month, the 100% take rate, coupled with an expected ten or twenty year term of service, provides a predictable and reliable revenue stream directly, and can indirectly strengthen a bond offering and make it more attractive to investors.

General Funding Strategies

Funding Source	Description	Notes
Revenue Bonds	Long term debt instruments guaranteed with revenue from the network.	Requires some equity/funding from other sources.
General Obligation Bonds	Long term debt guaranteed by local taxes.	Generally more difficult to get approval from elected officials and voters.
Revenue Bond Guarantees	Third party guarantees on revenue bonds, so that if revenue fails to meet financial targets, bond guarantor makes debt payments.	Guarantors could be local or state governments. Does not require a direct cash outlay. Guarantor must have a good credit rating.
eRate Construction Funds	Federal funds available to schools and libraries to construct new fiber network facilities.	The amount of funds allocated is based on the existing eRate percentage that has already been assigned (e.g. 50%, 70% of total cost).
New Markets Tax Credits	Tax credits are sold to investors, and funds are used for the network.	Project must meet eligibility requirements and typically takes a year to plan and to receive approval.

Funding Source	Description	Notes
State Funds	State agencies may be a source of planning and capital funds.	Capital funds are usually relatively small, but direct financial grants from the legislature are possible.
Federal Funds	Grants and loans of various kinds are often available from Federal agencies.	Federal grant programs and funding levels tend to change with changes in administration. Can often take 1-2 years for approval.
Municipal Leasing	A lessor builds the network and leases it to the local government over a 20 to 30 year period.	The local government does not have to borrow money to get the network built, but does have to guarantee the loan payments.
Commercial Loans	Local banks are often willing to assist with funding.	Usually requires pledging network assets as collateral. Must be able to show a revenue stream to pay back the loan. Good for small, high priority network extensions with guaranteed customers.
Business Contributions	Local business are sometimes willing to make donations to the effort.	Donations are typically made with the expectation of fiber services becoming available to the business within a reasonable time frame.
Grants and Donations	Citizens and local foundations will sometimes provide grants.	Local foundations may require tying funds to a specific purpose.
Sales Tax	Assess a small increase in the local sales tax to pay for construction, or use existing sales tax revenues as a bond guarantee.	May require a voter referendum.
Special Assessment Tax	A one time special assessment on all properties in a community. Typically paid in installments over several years.	May require a voter referendum.

Revenue Bonds

Revenue bonds are repaid based on the expectation of receiving revenue from the network, and do not obligate the local government or taxpayers if financial targets are not met. In that respect, they are very different from general obligation bonds. Many kinds of regional projects (water, sewer, solid waste, etc.) are routinely financed with revenue bonds. We believe most community projects will finance a significant portion of the effort with revenue bonds. Obtaining funding using revenue bonds requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network.

Revenue bonds must be used carefully, and a well-designed financial model is required to show investors that sufficient cash flow exists to pay back the loans. Some issues to consider are:

- Revenue bonds are paid back solely from system revenue.
- A very solid business plan is needed.
- Management, marketing, and operations of the network must be professional and with careful attention to meeting operational and financial targets.
- Market conditions at the time the initial bonding is attempted can affect the cost of the bonds and the success in selling those bonds.

General Obligation Bonds

General obligation bonds are routinely used by local governments to finance municipal projects of all kinds. G.O. bonds are guaranteed by the good faith and credit of the local government, and are not tied to revenue generated by the project being funded (i.e. revenue bonds). G.O. bonds obligate the issuing government and the taxpayers directly, and in some cases could lead to increased local taxes to cover the interest and principal payments.

Even though G.O. bonds are quite common for more traditional community infrastructure, local leaders and taxpayers have typically been resistant to using them to finance community telecom projects. G.O. bonds often require a voter referendum, which raises the bar even higher, but some community telecom projects, notably the City of Lafayette, Louisiana, prevailed in a voter referendum to build a city fiber network despite heavy advertising against the referendum by incumbent providers.

Revenue Bond Guarantees

Revenue bond guarantees are not a direct source of funds but can be extremely valuable as part of a revenue bond offering. A bond guarantee could come from local governments that are involved in the network development, a state financing authority that helps underwrite municipal bond offerings, or as a special authorization from the state legislature. Some community network project bond offerings have been guaranteed by tax revenues from the local communities (e.g. the Utopia project in Utah). The guarantee could be for just a first round of financing, and additional guarantees could be contingent upon the network meeting certain financial targets.

eRate Construction Funds

In 2015 the Federal eRate program was amended to allow qualifying institutions (e.g. typically K12 schools and libraries) to request eRate funds for construction of new fiber networks. Shaker Heights K12 schools qualify for a 50% eRate reimbursement. Formerly, eRate funds could only be used to purchase broadband services and could not be used for construction of new networks. Networks constructed with eRate funds can only be used by the qualifying institution, and

other data traffic (e.g. business, residential broadband services) cannot be carried over the network.

However, if the Shaker Heights schools received eRate construction funds, it would be possible for the City to use a "piggyback" contract to install additional infrastructure at the same time the eRate network is being built, and thereby potentially accruing substantial cost savings.

New Markets Tax Credit

New markets tax credits are a form of private sector financing supported by tax credits supplied by the Federal government. The New Markets Tax Credit (NMTC) Program permits taxpayers to receive a credit against Federal income taxes for making qualified equity investments in designated Community Development Entities (CDEs). The CDEs apply to the Federal government for an allotment of tax credits, which can then be used by private investors who supply funds for qualifying community projects. Substantially all of the qualified equity investment must in turn be used by the CDE to provide investments in low-income communities.

The credit provided to the investor totals 39 percent of the cost of the investment and is claimed over a seven-year credit allowance period. In each of the first three years, the investor receives a credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the final four years, the value of the credit is six percent annually. Investors may not redeem their investments in CDEs prior to the conclusion of the seven-year period.

Throughout the life of the NMTC Program, the Fund is authorized to allocate to CDEs the authority to issue to their investors up to the aggregate amount of $19.5 billion in equity as to which NMTCs can be claimed.

However, it can take up to a year or more to apply and then finally receive NMTC-related cash. This can be a useful long term source of funds.

State Funds

Many local broadband projects are receiving help from state sources of funding, particularly for early stage planning, but some funds are often available for pilot projects and specific expansion projects that meet certain kinds of public safety or economic development criteria.

State of Ohio agencies may also be able to assist with applying for Federal funds. Community Development Block Grants (CDBG) are now being provided for some kinds of local broadband efforts. CDBG grants have to meet eligibility requirements (e.g. Low and Moderate Income areas, distressed downtown areas, etc.). Some community broadband projects have also received direct grants from the state legislature.

Federal Funds

Several different Federal agencies provide some support for community or regional broadband efforts. The U.S. Department of Agriculture provides funds to rural communities and rural telephone and cable companies, but Shaker Heights would not qualify for USDA grants. HUD's CDBG grants could be useful, especially if a Moreland area project was part of the City's plans. The FCC occasionally has some funding for very specific kinds of projects (e.g. health care initiatives).Some other Federal agencies also provide funds for telecom, and Shaker Heights may be able to qualify for some of them by collaborating with the right mix of partners. The FCC recently distributed $400 million for community and regional telehealth and telemedicine projects across the U.S.

Earmarks can be a valuable source of funding, albeit a highly unpredictable one. The Eastern Shore of Virginia Broadband Authority was able to obtain several million dollars in earmarks funds to help build its 80 mile fiber backbone, but it took more than two years to get the funds approved and allocated. Earmark funds can be approved but not allocated, which has sometimes caused problems–approval by Congress for the earmark does not automatically ensure that the Federal agency serving as the administrator of the funds receives a budget allocation. In some cases, earmark funds that have been allocated can be re-allocated by the receiving agency for a related purpose. Strong Congressional support is needed for earmarks, and in the current Federal budget environment, earmarks should be regarded as a low priority effort.

Federal funds usually require long lead times to obtain (12 to 18 months is typical) and are best used for specific opportunities where the funding guidelines match well with a specific local need or opportunity.

Municipal Leasing

Communities routinely use municipal leasing to fund a wide variety of needs, including water and sewer projects, buildings, equipment, and vehicles like police cars, fire trucks, and public works equipment. In the past couple of years, several U.S. and international finance firms have begun offering communities a leasing program for community broadband. These programs are typically structured as a twenty-five or thirty year lease-buy vehicle: after twenty-five years of lease payments, the local government owns the network.

The primary benefit of this approach as opposed to using bonds is that the requirement for a referendum (public vote) can be avoided if the local government can negotiate the lease directly. However, these financing vehicles usually require a guarantee from the local government to cover the lease payments if the network does not meet financial targets.

Commercial Loans

Commercial loans from local banks are an option that could provide funds for large portions of the build out and/or small, urgent short term opportunities (e.g. building a short fiber run to reach a business that needs improved connectivity to

add jobs). If a business case can be developed that shows how the improvements or extensions will increase revenue to repay the loan, this form of financing should be easy to obtain.

The City of Bozeman, Montana recently obtained a $3.8 million loan from a consortium of local banks to finance the first phase of a planned city-wide network. The first phase includes connecting all of the schools in the City with Gigabit fiber, most city facilities and buildings, and passing more than 200 businesses in the downtown core area of the City.

For early fundraising, long term notes offered to local investors is an option. In this approach, the network offers long term notes (e.g. fifteen or twenty year terms) with the interest capitalized for several years; repayment starts after the interest capitalization period. This enables the network to raise funds relatively quickly and the interest capitalization period allows the network to develop adequate cash flow before having to make loan payments.

