



Digital Access Plan

June 2023



Digital Access Plan

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Executive Summary

The Town of Wilbraham has worked with EntryPoint Networks to develop this Digital Access Plan to assist with a planning and decision-making process to assist the Wilbraham Select Board in determining whether it is feasible to deploy and operate broadband infrastructure for the residents, businesses, and anchor institutions in the Town of Wilbraham. The information in this report will be used to assist in the planning and evaluation of the feasibility of implementing a network that can lower broadband costs and increase network value for all stakeholders in Wilbraham. Additionally, this report is designed to assist Town leaders in understanding the operational implications, important risk factors, and a realistic cost framework for developing and operating Town-owned fiber-optic infrastructure.

The Digital Access Plan is a living document that will first be used to analyze feasibility. If the Select Board determines that the project has sufficient merit, the planning process will continue toward a formal RFP process for engineering, construction, and network management tools. The steps to this process are covered at the end of this document in the Next Steps section.

The primary drivers for this analysis include an interest by the Board of Selectmen in lowering costs and improving network speed and reliability. In addition to reducing costs and delivering significant improvements in network speeds, additional objectives for the network include driving new economic development, enhancing livability, enabling new public safety capabilities, facilitating remote education, enabling trends in healthcare like hospital-at-home and aging in place, providing communication for a fiber connected smart grid, increasing the efficiency of government services, and providing universal access.

This report seeks to provide the data needed for Town leaders to thoughtfully plan and implement a communications infrastructure strategy that will benefit residents, businesses, and anchor institutions for years to come. Town leaders can use this document to lay the groundwork to address the challenges of a project of this size and scope. The key focus of the report is on the following primary activities:

- > Network Design & Architecture
- > Cost Analysis for Construction
- > Cost Analysis for Network Operations
- > Customer Acquisition
- > Risk Management



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Strategy

Deploying a large-scale fiber-optic network is a significant public works and information technology project.

Key strategic ideas guiding this Plan were established by the Town leaders and included the following:

- 1) **Improve Network Reliability** – Town leaders seek to promote network attributes that increase reliability for residents, businesses, and anchor institutions within Town limits.
- 2) **Create Local Resilience** – Today’s networking technologies make it possible for a community to be connected to the public internet and have local private networks independent of the public internet. This can be important for privacy, security, reliability, and local resilience in communication systems. The Town of Wilbraham is interested in ensuring that residents and businesses have a robust digital infrastructure to promote initiatives that will give the Town greater influence over this important infrastructure. In building these systems, the Town seeks to provide resilience during a natural disaster or other public safety event.
- 3) **Improve Affordability** – The Town of Wilbraham seeks to promote policies and initiatives to make internet access universally available and affordable throughout the Town limits.
- 4) **Establish Local Control over Essential Infrastructure** – The economy is now an information economy, and the importance of digital infrastructure continues to grow in significance. The Town of Wilbraham is interested in ensuring that the Town has a robust digital infrastructure, and it is interested in promoting initiatives that will give the Town greater influence over this important infrastructure.
- 5) **Mitigate Risk for the Town, Constituents, and Partners** – Town leaders are particularly interested in implementing a business model which mitigates financial and operational risks to the Town and its partners while at the same time helping the Town achieve its other objectives.
- 6) **Foster Competition & Choice** – The Town seeks to promote initiatives that will increase the number of service providers and types of services available to Wilbraham residents.
- 7) **Foster Innovation and Enable Access to New Services** – The economy is now an information economy, and the importance of digital infrastructure continues to grow to enable emerging applications and services. Examples of these new services include hospital-at-home devices like remotely managed IV pumps, smart grid integrated sensors, solar, solar batteries, and smart thermostats.
- 8) **Promote Abundant Bandwidth** – Town leaders seek solutions that move from the current practice of treating bandwidth as a scarce commodity toward policies and programs that treat bandwidth as an abundant resource.
- 9) **Create a Network this is Responsive to Community Members** – Local ownership of networks is important because networks are locally important.



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- 10) **Foster Economic Development** – The Town seeks to ensure that Town residents and businesses have access to infrastructure that will foster local innovation, economic development, and growth.
- 11) **Make Participation Voluntary** – A core component of the Town’s strategy is increasing connectivity options for Wilbraham stakeholders but not compel residents or local businesses to subscribe to a particular program or initiative.
- 12) **Solve the Digital Divide** – Town leaders are interested in promoting access for all residents by making access affordable and by promoting ubiquitous infrastructure.



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SWOT Analysis

This SWOT Analysis is not an analysis of current offerings within Wilbraham. Instead, the analysis considers the Strengths, Weaknesses, Opportunities, and Threats related to advancing the projects under consideration in this report.



<p>STRENGTHS</p>	<p>Support from frustrated subscribers. Operational experience with fiber optics (existing backbone). Community interest in increasing the number of ISP choices. Potential regional interest. Consumer demand following the pandemic. Increased awareness of the importance of broadband. Frustration with incumbent service providers has increased. Potential for access to stimulus spending focused on broadband.</p>
<p>WEAKNESSES</p>	<p>While the Town's Municipal Light Plant (MLP) status has enabled us to deploy and operate a fiber network benefiting our municipal facilities, we are prohibited from utilizing the municipally allocated space on utility poles to provide commercial internet services. Cost to rent space from the pole owner(s) is exorbitant going forward.</p>
<p>OPPORTUNITIES</p>	<p>Better service. Faster speeds. Increased reliability. Introduce competitive pricing and reduce costs. Increased value (speed/cost) for local businesses and impact on economic growth. Provide hotspots in strategic locations around the Town (parks). Improved property values.</p>
<p>THREATS</p>	<p>Resistance to change and fear of the unknown. Misinformation and propaganda. Potential for interest rates to increase. People will hear about failed municipal projects. Fear of increased taxes. Concern that new technologies will lead to obsolescence of fiber-optic technologies (5G) and low orbit satellite. Risks are outlined in the Risk Analysis section.</p>



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Infrastructure

Comparison of Available Media

The primary media used for internet access today in the United States includes DSL, coaxial cable, wireless, and fiber-optic cable.

DSL stands for Digital Subscriber Line, and it is one of the technologies used to provide internet connectivity to homes and businesses. DSL uses existing telephone lines and a transceiver, or modem to bring a connection into a home or business and allows the household to use the internet and make telephone calls at the same time. Verizon is the incumbent telephone company in Wilbraham and uses DSL technology. DSL is asymmetrical (the download speed is much faster than the upload speed), is a dedicated connection capable of download speeds up to 100 Mbps depending on the DSL standard, copper line age, and distance. Most consumers accessing the internet via DSL experience speeds between 5 – 25 Mbps.

Coaxial Cable uses copper cable designed with one physical channel that carries the signal surrounded by a layer of insulation and then another physical channel, both running along the same axis – hence the coaxial name. Coaxial cable is primarily used by cable TV companies to connect transmission facilities to customer homes and businesses to deliver cable TV and internet access. Spectrum is the incumbent cable company in the Wilbraham area. Coaxial cable is asymmetrical and shared between up to 200 customers or more. The most recent cable standard of DOCSIS 4.0 can provide up to 10 Gbps in shared bandwidth depending on supported standards and other environmental factors. The standard currently implemented in Wilbraham is 3.1 and the maximum speed available is 940 Mbps. In addition to the limitation of sharing among many customers, another limitation of coaxial infrastructure is that the signal begins to degrade after 300-400 feet.

Fiber-Optic Cable sends information down strands of glass known as optical fibers which are less than the size of a human hair. These fiber-optic strands can transmit 25 Tbps today and researchers have successfully demonstrated a transmission experiment over 1045 km with a data-rate of 159 Tbps.

Source: <https://phys.org/news/2018-04-fiber-transmission.html>

Fiber-optic cables carry information between two places using optical (light-based) technologies which convert electrical information from the computer into a series of light pulses. Fiber-optic cable is capable of symmetrical speeds up to 25 Tbps and the signal can travel as far as 60 kilometers, or approximately 37 miles, without degrading. Fiber-optic infrastructure is also less expensive to deploy than any other existing wireline infrastructure. Because the difference in capacity between fiber optics and alternative media is so significant, fiber optics should be the foundational media for any new broadband infrastructure project when financially feasible.

Wireless Internet access is made possible via radio waves communicated to a person's home computer, laptop, smartphone, or similar device. Wireless internet can be accessed directly through cellular providers like AT&T Wireless, Verizon Wireless, T-Mobile, or by a wireless internet service provider (WISP). Wireless reliability can be affected by poor weather conditions and may require line of sight.



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5G is the 5th generation of technology used in cellular networks and refers to a standard for speed and connection. Because of the extensive marketing around the emergence of 5G, many people wonder whether 5G will replace fiber-optic cables. In fact, 5G depends on fiber-optic infrastructure. All wireless technologies work better the faster they get back to fiber optics. 5G is not broadcast on a single frequency, rather there are several frequencies used by 5G networks and these different frequencies have different advantages and disadvantages – depending on the application.

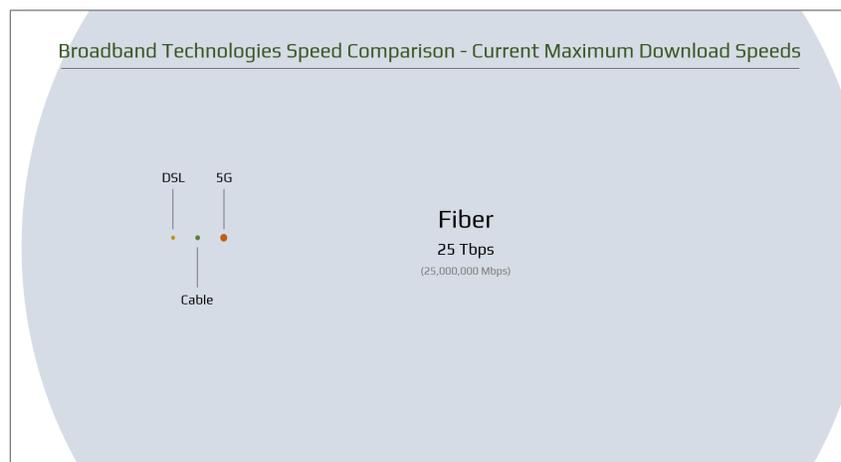
- **Low-band 5G** operates between 600-850 MHz. This is only moderately faster than 4G with speeds between 50-250 Mbps and offers similar coverage areas for each cell tower.
- **Mid-band 5G** operates in the 2.5-3.7 GHz range and delivers speeds between 100-900 Mbps. While offering less range per cell tower, this type of 5G is going to be the most common implementation of 5G networks for many years to come. It is a compromise between network speed and range in both medium-density urban areas and less dense rural regions.
- **High-band 5G** is the band that is most associated with 5G. Operating at 25-39 GHz, this is known as the “millimeter wave” spectrum and delivers gigabit speeds (currently tested as high as 3 Gbps). The millimeter wave transmitters have a very limited range and require the deployment of many small transmitters. Each transmitter connects to fiber optics.