Business Contributions

Some businesses recognize the value of having community fiber at their premises because they may be able to obtain previously unaffordable services and/or lower the cost of existing services. If the savings are substantial, some businesses may be willing to pay to obtain access to the community fiber, and we have spoken to businesses in other communities that have expressed willingness to make no strings attached contributions to the local effort. However, such contributions are usually linked to specific plans to pass the businesses with fiber within a reasonable time frame.

Grants and Donations

Grants and donations can provide funds for planning and for targeted construction projects (e.g. fiber to a local hospital, a community institution, etc.). Community foundations will often contribute funds to local technology projects. Sometimes the expenditures have to be tied to specific foundation goals (e.g. improved K12 education), but often local foundations will accept grant applications for a wide variety of local projects. Some community efforts have also received private donations, although these are usually modest, and have also usually been provided to support a specific need or project.

Sales Tax

The Arrowhead Electric Coop in rural Minnesota is paying for a full fiber build out to all homes and businesses by working with the local county government (Cook County) to collect a special 1% sales tax. The tax is actually used for a variety of infrastructure improvements, with the broadband build out using about 48% of the funds collected. The broadband portion of the sales tax is used to underwrite the cost of the CPE (Customer Premise Equipment), which is the box installed at the residence or business. This approach lowers the overall capital cost and reduces the financial risk for the electric coop. The Utopia project in Utah has been financed in large part by using loan guarantees backed by existing local sales tax revenue. This

approach does not require changes in how existing sales tax revenue is used unless the fiber project runs into financial difficulties; in that case, the localities collecting sales taxes would be obligated to use some of the sales tax collected to make loan payments.

Special Assessment Tax

The town of Leverett, Massachusetts recently funded the entire cost of a 100% fiber build out to all homes and businesses by passing a one time special assessment tax on every property in the community. This measure was passed with a citizen vote in Leverett's annual town hall meeting. Leverett is an underserved community with very limited current broadband offerings, so there was strong support for the measure. It is not likely to be an attractive or feasible option in some other communities, but it does show that under the right conditions, a community can self-fund the entire cost of a fiber build out.

Overview of the Financial Models

Four different pro formas were developed for each of the active build out scenarios, and have been provided as separate documents. The pro forma models have been developed using conservative estimates of construction costs, operating expenses, and revenue. There are five major sections in each of the pro formas.

- Pro Forma At a Glance - Provides a one page summary of key data modeled in the pro forma.
- Financials - Contains the financial assumptions used in the model. An Income Statement, Cash Flow Statement, and Balance Sheet are included, along with debt assumptions.
- Market Information - Contains the market size and take rate assumptions for the modeled markets (e.g. residential, business).
- Opex (Operating Expenditures) - The estimated cost of operating the network.
- Capex Summary (Capital Expenditures) - The estimated capital cost of building the network.

Pro Forma At a Glance Overview

The At a Glance section of the pro forma provides a one page summary of key data from other areas of the document.

- The Fiber Network section shows the number of connected customers by market segment and the annual take rate for each market segment.
- The Revenue section shows the annual dollar value of revenue from each market segment.
- The Operational Cost Per Subscriber is an important value. It is ordinary that this figure starts high and then declines over time. In the first years as the network may still be acquiring subscribers, certain fixed and variable costs accrue somewhat independently of subscriber count. As the total number of subscribers increases, operational costs typically flatten out and the cost per subscriber diminishes to an appropriate value (target is typically less than $20/month).
- Expenses represent the operational costs of maintaining the network. SG&A (Staff, General, and Administration) costs tend to be somewhat independent of the size of the network (although some costs do increase as the network grows). Opex (Operational Expenses) tend to increase somewhat more proportionately to network growth. Debt Service includes both interest and principal payments on any debt.

- EBITDA Margin (EBTIDA divided by Total Expenses) provides a useful indication of the ratio between earnings and expenses.
- The Operating Subsidy represents additional contributions needed to keep the project in the black.
- Cash At Year End is one of the most important values. A network may lose money for a year or two, but as long as the Year End Cash retains an adequate positive balance, the network can continue to grow and expand. Cash Reserves represents funds set aside to support long term maintenance and equipment replacement. Fiber network equipment typically has a seven to ten year life span, and so funds must be held in reserve to fund equipment replacement.

Financials

The Financials section provides a high level overview of the entire set of financial projections, including a one page summary (the Income Statement) that shows key projections for revenue, expenses, interest payments, and capital expenses over a ten year period.

The Cash Flow Statement and Balance Sheet are designed to provide financial information in a standard accounting format similar to any other business financial statement.

The Financial Assumptions table is an important area of the pro forma because key assumptions are made here that have large effects on the overall projections. These assumptions include:

- The amount of debt vs. equity that the project takes on, year by year.
- Interest paid on cash on hand
- Calculations on up to five loans or bonds, including interest, principal, and loan balances, and the option to make interest only payments for a period of years.

The Financial section has the ability to calculate the carrying costs of up to five separate loans, including fees and closing costs, interest payments, principal payments, and deferred interest (e.g. no interest for the first two years). Loans with interest only payments for the first year or two are commonly known as construction loans.

Market Information

This section forecasts revenue, market size, take rates, services, and service prices for three separate market segments: residential, business, and government. Each market segment tends to have different service and pricing requirements, and breaking services and projections out by market provides a more accurate and more detailed projection of revenue.

Each market segment is organized similarly, with four key sections.

- Market Assumptions includes the projected size of the market, year by year growth in the size of the market, and the take rate assumptions for that market. The term "available market" refers to the actual number of connected customers that could purchase a service. "Homes Passed" refers to homes that have been passed by fiber and could buy service. The "Take Rate" is the percentage of Homes Passed that actually get connected and do buy services from the network. The term "addressable market" refers to the locations that actually purchase a service as a percentage of the entire market.
- Monthly Cost of Service is the fee paid by connected homes in the Residential market.
- In the Business and Govt/Institutional markets, Services (Monthly) are the services offered to those users and the projected prices for those services. Note that these are projections, and that once the network is built, service providers will set their own prices. These pro forma prices are a projection based on markets and prices from other networks and from data collected locally.
- The Annual Revenue provides projections of revenue by service, by year.

OPEX

The Operational Expenses section has two parts. Salary, General, and Administrative (SG&A) projects expenses that are relatively independent of the size of the network, although this is only a rough rule of thumb. Costs like staff and marketing do tend to grow over time as the network expands. The Operational Expense table projects expenses that are more tightly linked to the growth of the network.

Some of the SG&A costs tracked include:

- Staff costs, including salary, benefits, and staff-related expenses like travel, phone/Internet access, and miscellaneous overhead. Staff costs are a blended estimate that could include some City staff and outsourced costs.
- General office expenses, including office supplies, computer supplies (e.g. ink, paper, toner), and shipping and postage.
- Marketing expenses, which are typically calculated based on the growth in customers. In the lease-buy model, all marketing expenses would be covered by the leasing firm. If this is a City project, then these costs are included as part of the project expenses.
- Other expenses, including legal counsel, consultants, insurance, and miscellaneous costs.

Operating expenses include:

- Support Fees, which are related to the cost of extended warranties for equipment and allocations for space parts, as well as software license fees.
- Network Operations Costs, which include any OSS/BSS (Operations Support Software/Billing Support Software) software per subscriber fees, the cost of contracted network operations, and other infrastructure-related expenses.
- Outside Plant Maintenance, which budgets maintenance costs for fiber and wireless assets (e.g. fiber cable, handholes, cabinets, wireless towers, etc.).

Note that at the bottom of the Operating Expenses table, there is a row that calculates the operational costs on a per subscriber basis. In the early years of a project, it is likely that this projected amount is higher than the ARPU (Average Revenue Per User) amount. But if the two projected figures do not converge in later years, then more customers need to be added to the network, the pricing needs to be adjusted, and/or costs need to be reduced.

Capital Expenditures

This section models the cost of construction of an active network.

Capital Expenditure Summary

The Capital Expenditure Summary (Capex) table provides a summary of the costs associated with the construction of the network. A summary of the depreciation and amortization costs are also included. Most fiber and outside plant assets can be depreciated over thirty years. Most equipment is depreciated on a much shorter time schedule of five to seven years, and a few items like software are typically amortized over a three to five year time frame.

Startup Costs

The assumptions on this page provide costs for outside plant (e.g. fiber cable, duct, handholes, shelters and cabinets, data center, etc.), equipment costs (e.g. fiber switches, routers, power supplies, CPE, etc.), and the other professional services needed to get the network built (engineering, project management, legal, specialty consulting, software, etc).

Growth Costs and Growth Rate

The growth costs accrue after initial construction is complete, and it is driven by a complex set of formulas that calculate year by year take rate and new construction cost estimates. Those projections calculate the costs associated with overall growth of the network.

Depreciation and Amortization Schedule

The depreciation schedules allow for separate depreciation of active and passive assets, including adjusting the term of each schedule in years. Passive assets are typically depreciated for at least twenty years, and active assets like network electronics are depreciated for a much shorter time (e.g. five years). An amortization schedule allows for a write down of "soft" assets like software licenses.

Governance and Ownership Options

There are several different ownership and governance options available for consideration. Note that these options are not necessarily mutually exclusive, and the strategy chosen by the the City, K12 schools, and other interested parties could include elements of more than one option.

For example, the City of Shaker Heights might choose to install duct and lease it to the private sector as a very low level of City government involvement. The City might also seek a private sector company willing to provide a lease-buy back arrangement. As yet another alternative, the City could bond for the cost of a fully provisioned active network infrastructure and lease capacity to private sector service providers.

About Public/Private Partnerships

Public/private partnerships can take a wide variety of forms and public/private partnerships exist on a continuum. In fact, any telecom enterprise is, at some level, a public/private partnership.

- At one end of the continuum, existing private sector telecom companies are a public/private partnership (albeit a minimal one) because they use public right of way to place telecom cables, vaults, cabinets, and related infrastructure.
- At the other end of the continuum, municipal retail telecom enterprises (e.g. Lafayette, Louisiana; Chattanooga, Tennessee; others) are a example of a mostly public enterprise, but these public enterprises are buying services like Internet and TV packages from the private sector at wholesale rates and reselling them at retail rates. They are still a form of public/private partnership.
- In the middle of the spectrum, one would find other examples of public/private partnerships, including open access networks, in which the local government typically owns the network assets and leases capacity to private sector service providers. And

Recommendation

Shaker Heights should consider two ownership options.

Direct Municipal Ownership -- The City would finance and own the assets directly, and would use the open access business model to avoid direct competition with existing private sector service providers. Service providers would be invited to use the network to sell their own services directly to their customers, and revenue from providers and customers would pay for the cost of operations and debt.

Lease-Buy Back -- In this option, the City would enter into an agreement with a private sector firm that would design, build, and operate the network under a long term lease agreement that eventually would expire and network assets would become the property of the City.

Both options would likely require some form of debt financing, but the structure of the long term repayment of the debt differs between the two.

the municipal lease-buy arrangement is another form of public/private partnership, in which the initial investment in infrastructure is covered by a private sector company and the local government pays leases fees for use of the network.

- In yet another example, a regional authority might outsource network operations and network maintenance to private sector firms, qualifying those arrangements as a "public/private partnership."

For Shaker Heights, there are at least two public/private partnership options.

In one option, the City would finance and own the fiber assets, but management and operation of those assets is turned over entirely to a private business, which would lease capacity, collect revenue, pay all expenses, and share a portion of revenue with the government entities. The private sector partner could be selected via an open bidding process to identify both the most qualified firm to run the network and the best revenue sharing offer.

Advantages of this approach would include:

- The City would not have to create a new department to manage the enterprise and staff changes would be minimal.
- Outsourcing most operational and maintenance responsibilities to qualified private sector firms would be more efficient and less costly.

Disadvantages of this approach include:

- The firm managing the assets would have to be selected very carefully, and there would have to be contractual oversight and control to ensure that revenue is spent on appropriate expenses.
- Continued expansion of the network to additional residents and businesses would have to be ensured contractually, and the City would have to have contractual enforcement options to be able to manage expansion in a consistent and fair fashion.

A second option would be the lease-buy arrangement. The primary difference between this and the first option is the financing. A private sector firm or firms will design, build, and operate the network, and would retain ownership until the lease period expires. At that time, ownership of the network would be transferred to the City.

Advantages of this approach would include:

- The entire process of designing, building and operating the network is handled by the leasing firm.
- All marketing and sales is also handled by the leasing firm.

Disadvantages of this approach include:

- The two firms that have made offers to the City both expect lease payments to be made even if revenue falls below break-even projections. If the leasing firm fails to obtain enough customers to cover operating costs, the City has to subsidize the cost of the network while having little or no control over marketing, sales, and pricing.
- The proposed twenty-five or thirty year lease-buy back term leaves the City with a network at the end of the term that requires extensive maintenance and upgrades.

Definitions of Entity Types

During the course of this analysis, the ownership/governance entity types listed below were examined for their suitability as a governance entity for the City of Shaker Heights.

Government Ownership

Many communities in the United States have municipal entities that offer services to the general public. The most common services are water and sewer, and are administered operationally either as a department of the government or as an authority. Typical water and sewer authorities are quasi-public entities that operate independently of direct local government oversight but operate as a nonprofit.

Also common are municipal electric service operations. Several hundred communities in the U.S. have municipal electric power, and some have moved into the telecommunications arena, largely because it is convenient to do so--the organization already has utility pole access, experienced staff, and equipment like bucket trucks.

Government operated networks using the muni retail model attract legislation forbidding localities from offering telecommunications services. Several states, including Pennsylvania, Nebraska, South Carolina, North Carolina and Virginia, have enacted legislation making municipal telecom services illegal within the state shortly after a municipality or public service company started a data service. For example, the Virginia bill was overturned by the Federal Circuit court in a remarkably brief decision that seems crystal clear:

> *I find that the broad and unambiguous language of § 253(a) [the Federal Telecom Deregulation Act] makes it clear that Congress did intend for cities to be "entities" within the meaning of the Telecommunications Act. Therefore, § 15.2-1500(B) [the Virginia legislation in question] is in direct conflict with federal law, and is void under the Supremacy Clause. Section 253(a) is a concise mandate that no state "may prohibit or have the effect of prohibiting the ability of any entity to provide any interstate or intrastate telecommunications service." 47 U.S.C.A. § 253(a) .....Simply put, it strains logic to interpret the term "any entity" in § 253(a) to mean "any entity except for municipalities and other political subdivisions of states." While it is true that such an interpretation is possible, the Supreme Court has cautioned that "[a] statute can be unambiguous without addressing every interpretive theory offered by a party." .....The federal statute, therefore, not only mandates that no state statute "may prohibit" telecommunications competition, but also that*

no state statute "may have the effect of prohibiting" telecommunications competition. 47 U.S.C.A. § 253(a).

While most communities that have been challenged by lawsuits have eventually won in court, the legal battles usually add years and significant expense to such efforts. Lafayette, Louisiana, as one example, spent substantial sums of money and nearly two years in court to defend the right to build a community-owned network. The city eventually prevailed and now has an outstanding network offering some of the lowest telecom service prices in the U.S., but the effort was delayed for years by the lawsuit from the incumbents.

In 2015, the FCC declared that these state level statutory restrictions on communities were superseded by the FCC's regulatory authority. However, it is not at all clear that this has resolved the state level prohibition problem, and it is likely that this ruling will be challenged in Federal court in the near future.

Private Coop

Cooperative business enterprises as formal entities date from the mid-1800s. The first cooperative was set up in England to serve customers unhappy with local merchants. In the United States, the Grange movement began setting up cooperatives in rural areas to sell needed items to members and to help sell produce and other agricultural products that were produced by members. Today, credit unions are the most common form of coop business in the United States, with more than 65 million people obtaining services from over 12,000 credit unions.

Telephone and electric coops continue to be very common in rural parts of the U.S., and in fact, the majority of telephone companies in the United States are coops, but most have very small numbers of customers--often less than a thousand subscribers. Telephone coops serve more than a million subscribes in thirty-one states. The True Value and Ace Hardware chains are actually buying coops that help keep independent hardware stores competitive with the large chain stores.

The U.S. Department of Agriculture (USDA) provides extensive support for existing coops, and also helps communities start coops. One of their publications lists the principles of the coop:

- User-Benefits Principle -- Some purposes of a coop are to help members get services that might otherwise not be available, to get access to markets, or for other "mutually beneficial" reasons.
- User-Owner Principle -- The users of the cooperative own it.
- User-Control Principle -- The owners of the coop (i.e. members) control the coop through voting (annual meetings, etc), and indirectly by electing a board of directors to manage the enterprise. Large users who make high volume purchases of goods or services may receive additional votes.

Because cooperatives are user-managed, control of the enterprise is vested in the community or region where the users reside. Cooperatives also return excess earnings to its members; these refunds are called patronage refunds, and are typically computed at the end of the fiscal year. The expenses and income of the coop are calculated for the year, and any excess is returned to members, based on the percentage paid in by each member (e.g. a member that paid in 1% of total earnings would get a refund of 1% of any excess earnings).

Most cooperatives do not pay dividends on capital. This helps keep outsiders from taking control of the company, which would result in the community losing control over the quality of services and direction of the enterprise.

Coops are organized in part based on the territory they serve, and there are several classifications that may be relevant for community broadband efforts. A local coop serves a relatively small area that may be a single town or county and/or a radius of ten to thirty miles. A super local coop serves two or more counties. A regional coop may have a service area of several counties up to an entire state (or multiple states). For projects that involve several local government entities that are already trading services like local public safety dispatch, a super local coop may be the most appropriate designation.

Most local and super local coops use the centralized governance structure, which means that individuals and businesses represent the bulk of members.

Cooperatives offer one or more of three kinds of services:

- Marketing coops help sell products or services produced by members.
- Purchasing coops buy products and services on behalf of members.
- Service cooperatives provide services to members, and service coops include the credit unions, the electric coops, and the telephone coops.

Equity is typically raised for coops by direct investment from members. In return for an investment, members receive a membership certificate. The member may also receive shares of stock if the cooperative issues stock (some do, and some do not). Once a member has invested, they gain the right to vote in elections. As an example, if the local governments made a large initial investment in the cooperative, they could gain substantial influence in the affairs of the organization by gaining multiple shares and increased voting rights. Property owners (residential property owners and business property owners) who paid an initial connection or pass-by fee would also gain shares in the business, so every property owner that pays the connection fee gains ownership in the enterprise--an important selling point when encouraging property owners to, quite literally, invest in the project.

Although cooperatives are typically constrained by both Federal and state laws to do a majority of business with members, in most cases, cooperatives are able to do business with nonmembers up to some percentage of business income that can be as high as 49 percent. Note that this may be affected by the underlying legal incorporation of the cooperative--if

incorporated as a 501(c)(12), the IRS requires that 85% of income must come from members for the purpose of meeting ordinary expenses.