Source: <https://www.businessinsider.com/what-frequency-is-5g>

Satellite Internet is a wireless internet connection that is available nearly everywhere in the U.S. While it is relatively slow in comparison to cable or fiber-optic connections, satellite internet access is faster than some DSL options. This makes it a good option for some rural premises.

Satellite internet speeds range from 1 Mbps – 100 Mbps for download speeds and it is common to have latency and packet loss issues because the signal must travel to space and back. Satellite internet providers include HughesNet, ViaSat, and Starlink. These providers DO NOT promote themselves as a solution for suburban or metro areas.

Satellite internet does require special equipment, including a satellite dish that connects to a communication satellite in space.





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Impact of Bandwidth on Applications

Length & Type of Media	Approx Size	10 Mbps	20 Mbps	100 Mbps	1,000 Mbps
4-Minute Song	4 MB	3 sec	1.5 sec	0.3 sec	0.03 sec
5-Minute Song	30 MB	26 sec	13 sec	2.5 sec	0.2 sec
9-Hour Audio Book	110 MB	1.5 min	46 sec	9.2 sec	0.9 sec
45-Minute TV Show	200 MB	3 min	1.5 min	16 sec	1.7 sec
45-Minute HDTV Show	600 MB	8.5 min	4 min	50 sec	5 sec
2-Hour Movie	1.0-1.5 GB	21.5 min	10.5 min	1.5 min	8 sec
2-Hour HD Movie	3.0-4.5 GB	60 min	32 min	4.5 min	25 sec
Large Archive File	10 GB	Too Long	Slow	Better	80 sec

Wi-Fi is common in homes and commercial buildings and is a way to deliver a network connection from a network hub over a wired connection to wireless devices via a wireless access point. Most people access the internet over a wireless connection, but it is important to remember that wireless connectivity ultimately depends on a wired connection and wireless access works best the faster it gets back to a wire.

Upload vs Download Speeds

In addition to the fact that fiber-optic cable will offer exponentially greater bandwidth than DSL and coaxial cable, fiber-optic cable also offers the ability to deliver symmetrical speeds. In an asymmetrical connection, the download speeds are much faster than upload speeds.

Upload speed is the amount of data a person can *send* in one second and download speed is the amount of data a person can *receive* in one second. Upload speeds can be especially important for businesses, including home-based businesses or people who work from home. It is also important for telemedicine and online schooling to ensure good picture quality with video calls. Applications that depend on good upload speeds include sending large files, cloud applications like Google Docs, Dropbox, VoIP, FaceTime, Skype, Zoom, WebEx, Microsoft Teams video calls, hard drive backups, and in-house web hosting.



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Assessment of Existing Broadband Infrastructure

A 2017 Deloitte Consulting analysis summarizes the current needs and realities for legacy broadband infrastructure in the United States in this way:

“The United States requires between \$130 and \$150 billion over the next 5–7 years to adequately support broadband competition, rural coverage, and wireless densification.

Despite the demand and potential economic benefits of fiber deployment, the United States lacks the fiber density in access networks to make the bandwidth advancements necessary to improve the pace of innovation and economic growth.

Some wireline carriers are reluctant or unable to invest in fiber for the consumer segment despite the potential benefits. Expected wireline capital expenditures range between 14–18 percent of revenue. Wireline operating expenditures can be 80 percent of revenue. Fiber deployment in access networks is only justified today if a short payback period can be guaranteed, a new footprint is being built, repairs from rebuilding after a storm or other event justifies replacement, or in subsidized geographies where Universal Service funds can be used. The largest US wireline carriers spend, on average, five to six times more on operating expenses than capital expenditures. Excessive operating expenditures caused, in part, by legacy network technology restrict carriers’ ability to leverage digital technology advancements. Worse, as legacy networks continue to descale, the percentage of fixed costs overwhelms the cost structure leading to even greater margin pressure.”

Source: <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-5GReady-the-need-for-deep-fiber-pov.pdf>

The Deloitte report is not specific to infrastructure in Wilbraham, Massachusetts. Still, the conclusions from the Deloitte report are generally applicable. Telco and cable operators in U.S. cities often have fiber to an aggregation point and then legacy infrastructure from the aggregation point to the premise.

The primary finding of the Deloitte report is that legacy infrastructure needs to be replaced with fiber-optic cable in the near term to meet bandwidth demands. There is no indication that incumbents will soon replace legacy infrastructure with fiber-optic infrastructure. Even if they did, this upgrade would solve the base infrastructure problem. Still, there needs to be more competition or premium pricing for gig speeds.

Legacy copper and coaxial infrastructure will need to be replaced with state-of-the-art infrastructure to meet the ever-growing demands for greater bandwidth and faster speeds. An important question is whether unique value can be derived by having the Town and its residents own and control this infrastructure or whether private companies should continue to own and operate all communications infrastructure.