In summary:

- Coops are member (subscriber) owned, meaning they are strongly vested in the community. Any effort by the coop board to dispose of assets or to sell the coop would have to be approved by a majority vote of the members.
- Members play an active long term role in governance by nominating and electing board members. So members have a straightforward way of influencing decision-making by the board.
- Coops generally operate on a cost-plus basis. Income that exceeds some preset level is returned to members periodically as a distribution of funds.
- Broadband coop bylaws must be carefully written, especially if there is an interest in several classes of membership. Each class of membership can be charged a different membership fee, and this can be a valuable source of start up funds, but membership categories are difficult to change later.
- Coops are largely immune to challenges by incumbent telecom providers due to the long history of existing coops and because of special legislation passed by Congress.
- Coops can tap USDA funds, but the application process would be time-consuming and expensive for a start up coop.

Non-profit

There are various kinds of nonprofit businesses. The most common is the 501(c)(3), which is limited to strictly charitable efforts. A 501(c)(3), according to IRS rules, must have a well-defined charitable purpose targeted toward a specific need and/or a specific target population. In other words, a 501(c)(3) cannot, according to IRS rules, operate as a nonprofit business that provides services to the general public.

Many of the first community networking projects in the early and mid-nineties were formed as 501(c)(3) organizations; it was common for these entities to offer dial-up Internet access to the general public at a time when Internet service providers were still relatively uncommon. But by 2000, most of these organizations had closed their doors and/or discontinued their Internet access services because of IRS challenges. In recent years, there has been a return to the nonprofit model, and with FCC and Federal encouragement of community-owned networks, tax issues no longer seem to be problem.

Today (2015), we see new 501(c)(3) organizations repeating this approach by offering broadband services either directly or indirectly (using an open access business model).

There are other circumstances in which one or more nonprofit businesses may be useful as part of the overall effort. A 501c3 may be desirable as a mechanism to accept charitable

donations, and more importantly, to apply for certain kinds of grants. Once the funds have been received by the 501c3, and the donors have received the tax credit, the nonprofit can, in turn, give or loan those funds to another organization (e.g. an authority or coop chartered specifically to provide services).

For profit business

There are various types of for profit business organizations: individually owned businesses, partnerships, general business corporations, and limited liability companies. A for profit business avoids many of the legal and regulatory problems related to broadband assets that are owned directly or indirectly by local governments, but some of the other issues of a private enterprise would include:

- A private sector company will not have the same direct access to public funds are involved in the development of the system (e.g. revenue bonding, tax funds).
- A for-profit enterprise may not be as firmly vested in the community, even if the owners are largely local investors.

The lease-buy financing approach would fall under this category, as the ownership and much if not all of the management responsibility would belong to the private sector firm offering the lease financing to the local government.

Ad Hoc and Informal Partnerships

Some local governments have deployed duct and/or dark fiber and have made ad hoc arrangements to provide capacity to other institutions like K12 school systems or adjacent local governments. In some cases, they have a policy for leasing duct or fiber to the private sector (the city of Sacramento, California has leased duct for over a decade) but have not developed a comprehensive plan for management and expansion.

EDC Ownership

EDCs (Economic Development Corporations) and similar organizations like IDAs (Industrial Development Authorities) often have access to state and Federal funds that can be used to get a broadband project started, and many of these organizations have the management expertise to build and operate a business enterprise over the long term.

As an example of this approach, the community-owned New Hampshire FastRoads network has been formed as an LLC, but it is a wholly owned subsidiary of the Monadnock Economic Development Corporation (MEDC). MEDC is a non-profit, so that eliminates any tax liability, and the MEDC board already has appropriate regional/community representation, which protects the interests of the forty-three towns that comprise the FastRoads region.

Other communities across the United States are already actively pursuing new and innovative public/private partnerships to improve the access and affordability of telecom services delivered via broadband. In September (2008) the Fiber To The Home Council provided some statistics on the growth of residential fiber in the United States. Over 1.6 million homes were connected with fiber in the past twelve months, but only about 15% of American homes have fiber connections at this time. The deployment of fiber is highly dependent upon location, so some densely populated urban areas, primarily on the East Coast, are getting fiber much more rapidly than other areas of the country.

Communities that have affordable broadband are enjoying a faster rate of economic growth than communities that lack broadband, based on a CMU/MIT study (Measuring the Economic Impact of Broadband Deployment, Sirbu and Gillett, 2006).

A Brookings Institution study (Crandall, Lehr, and Litan) in 2009 found that for every 1% increase in the availability of broadband in a community, the level of employment increases correspondingly by .3% annually. The study also found that as the level of Internet users increased in a community, there was a corresponding increase in economic growth, with a 10% increase in Internet use yielding a 1.3% increase in the economy.

A new digital divide is emerging, with fiber as a differentiator. Communities with affordable broadband infrastructure and the ability (i.e. fiber) to expand capacity as demand grows over the next seven to ten years should enjoy a measurable economic development advantage over communities that lack such infrastructure.

Fairlawn, Ohio

FairlawnGig is a municipal broadband utility for the City of Fairlawn, Ohio.

On February 12, 2015, The City of Fairlawn issued a Request for Proposals to solicit ideas on developing a public private partnership to design, build, operate, and maintain FairlawnGig. On September 21, 2015, the Fairlawn City Council approved the next step in the development of FairlawnGig, which is the pre-construction planning phase. The City of Fairlawn has assembled a team of private industry experts to create a detailed design for the network and develop a business plan for the operation of the FairlawnGig municipal broadband utility. Fujitsu Network Communications has been awarded an Engineering Design Contract for this phase and will lead the team which includes Roetzel Andress, the Environmental Design Group, Extra Mile Fiber, and PB Ventures Limited.

FairlawnGig is designed to be a universal high-speed broadband access for the entire City of Fairlawn. The City will create a municipal broadband utility that owns and operates a comprehensive fiber and carrier grade Wi-Fi network for all residents and businesses in Fairlawn. Fairlawn is investing in the last mile infrastructure that will enable FairlawnGig to deliver the fastest, most reliable internet access services possible at competitive prices.

The City will also utilize the network to enhance its municipal services and public safety operations.

The City of Fairlawn will build a fiber to the premises network to residents and businesses in Fairlawn and the Akron-Fairlawn-Bath Township Joint Economic Development District (JEDD). Fairlawn will also build a carrier grade Wi-Fi access network that provides high-speed coverage throughout Fairlawn and the JEDD. These networks will be operated as a unified system providing a variety of services throughout Fairlawn. The City of Fairlawn intends to establish a Public Private Partnership that will create the FairlawnGig network.

The long-term objectives of FairlawnGig are as follows:

- Make world-class, broadband internet services available to all residents and businesses in the City of Fairlawn and the Akron-Fairlawn-Bath Township Joint Economic Development District (JEDD) at reasonable prices.
- Promote commercial and residential growth, and stimulate economic development in the City of Fairlawn and the JEDD.
- Enhance the Fairlawn experience for the 30,000 daily visitors.
- Encourage entrepreneurial, high-tech ventures to locate in Fairlawn.
- Encourage competition by making the FairlawnGig network open and available for use by other internet service providers.
- Improve city services and public safety communications, awareness and responsiveness.

Hudson, Ohio

Hudson Ohio plans to wire the entire city with fiber optic cable, enabling speeds as fast as a gigabit per second. City officials have announced a multi-year project to install the service through the creation of Velocity Broadband, a city-owned Internet provider.

Velocity Broadband will compete with other Internet providers inside Hudson and will provide fiber optic connections to public and private buildings. The first test-case fiber optic connections occurred in September for three businesses in the Executive Parkway business park.

The citywide project will be built in phases, starting with the downtown area in 2016, and could take as long as five years to complete. Hudson hopes to become the first city in Ohio to offer true gigabit Internet service. The city plans to own and operate the system and claims that it's moving ahead because local businesses are demanding it.

Like other municipalities in northeast Ohio, Hudson said the project is an economic development tool. The city sees high-speed Internet as a means to attract and retain

businesses. A recent city survey showed that 58 percent of Hudson businesses said current Internet services do not meet their needs.

Velocity Broadband grew out of a 94-page "Broadband Needs Assessment & Business Plan" the city commissioned in 2014 and presented to officials in February. Velocity Broadband will also be made available to the city's 22,000-plus residents. Residential service is hoped to be available simultaneously with the business service. Hudson will initially offer data and voice services.

The city's initial investment in Velocity Broadband is $800,000 and the city is searching for additional funds to expand the roll out. Income generated from subscriptions to the service will repay the investments. Excess revenue would be used on other Hudson infrastructure, such as road maintenance and improvements.

The city is not increasing taxes to pay for Velocity Broadband. Prices for Velocity Broadband will be comparable to or less expensive than other Internet service charges.

Testing of Velocity Broadband is being conducted in companies located near the city's municipal offices off Executive Parkway. A 50-megabit-per-second package from Velocity Broadband, not the full Gigabit, is employed for testing.

Lakewood, Ohio

A new agreement with Everstream, a local broadband provider, will establish an advanced fiber-optic network in Lakewood designed to dramatically increase networking speeds. It is expected that the service improve the city's economic development opportunities by attracting new businesses, enhance existing businesses that work online and provide free WiFi access at five of the city's largest public parks.