The ideal infrastructure includes more than just the fiber-optic cables running throughout the Town. Important infrastructure considerations include the electronics at both ends of the fiber and systems that



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manage and control the network. As the Town deploys its infrastructure, the following are important considerations guiding its decision-making framework:

- **Capacity & Speed:** The demand for bandwidth and speed will continue to grow.
- **Emerging Services and Applications:** 5G, connected vehicles, edge computing, and virtual reality are all examples of emerging applications with infrastructure dependencies. An important consideration is how flexible the business model and technology systems are to enable whatever may come.
- **Local Control:** An advantage of a network that is locally controlled is that the network can be much more responsive to local needs and may enable innovation and adaptation for emerging opportunities.
- **Local Resilience:** Many communities are not locally resilient against attacks on internet infrastructure. It is possible to design networks to provide residents and businesses with a locally resilient network if, for some reason, middle mile connections are severed.
- **Privacy & Security:** Subscribers are increasingly sensitive to security, privacy, and confidentiality controls.
- **Risk Analysis:** Considering the risks for all potential network stakeholders is an essential part of the planning process.



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Market Analysis

In Wilbraham, most residents and businesses subscribe to wireline internet services from the cable operator (Spectrum) and telephone incumbent (Verizon).

Residential

Spectrum

Spectrum advertises the following residential ISP services in Wilbraham:



Speed (Mbps) [Down / Up]	Introductory Pricing [contract required]	Standard Pricing [not including taxes & fees]
100 / 10	\$50.00	\$75.00
400 / 12	\$70.00	\$95.00
940 / 25	\$110.00	\$130.00

Taxes and Fees commonly add 20%-30% above standard pricing

Shared Network – Speeds are “up to” not guaranteed.

Speeds are not symmetrical.

Data caps not clearly defined.

The promotional rate is subject to change during or after the promotional period.

Availability depends upon location – not available in all areas.

EntryPoint reviewed 20 Spectrum invoices provided by Wilbraham residents. The average monthly cost of residential Spectrum services = **\$174.07** per month.

Verizon



Verizon now offers fiber-based, residential internet service in Wilbraham (or at least portions thereof). Current Verizon Wireless customers enjoy monthly discounts when they subscribe to the company's residential I-net service.



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Business

These are a few examples of commercial services in Wilbraham.

Spectrum Business

Spectrum advertises the following business ISP services in Wilbraham:



Speed (Mbps) [Down / Up]	Advertised Pricing [with Bundle and Contract]	Actual Billing [Wilbraham Business]
200 / 10	\$50.00- \$70.00	\$145.00
940 / 35	Not Listed	No Data

Taxes and Fees commonly add 20%-30% above standard pricing

Shared Network – Speeds are “up to” not guaranteed.

Speeds are not symmetrical.

The promotional rate is subject to change during or after the promotional period.

Availability depends upon location – not available in all areas.

Verizon Business

Verizon advertises the following business services in Wilbraham:

Dynamic IP Plans



Speed (Mbps) [Down / Up]	Introductory Rates [Contract Required]	Standard Pricing [Not Including Taxes & Fees]	Install Fee
1 / .4	\$50.00	\$60.00	\$50.00
3 / .7	\$63.00	\$73.00	\$50.00
5 / .7	\$80.00	\$90.00	\$50.00
7 / .7	\$80.00	\$90.00	\$50.00
10 / 1	\$80.00	\$90.00	\$50.00

Static IP Plans

Speed (Mbps) [Down / Up]	Introductory Rates [Contract Required]	Standard Pricing [Not Including Taxes & Fees]	Install Fee
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3 / .7	\$83.00	\$93.00	\$50.00
5 / .7	\$100.00	\$110.00	\$50.00
7 / .7	\$100.00	\$110.00	\$50.00
10 / 1	\$100.00	\$110.00	\$50.00

Taxes and Fees commonly add 20%-30% above standard pricing.

Shared Network – Speeds are “up to” not guaranteed.

Speeds are not symmetrical.

Availability depends upon location – not available in all areas.

Granite Telecommunications for Business

Granite Telecommunications charges the following to a local business in Wilbraham for telecom services:



Speed (Mbps) [Down / Up]	Internet [Monthly]	Voice [Monthly]	Other – T1 [Monthly]	Taxes [Monthly]	Total [Monthly]
60 / 5	\$197.10	\$445.23	\$255.00	\$109.57	\$1,006.90

Shared Network – Speeds are “up to” and are not guaranteed.

Speeds are not symmetrical

Note: The market research was conducted in January 2021. Packages and prices may have changed since that time.



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Community Engagement

The sample Community Engagement Plan that follows is built on the assumption that Wilbraham will go forward with a Town-sponsored project. If the Town elects to support an alternative approach (cooperative or public-private partnership) the community engagement approach will change.

Goals & Objectives

A Wilbraham Community Engagement Plan aims to achieve a minimum 40% take-rate for homes and businesses within the Wilbraham town limits. Additionally, a scale of 2,500 subscribers is an important target for the project to be operationally sustainable. In the financial section later in this report, the financial models are built to a target of a 60% take-rate. The modeling can easily be adjusted to match actual take-rates.

Evaluation & Education

Document the current state of broadband and determine the level of interest among residential users and business owners.

Community Survey

A survey for residents and business owners was conducted to determine the level of interest in a municipal fiber network. Education and promotion programs should be influenced by ongoing survey engagement and response.

Publish Educational Information

Leverage website content specific to the municipal fiber program to outline the core message of broadband as a Town-owned service offering lower costs, an increase in choice, subscriber control, and fosters digital inclusion. Use customized videos to educate online visitors on topics such as: functionality of the community fiber network, options for services, frequently asked questions (FAQ's), and more.

Mapping Community Interest

Distribute an "I am interested" sign-up form with associated heat map where residential and business property owners can register as someone interested in municipal fiber.

Marketing & Promotion

Utilize press releases to promote the municipal fiber network, driving traffic to the fiber website with the goal of educating community members, generating interest, and encouraging community participation. Use all available social media platforms (e.g., Facebook, Instagram, Twitter) to promote the fiber network.

Neighborhood Entrance and Yard Signs

As construction (fiber build) begins in a neighborhood, Wilbraham can post signs at neighborhood entrances announcing the construction and letting residents know they can still sign-up to get connected while crews are in the neighborhood.



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As homes are connected in the neighborhood, yard signs can be placed in the yards of subscribers indicating that the home now enjoys a fiber broadband connection.

Grassroots Engagement

Webinars & Open House Events

Wilbraham can use webinars and open house events to educate residents and business owners about the fiber project, ask questions, become educated about the business model, infrastructure, and costs.

Webinars and open houses are promoted using utility bill inserts, press releases, public service announcements, local news reports, City websites, social media platforms, and more.

Webinars and open house events are intended to educate residents, promote the network, and identify fiber champions in the various neighborhoods (fiber zones).

Fiber Champions

Fiber champions are individuals that demonstrate a voluntary commitment to promoting the network within their neighborhood. Fiber champions may be incentivized by a practice of building to those neighborhoods that have the highest level of engagement or demand (initial fiber zones are connected in order of take-rates – highest to lowest). Fiber champions assist sign-up efforts within their designated neighborhood (fiber zone). They organize and lead neighborhood meetings where neighbors can learn about the Wilbraham fiber program. Wilbraham leaders and employees provide support to the fiber champions in their efforts. Fiber champions drive conversations and contractual commitments of neighbors via the door-to-door sales and education campaign.

A Wilbraham Community Broadband Committee could provide an advisory governance role and could be composed of a champion from each neighborhood to represent a diversity of views and lived experiences.

Grassroots Engagement Budget = TBD

Door-to-Door Campaign

Individuals representing the local network contact residents and business operators within the planned footprint to answer questions and ascertain the potential subscribers' interest in participating. [Yes (Opt-in) or No (Opt-out)].

This direct person-to-person contact gives everyone in the community an opportunity to ask questions, clarify understanding, and express a level of interest in participating.

To maximize the effectiveness of this process, door hangers are distributed to every home and business prior to canvassing a neighborhood. These inform property owners that a representative will be stopping by to explain the value proposition, answer questions, and determine the level of interest from potential subscribers.



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Door-to-door campaigns are very effective in giving people an opportunity to learn and ask questions in a one-on-one interaction.

It is important to support this effort with public notifications, press releases, mass emails, websites, social media sites, mobile applications, and other community outreach venues. This may include outside professional marketing and/or public relations firms.

The door-to-door campaign budget = \$100 per premise that subscribes. This cost can be included in the sign-up fee or wrapped into the infrastructure installation costs.

***Note:** The work outlined in this Community Engagement Plan, in whole or part, can be managed by internal Wilbraham personnel or it can be outsourced to a professional marketing and promotions organization.*



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Wilbraham Broadband Survey Results

The Town deployed a website to begin educating the public regarding its evaluation of the feasibility of a Town sponsored fiber-optic network. The Town distributed an initial survey to Wilbraham residents assessing current sentiment regarding existing services and the level of interest in a municipal network. Professional survey administrators did not develop this survey. To date, key findings from the survey include the following:

Total Responses	368		
Support Fiber Network			
	3	No	0.82%
	12	Possibly	3.26%
	353	Yes	95.92%
	Support Project – Yes / Possibly		99.18%
Importance of High-Speed Internet			
	1	Not Too Important	0.27%
	6	Important	1.63%
	59	Very Important	16.03%
	302	Essential	82.07%
	Speed is Essential / Very Important		98.10%
Rate Reliability, Speed, & Cost of ISP			
	105	1-2 Poor	29.00%
	102	3-4 Fair	28.18%
	118	5-6 Okay	32.60%
	34	7-8 Good	9.39%
	3	9-10 Very Good	0.83%
	Current ISP is Good / Very Good		10.22%
Rate Experience with Current ISP			
	108	Poor	29.35%
	140	Fair	38.04%
	91	Good	24.73%
	26	Very Good	7.07%
	3	Excellent	0.81%
	Current ISP is Poor / Fair		67.39%
Average Monthly Internet Cost	323	Monthly Internet Cost	\$90.05



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Municipal Broadband Models Comparison

The Institute for Local Self Reliance has mapped municipal networks throughout the United States using an interactive map that can be found at the following link: <https://muninetworks.org/communitymap>.