A portion of the network will be used for public institutions, including the schools, public library and 16 city of Lakewood facilities, and the other portion will run along Madison and Detroit avenues with services for local businesses.

At rates as high as 10 Gigabits per second, connectivity speeds are expected to be more than 1,000 times faster than traditional Internet speeds. The city is adopting this innovative technology in an effort to look ahead and remain competitive in the future.

The fiber-optic network project is the result of a public/private partnership between the city of Lakewood and Everstream. Under a 20-year agreement, Everstream will install 144 strands of fiber optic cabling throughout the city, mostly along the main business corridors. 48 of those strands of fiber will be used to connect the sixteen City of Lakewood government facilities with special accommodations made to allow the Lakewood city schools and Lakewood Public Library to optionally join to connect their facilities at a time convenient for those institutions.

The remaining 96 strands will be used by Everstream to offer high-speed Internet at up to 10 gigabits per second (Gbps) and "dark fiber" services to current and prospective business

customers in Lakewood. The typical cost barriers to bringing extremely high-speed networking and Internet access to businesses will be reduced because of the close proximity of the fiber network path with respect to those businesses, according to the agreement.

Under the agreement, the city of Lakewood will fund the build-out of the network. In return, Everstream will be responsible for the maintenance of the network. Furthermore, Everstream has agreed to provide the City of Lakewood government, 1 Gig Internet service at no additional charge for the length of the agreement.

Dublin, Ohio

The city of Dublin, Ohio began investing in fiber infrastructure in 1999. The city was concerned that private fiber providers were going to be digging up streets and sidewalks constantly as each firm installed its own conduit and fiber. Instead, the city government opted to install 25 miles of conduit and fiber to connect City buildings. The initial investment enabled the City to eliminate many of its leased telecommunications lines that resulted in an annual savings of more than $400,00 per year (over the past twelve years, that has represented $4.8 million in saved expense to the City).

Through 2014, the City has invested a total of $5.5 million on the municipal network and estimates a total benefit of $35 million, which includes both direct savings in City telecom costs but also indirect benefits of increased employment and higher tax revenues. The City leases dark fiber to private sector companies and service providers, and the network also supports healthcare facilities and local schools. Ohio Health made the decision to expand in Dublin because of the excellent fiber facilities and went from 300 employees to 1200 employees. The City has stated that the network has also attracted a $52 million data center investment.

In 2015, the City announced that it was adding 100 Gigabit capacity to the network and would enable further expansion of the network to more office buildings.

Other Ohio Communities

Other Ohio communities that have made fiber investments include:

- City of Hudson
- City of Hamilton
- City of Columbus
- City of Springfield
- Medina County
- City of Lakewood
- City of Fairlawn

Lincoln, Nebraska

Lincoln is one of Nebraska's larger cities, with a population of about 270,000. In 2012, the city government began making investments in telecommunications conduit. The intitial investment was three quarters of a million dollars, but has since been expanded to include more than 300 miles of conduit. The city uses it for municipal purposes but also leases out conduit space the private sector. At the end of 2015, six providers were using the city conduit for fiber distribution, including large national providers like Level 3.

Google Fiber Initiatives

In 2013, fiber deployments began to accelerate in the wake of Google Fiber's announcement that they were expanding their fiber deployments to Austin, Texas and Provo, Utah. Google's first project was in Kansas City, Missouri.

In Austin, AT&T, the incumbent provider there, immediately announced they would begin deploying fiber in that city, despite the fact that the company had been previously stubborn about insisting that "nobody needs fiber." AT&T might have to update that mantra to "Nobody needs fiber in our markets until someone tries to compete with us, and then we will suddenly discover fiber is very important."

Google is currently evaluating proposals from more than thirty other large metro areas, and is expected to start additional fiber deployments in a handful of them.

A Google-connected home or business gets low cost Internet, but the service agreement gives Google wide latitude to examine all of the traffic moving over the customer connection (e.g. Web pages, email addresses, documents, spreadsheets, etc) so that the firm can mine that data to target specialized advertising as well as sell the data to third parties.

Attribute	Description
Governance	In Google Fiber cities, Google is the retail provider. While Google touts its projects as public-private initiatives, Google networks are entirely in the private sector.
Funding	Google uses its own funds to build and operate the networks.
Business Model	The primary service is Internet access. Google does have a streaming TV offering (Chromecast) but it is not, strictly speaking, comparable to a traditional cable/satellite TV service. Customers get whatever Google gives them, and the company encourages the use of Google-branded services like Google Docs, Google+, and gmail.
Management	The network is managed entirely by Google staff.
Technology	Google networks include both GPON and active Ethernet technologies.

Chattanooga, Tennessee

The City of Chattanooga is an electric city with its own electric utility. As the electric utility began to examine the feasibility of using smart meters to better manage the electric grid and to reduce energy costs to its customers, it realized that just implementing smart meters to all its customers was a significant portion of the cost of building a general purpose all fiber network that would also support smart meters and the utility's grid management needs.

The utility was able to secure a $110 million grant from the U.S. Department of Energy, bonded an additional $220 million, and by 2013, more than 56,000 homes and businesses had been connected with Gigabit fiber, and more than 170,000 meters had been connected. A residential Gigabit fiber connection costs $70/month. The electric utility estimates that it is saving as much as half of its overtime costs per year because of improved energy management.

The utility owns and operates the fiber network, and customers are billed for services directly by the electric utility. The primary service offering is Internet access, but customers can also purchase TV and voice services. A triple play package of Internet, voice, and TV sells for $125/month. Most customers purchase a 100 meg Internet service. The network is operated as a retail triple play business model, and would not be considered open access, as all services are provided by the electric utility.

Attribute	Description
Governance	The network is owned by the City electric utility.
Funding	A U.S. Department of Energy grant provided $110 million, and the City issued bonds for an additional $220 million dollars to connect more than 170,000 customers with smart meters and to provide fiber connectivity.
Business Model	The network is operated as a retail triple-play business, with customers buying all services directly from the electric utility.
Management	All management, maintenance and repairs are handled in-house by the electric utility.
Technology	Most customers get a GPON (passive) Gigabit fiber connection. The utility can provide active Ethernet connections to businesses who need it.

City of Eagan, MN

The City of Eagan began planning for a city-owned fiber network in 2008 at the urging of key business leaders who represented both large and small businesses, including some Fortune 500 companies. One of the first efforts by the City included asking the private sector, including the incumbents, to help solve the bandwidth affordability problem. Both the primary cable and telephone company in Eagan declined to offer any substantive improvements. Several other private sector firms also submitted proposals, but none were deemed adequate to meet the needs of a diverse business community employing tens of thousands of employees.

During the planning process, the City also began to examine strategies to attract one or more commercial data centers to the community, and it was determined that the availability of City-owned competitive fiber would assist in that effort.

In 2011, the City allocated funds to construct AccessEagan, which would be 17 miles of high performance, business class Gigabit fiber that passed a large percentage of the business and commercial areas of the city. The network was constructed to meet the most demanding technical requirements of Eagan's larger businesses, with a Gigabit connection as standard for any connected business, and the active Ethernet network has ample capacity to provide 10Gig, 40Gig, 100Gig, and wavelengths as needed to meet business requirements.

Operating as an open access, lit circuit network, four private sector providers have signed master agreements to sell services, and the City began taking orders from those providers for the first connected businesses in 2013. The City also announced in 2013 that a data center was coming to the City, and was to be located in an existing building that was passed by the City-owned fiber.

Attribute	Description
Governance	AccessEagan is owned by the City and is operated as an enterprise fund.
Funding	Funds from cellular providers who rent space on City structures was used to construct the initial build out.
Business Model	Operating as an open access network, with all business services provided by private sector companies.
Management	The City IT department manages the network. New construction (e.g. drops to businesses) is contracted out.
Technology	AccessEagan is an active Ethernet network.

Palm Coast, Florida

In 2008, the City of Palm Coast began exploring the potential of making existing City-owned fiber assets available for business and commercial use. Existing Palm Coast businesses were expressing concern to City leaders about the high cost of Internet access and the limited bandwidth available in the City. After a six month study of various business and financial options, the City decided to focus on developing the network as a "carrier class" commercial network capable of supporting virtually any level of business service that might be needed.

As of early 2012, all four redundant fiber loops had been completed. The City invested in a dedicated colocation facility with both shared rack space and private cages for service providers, and purchased "carrier class" network switches and routers to light up the fiber. Palm Coast FiberNET was made available for service in May, 2010 (http://www.ci.palm-coast.fl.us/PalmCoastFiberNET/), and had three service providers committed on day one.

Palm Coast FiberNET provides service to City buildings and locations, and successfully won a bid to provide services to Flagler County Public Schools. The local hospital also uses the network to connect hospital medical records and data services with several local health clinics and medical offices. FiberNET was operating in the black in year one, and continues to do so as it enters its fifth year of operation.

Attribute	Description
Governance	Palm Coast FiberNET is owned by the City of Palm Coast.
Funding	City enterprise funds were used to pay for the initial $2.5 million in fiber construction, equipment, and the colocation facility.
Business Model	FiberNET is operated as an open access network. Providers pay a monthly fee per customer, based on connection size.
Management	The City IT Department manages network operations, and private sector contractors are used for outside plant maintenance and construction work.
Technology	FiberNet is an active Ethernet network that provides symmetric 100 mega-bit, Gigabit, and 10Gigabit connections as standard. DWDM circuits can be provided upon request.