A mix of prominent municipal fiber-optic projects was selected to illustrate the types of models that have been deployed in the United States. The following comparison summarizes different approaches to funding and operating municipal broadband infrastructure and services, followed by a description of the advantages and disadvantages of each:

Municipality	Population	Model Type	Electric Utility	Take-Rate	Cost of 1 Gig
Chattanooga, TN	179,139	Electrical Utility ISP	Yes	60%	\$68.00
Lafayette, LA	126,000	Electrical Utility ISP	Yes	40%	\$99.95
Westminster, MD	19,000	City Fiber, Private ISP	No	20%	\$89.99
Huntsville, AL	194,585	Dark Fiber Open Access	Yes	Not Published	\$70.00
Sandy, OR	10,000	Municipal ISP	No	60%	\$59.95
Longmont, CO	86,000	Electrical Utility ISP	Yes	55%	\$69.95
Ammon, ID	17,000	Automated Open Access	No	65%	\$47.50
Monmouth, OR	15,083	Municipal ISP	No	80%	\$129.65
Lexington, KY	321,959	Private Partner Owned	No	Not Published	\$59.95
Santa Monica, CA	110,000	Dark Fiber Business Only	No	N/A	N/A
Fort Collins, CO	165,000	Electrical Utility ISP	Yes	Early Stage	\$59.95
UTOPIA	150,000+	Manual Open Access	No	15%	\$70.00

Disclosure: Ammon, Idaho is a client of EntryPoint Networks.

Ownership Considerations

Vertically Integrated – Privately Owned & Operated

A private owner designs, builds and operates a network. The private builder and operator controls pricing, the business model, architecture, and assumes all the risk and does the work of overseeing design, project management, construction, customer acquisition and operations.

This model leaves the community vulnerable to the private owner operating as a monopoly or selling the network to a monopoly operator. A national or regional private operator reduces the ability of the subscriber to influence the policies, practices, and pricing of the operator. Historically, private owners have not demonstrated a willingness or ability to solve the digital divide.



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Publicly Owned & Privately Operated

A community (e.g., city, town, or county) owns the network and utilizes a third-party operator to maintain and operate the network. The primary value of publicly owned infrastructure is that the network will not be under the control of an unregulated, or semi-regulated private company, which is not accountable or vulnerable to an election cycle where subscribers are empowered to influence outcomes. A private operator may be more expensive for subscribers due to the additional cost for profit. However, this depends on variables like efficiency, the cost of employment, and the percentage the operator takes for profits. Public owners have greater incentives to solve the digital divide. The private operator has limited risk because it does not need to recover a capital investment.

The current model suggests that each ISP builds their own infrastructure. That is not necessary with fiber optics. One good fiber network will provide up to a 100-year infrastructure. Multiple fiber networks will only drive up the costs for consumers and will provide no new or added value to the community.

Publicly Owned & Operated

A neutral host such as a city or county owns and operates the network. This model protects the community from a private owner operating as an unregulated monopoly or selling the network to a monopoly operator. It also makes the network operator accountable to subscribers via an election cycle where subscribers are empowered to influence outcomes. Public owners have greater incentives to solve the digital divide.

Access Model Considerations (Single ISP vs Open Access)

Single ISP – Closed Access

This model is the most common infrastructure built out today and mainly provides advantages only to the ISP. A single ISP does not expand choice or competition and may be more expensive for subscribers than an open access model.

Dark Fiber Open Access

Dark fiber open access is a model where infrastructure is built to the curb and the subscriber then selects an ISP as its provider. The ISP finishes the connection to the home with its own infrastructure and electronics. Operating a dark fiber network is less complicated than operating a lit network and the dark fiber model also enables public ownership of infrastructure. While the dark fiber model increases choice for consumers, the downside is that the subscriber and operator give up control over last mile infrastructure. For example, giving up control over the drop from the curb to the premise. The dark fiber model therefore limits the usability of each strand of fiber. With an isolated dark fiber connection, the range of possible services and service attributes is limited to services offered by the ISP controlling the drop to the premise. The dark fiber model also does not scale efficiently due to difficulty in anticipating the required fiber count to meet the demand. This can create significant complications for the network operator.

Lit Fiber – Manual Open Access

Lit Fiber – Manual Open Access is a model where the network is lit end to end. This means the network operator places and controls the electronics at both ends of the network. Switching internet service providers can be requested from a web portal and may appear to be automated but the network provisioning is done manually. A manual open access network increases choice for consumers. However, it does not necessarily produce the desired effects of competition if the business model presents barriers to



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competition. Operating a manual open access network is more complex than operating other models because of the requirement for human management of network tasks and any increase in the number of service providers operating on the network adds to network complexity.

Lit Fiber – Automated Open Access

Lit Fiber – Automated Open Access is a model where the network operator places electronics at both ends of the network and subscribers can dynamically select service providers in real-time. Software defined networking is used to automate various network management tasks. In this model, multiple service providers can deliver services simultaneously and independently across a single wire. When a subscriber selects a new service provider, the provisioning is done using automation and therefore happens on-demand. Automated provisioning creates a marketplace for services which includes ISPs and private networks for other services. The ability to switch service providers on demand increases choice and competition. This network model also includes the ability to provide local network resilience via local communications if connections over the middle mile are down.

Disclosure: EntryPoint Networks owns and operates a SaaS model automated open access solution and is a technology solution provider in these networks.

Massachusetts Municipal Fiber Networks

There are several cities in Massachusetts operating fiber-optic networks under the authority of a Local Improvement District. Existing municipal networks in Massachusetts include:

Municipality	Model Type	Public vs Private ISP & M&O	Residential Cig	Commercial Cig
Concord, MA	Municipal Light Plant	Municipal ISP & M&O	\$89.95	Call for Pricing
Leverett, MA	Municipal Light Plant	Third-Party ISP & M&O	\$83.40	\$299.95
Taunton, MA	Municipal Light Plant	Municipal ISP & M&O	\$69.95	Call for Pricing
New Salem, MA	Municipal Light Plant	Third-Party ISP & M&O	\$85.00	\$110 - \$260
Shutesbury, MA	Municipal Light Plant	Municipal ISP & M&O	\$75.00	Call for Pricing
Wendell, MA	Municipal Light Plant	Third-Party ISP & M&O	\$99.00	\$99.00
Peabody, MA	Municipal Light Plant	Closed	\$89.95	\$299.95
Westfield MA	Municipal Light Plant	Third-Party ISP & M&O	\$69.95	\$84.95 - \$399.95

Whip City Fiber is a third-party network operator for several small Western Mass towns. Whip City was created and is operated by Westfield Gas & Electric in Western Massachusetts. Whip City partners with and provides services to Municipal Light Plants in Westfield, Alford, Ashfield, Becket, Blandford, Charlemont, Chesterfield, Colrain, Cummington, Goshen, Heath, Leyden, New Ashford, New Salem, Otis, Plainfield, Rowe, and Washington.



Digital Access Plan

Network Design

Switched Ethernet Network

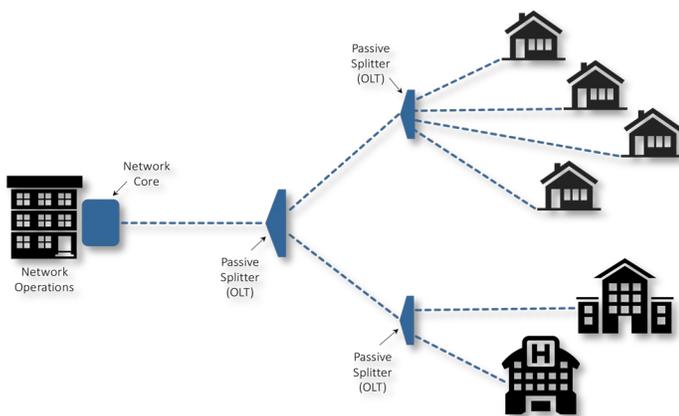
The Switched Ethernet architecture provides a dedicated connection for each customer rather than a shared connection and the customer experience is significantly better than in a shared architecture during periods of network congestion. This is due to the fact that the throughput of switch-based architecture is superior to a bus-based architecture during times of network congestion.

Passive Optical Network (PON)

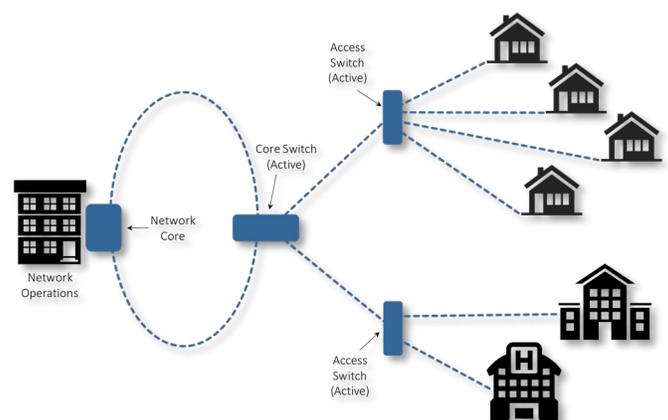
Passive Optical Networks (PON) and coaxial (cable) networks follow a bus architecture.

A bus architecture is a shared architecture. A splitter is placed in the field and a connection is often shared between 32 or 64 premises. The bus architecture leads to more packet collisions on the network which can result in high amounts of packet loss during congestion. Additionally, it is more difficult to isolate and troubleshoot faults in the network with a bus topology.

Passive Optical Network (PON) Design



Switched Ethernet Network Design



Proponents of PON architecture will argue that PON is less expensive than an ethernet design. That was true historically. The illustration below shows that the variable costs of a switched ethernet deployment is now equal to PON. This change in pricing differences was driven by the fact that all data center deployments use switched ethernet architectures and the enormous growth of data centers over the past 20 years has driven down the cost of ethernet electronics.