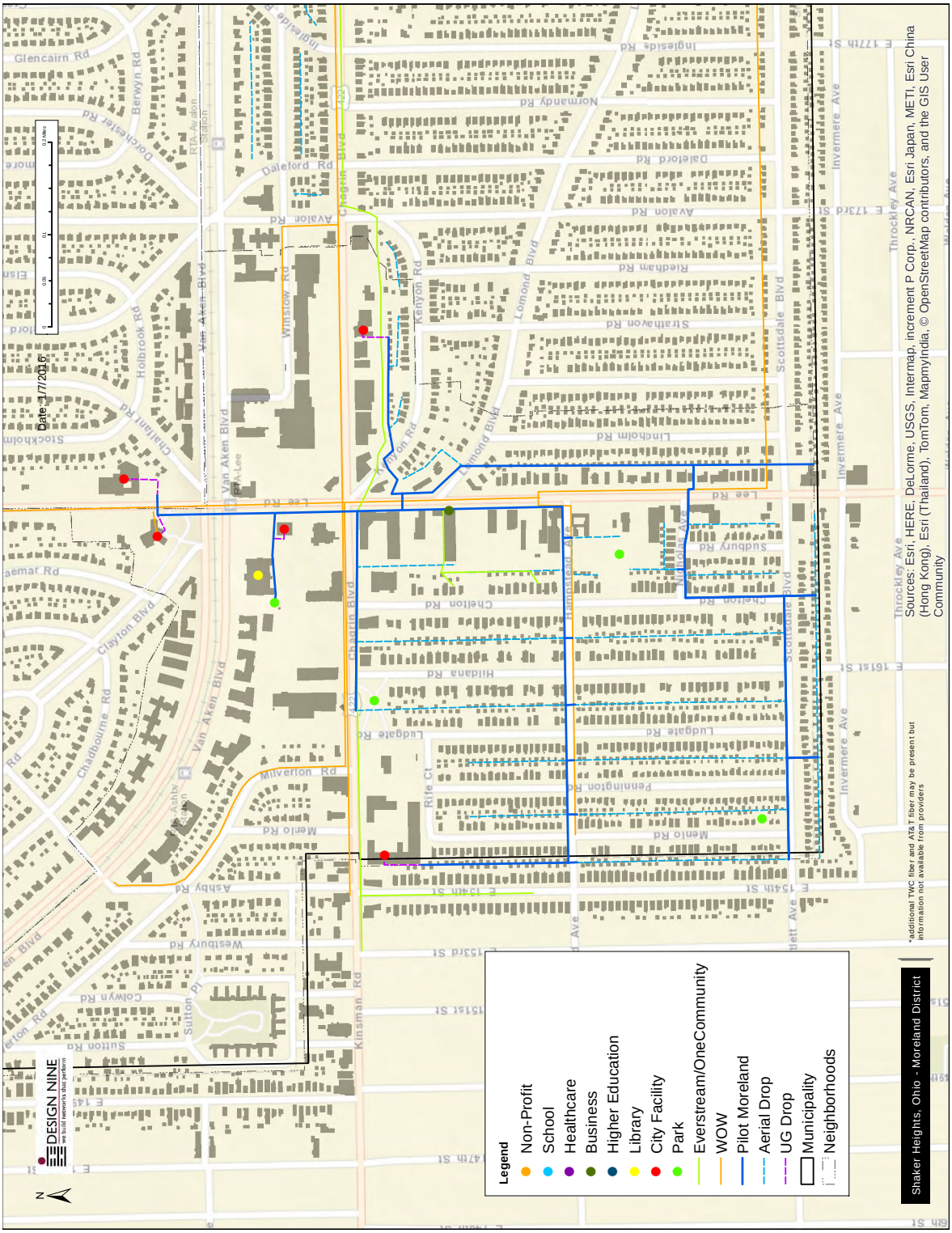
Appendices

Appendix A: Maps

The maps below are included in this appendix.

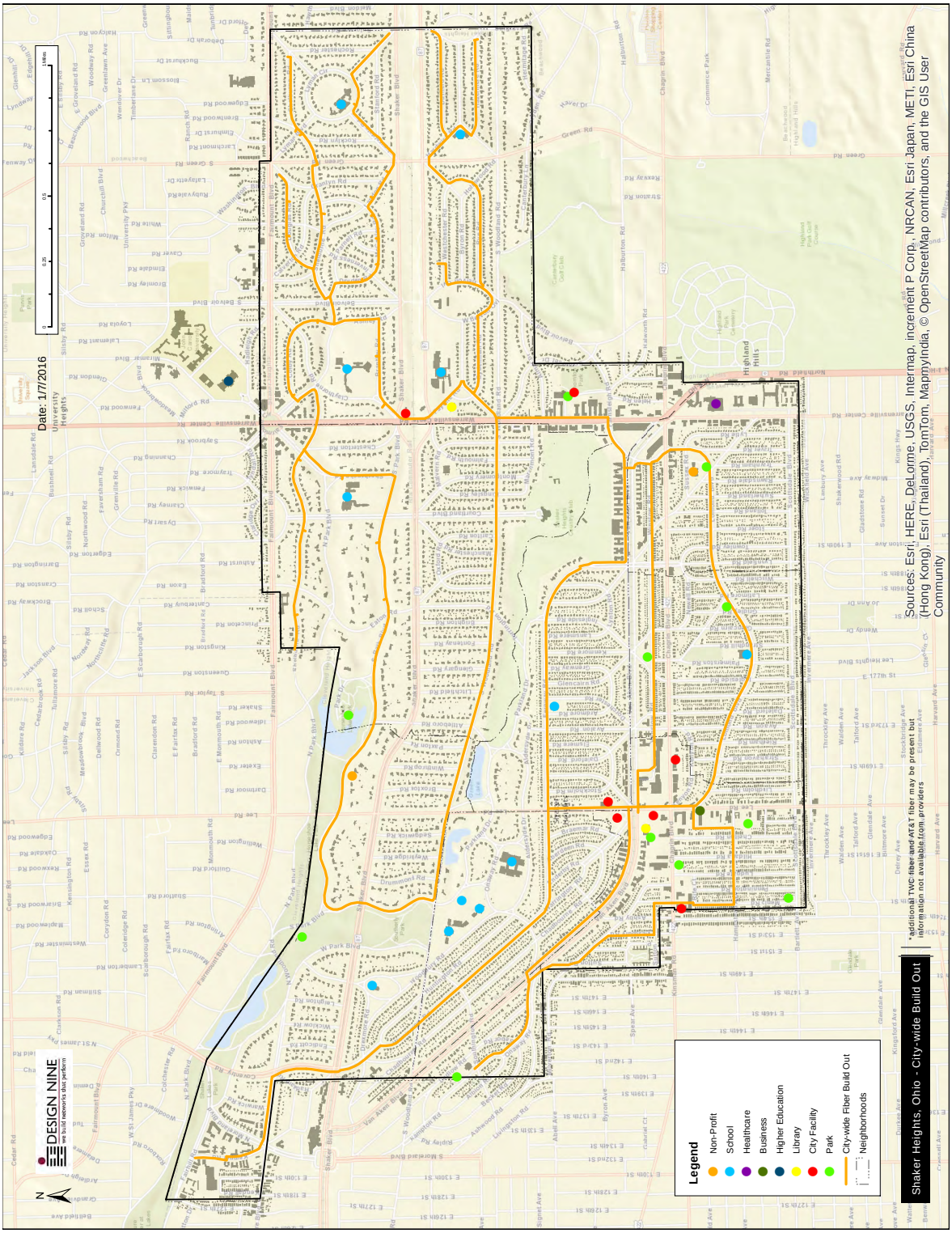
- Moreland Area Build Out Fiber Routes
- Incremental Build Out Fiber Routes
- City-wide Build Out Main Fiber Routes
- Shaker Heights Competitive Fiber
- Shaker Heights Overview of Community Facilities (labeled)
- Shaker Heights Overview of Community Facilities
- Shaker Heights Neighborhoods

Moreland Area Build Out Fiber Routes

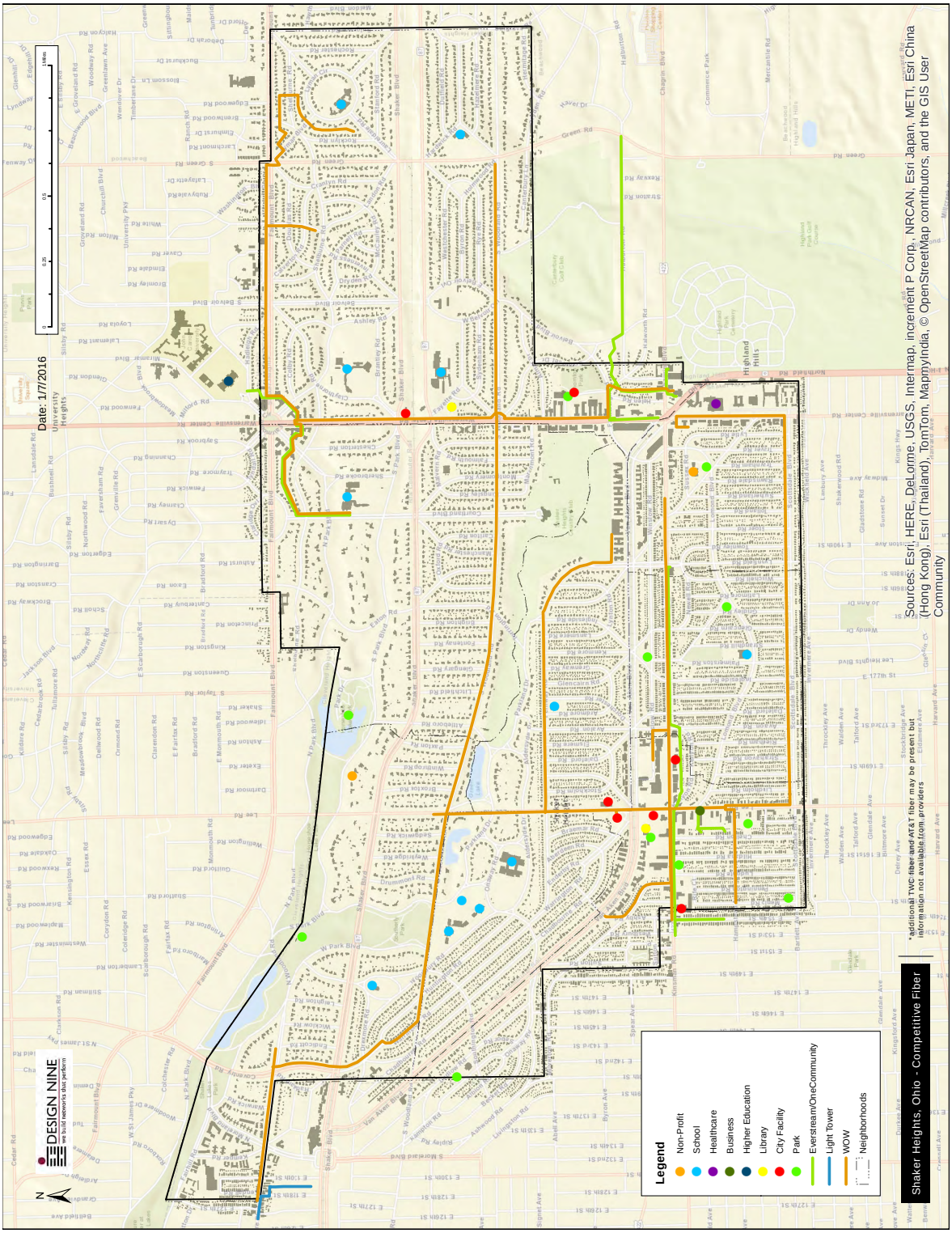


Incremental Build Out Fiber Routes

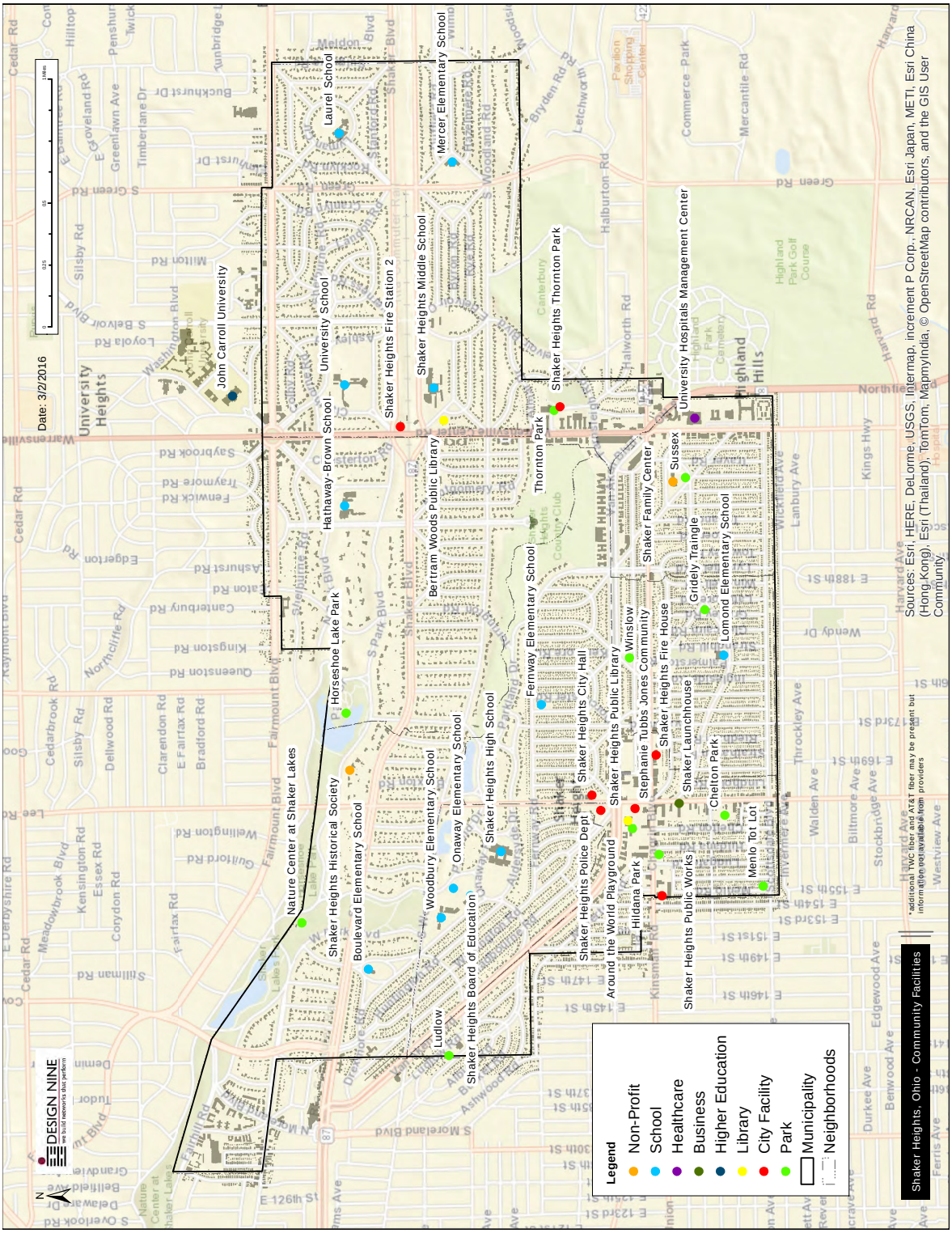
City-wide Build Out Main Fiber Routes



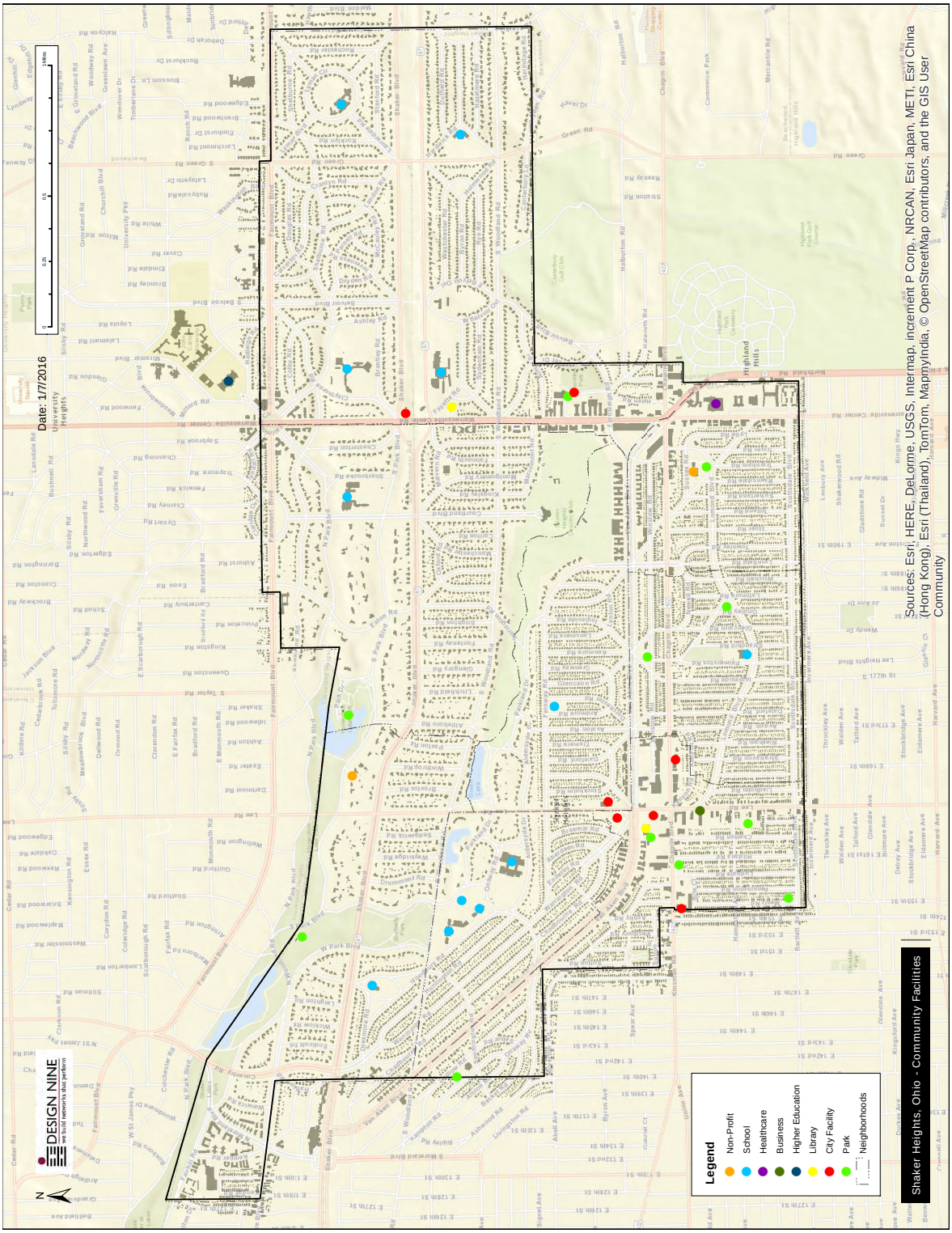
Shaker Heights Competitive Fiber



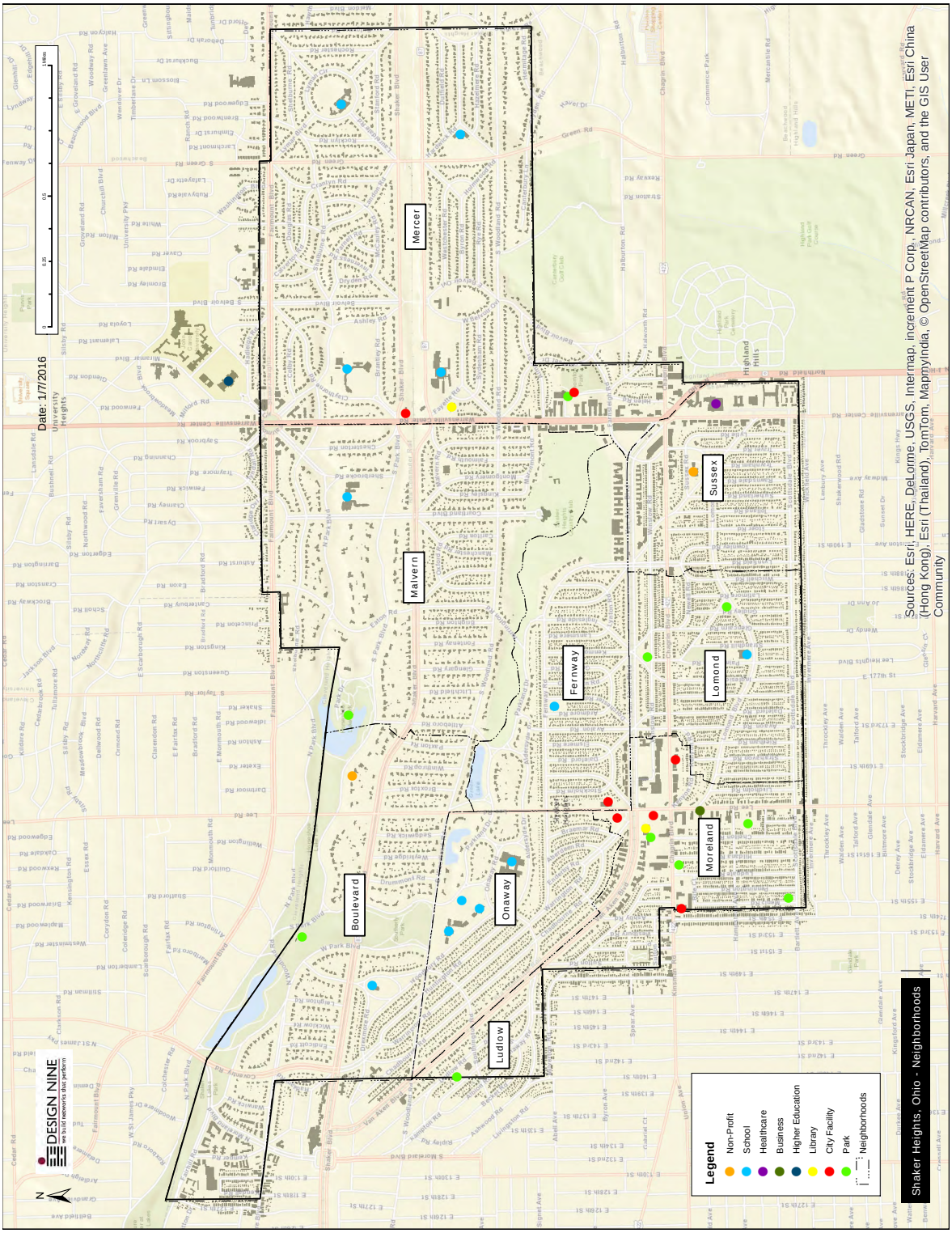
Shaker Heights Overview of Community Facilities (labeled)



Shaker Heights Overview of Community Facilities



Shaker Heights Neighborhoods



Appendix B: Cost Estimate Summaries

The tables below provide an estimate of costs for each of the three build out options in the study (costs of construction are the same for the full build out (bonding) and full build out (lease buy back).

Full Build Out

Cost estimate assumptions: The distribution network will be constructed primarily using underground construction methods. In neighborhoods, the access portion of the network will be extended from the underground distribution and will be constructed primarily using aerial construction methods. Hand-holes/vaults are estimated to be installed every 500' along the underground network. Utility poles are estimated to be approximately 200' apart on average, and about 1 pole in 100 will need to be replaced completely. The estimate accounts for 1 fiber optic splice closure (FOSC) being installed per 8 subscribers. Cabinets and equipment, which can be upgraded, will be installed to accommodate a 40% take rate initially. A line item for a 150,000 co-location facility is included in the estimate.

1	ITEM/PROJECT	ESTIMATED
2	Shaker Heights - Full FTTx Construction Materials	$1,474,223.08
3	Shaker Heights - Full FTTx Distribution Labor	$11,665,446.00
4	Shaker Heights - Full FTTx Structures, Cabinets, and Equipment	$1,256,150.00
5	Shaker Heights - Full FTTx Drop Construction	$5,850,102.00
6	Shaker Heights - Full FTTx Backhaul One Time Costs	$7,500.00
7	Shaker Heights - Full FTTx Special Line Items (includes items like land clearing, easement acquisitions, landscaping, buildings, etc.)	$150,000.00
8	Network Construction Subtotal	$20,403,421.08
9	Project Management, Network Engineering, Integration, and Testing	$3,060,513.16
10	Engineering, Permitting	$441,000.00
11	Misc Fees, Advertising, Technical Services	$150,000.00
12	Bookkeeping and Administration	$50,000.00
13	Other Costs Subtotal	$3,701,513.16
14	**Project Total (No Contingency)**	**$24,104,934.24**

Incremental Build Out

Cost estimate assumptions: The distribution network will be constructed primarily using underground construction methods. In neighborhoods, the access portion of the network will be extended from the underground distribution and will be constructed primarily using aerial construction methods. Hand-holes/vaults are estimated to be installed every 500' along the underground network. Utility poles are estimated to be approximately 200' apart on average, and about 1 pole in 100 will need to be replaced completely. The estimate accounts for 1 fiber optic splice closure (FOSC) being installed per 8 subscribers. Cabinets and equipment, which can be upgraded, will be installed to accommodate a 40% take rate initially. A line item for a 150,000 co-location facility is included in the estimate.

1	ITEM/PROJECT	ESTIMATED
2	Shaker Heights - Incremental Project Construction Materials	$137,703.91
3	Shaker Heights - Incremental Project Distribution Labor	$1,130,031.13
4	Shaker Heights - Incremental Project Structures, Cabinets, and Equipment	$286,725.00
5	Shaker Heights - Incremental Project Drop Construction	$970,050.00
6	Shaker Heights - Incremental Project Backhaul One Time Costs	$7,500.00
7	Shaker Heights - Incremental Project Special Line Items (includes items like land clearing, easement acquisitions, landscaping, buildings, etc.)	$150,000.00
8	Network Construction Subtotal	$2,682,010.04
9	Project Management, Network Engineering, Integration, and Testing	$402,301.51
10	Engineering, Permitting	$40,995.00
11	Misc Fees, Advertising, Technical Services	$150,000.00
12	Bookkeeping and Administration	$50,000.00
13	Other Costs Subtotal	$643,296.51
14	**Project Total (No Contingency)**	**$3,325,306.54**

Moreland Area Build Out

Cost estimate assumptions: The distribution network will be constructed primarily using underground construction methods. In neighborhoods, the access portion of the network will be extended from the underground distribution and will be constructed primarily using aerial construction methods. Hand-holes/vaults are estimated to be installed every 500' along the underground network. Utility poles are estimated to be approximately 200' apart on average, and about 1 pole in 100 will need to be replaced completely. The estimate accounts for 1 fiber optic splice closure (FOSC) being installed per 8 subscribers. Cabinets and equipment, which can be upgraded, will be installed to accommodate a 40% take rate initially. A line item for a 150,000 co-location facility is included in the estimate.

1	ITEM/PROJECT	ESTIMATED
2	Shaker Heights - Moreland Construction Materials	$83,056.90
3	Shaker Heights - Moreland Distribution Labor	$651,829.50
4	Shaker Heights - Moreland Structures, Cabinets, and Equipment	$55,575.00
5	Shaker Heights - Moreland Drop Construction	$186,810.00
6	Shaker Heights - Moreland Backhaul One Time Costs	$7,500.00
7	Shaker Heights - Moreland Special Line Items (includes items like land clearing, easement acquisitions, landscaping, buildings, etc.)	$150,000.00
8	Network Construction Subtotal	$1,134,771.40
9	Project Management, Network Engineering, Integration, and Testing	$170,215.71
10	Engineering, Permitting	$24,570.00
11	Misc Fees, Advertising, Technical Services	$150,000.00
12	Bookkeeping and Administration	$50,000.00
13	Other Costs Subtotal	$394,785.71
14	**Project Total (No Contingency)**	**$1,529,557.11**