Digital Access Plan

PON - Network Access Equipment

Description	Unit Cost	Qty	Extended Cost
Install Package	\$696.50	1	\$696.50
Splitter Shelf	\$84.00	8	\$672.00
OLT	\$4,196.50	2	\$8,393.00
10GE SFP+	\$837.90	2	\$1,675.80
2x 1GE BIDI CSFP	\$157.50	24	\$3,780.00
Access Line-up			\$15,217.30
Number of Subscribers Served			96
Average Cost per subscriber			\$158.51

Ethernet - Network Access Equipment

Description	Unit Cost	Qty	Extended Cost
Switch	\$1,300.00	2	\$2,600.00
SFP	\$12.00	96	\$1,152.00
Access Line-up			\$3,752.00
Number of Subscribers Served			96
Average Cost per subscriber			\$39.08

PON - Premise Equipment

Description	Unit Cost	Qty	Extended Cost
Indoor ONT	\$225.15	1	\$225.15
Power supply for 700GE ONT	\$12.00	1	\$12.00
Premise Line-up			\$237.15
Number of Subscribers Served			1
Average Cost per subscriber			\$237.15

Ethernet - Premise Equipment

Description	Unit Cost	Qty	Extended Cost
White Box VBG	\$330.00	1	\$330.00
1000Base 1310nm-Tx/1550nm RX 10km	\$9.00	1	\$9.00
Premise Line-up			\$339.00
Number of Subscribers Served			1
Average Cost per subscriber			\$339.00

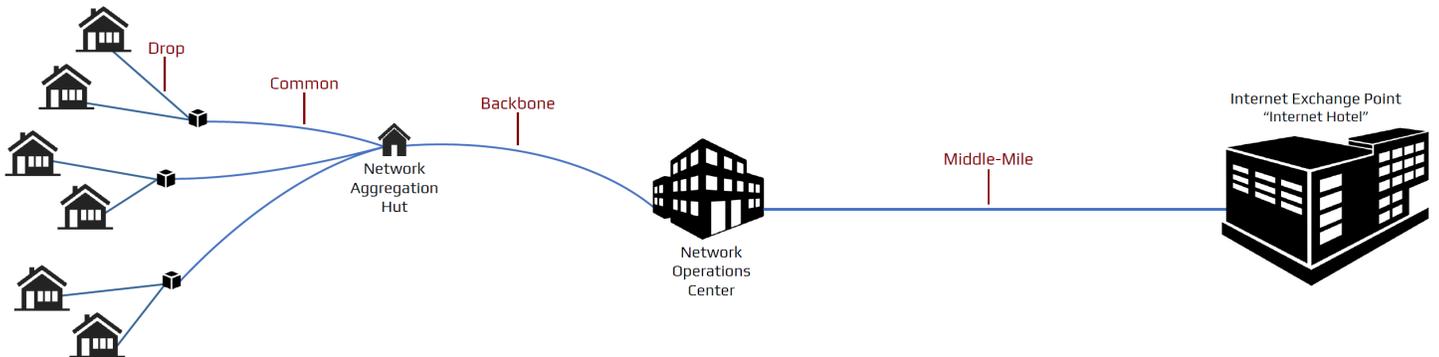
Per Premise PON Equipment Costs

Total cost per Subscriber	\$395.66
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Per Premise Ethernet Equipment Costs

Total cost per Subscriber	\$378.08
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Network Seaments – Definitions & Costs Allocations



Drop = Fiber run from street to premise (home or business). The cost of the drop is borne by the individual subscriber.

Common = Fiber runs from street in front of premise to closest aggregation hut. The cost of the common is borne by all subscribers on the network.

Backbone = Fiber runs from aggregation hut back to the network operations center. The cost of the backbone is borne by all network subscribers, with potential municipal contribution.

Middle-Mile = Third-party fiber run from the network operations center to the closest internet exchange point. The cost of the middle mile is included in the monthly M&O utility fee and is borne by all networks.



Digital Access Plan

Project Partners

Middle Mile

Middle mile is an industry term that describes the network infrastructure that connects local networks to service providers at an internet exchange point. The last mile is the local part of a communication network which connects a service provider to a customer.

Approximately 2,500 customers can be served by a 10 Gbps circuit. If the Town pursues a Town- owned network, it will need to adjust middle mile capacity according to take-rate and utilization. Peak usage is an important data point for monitoring and is used to inform capacity planning. The cost of the middle mile connection should be allocated on a per subscriber basis.

Internet Service Providers (ISP) Partners

An internet service provider gives subscribers access to the internet. The Town will need to determine what model it will follow or support before it engages one or more internet service providers. If the Town selects an open access model, there are a number of ISPs that have expressed a verbal interest in being service providers to Wilbraham subscribers. The participation of these ISPs could be formalized through an MOU process.



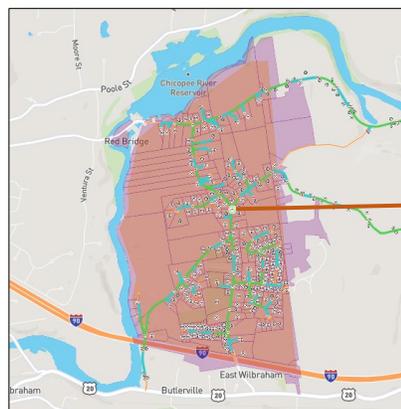
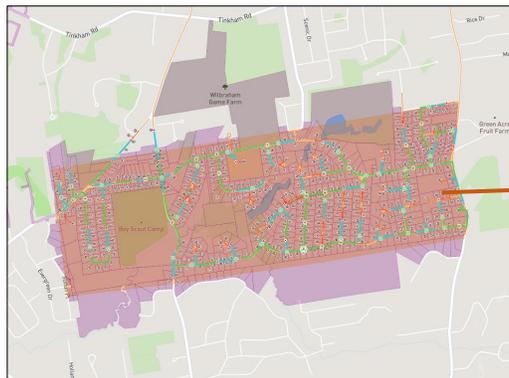
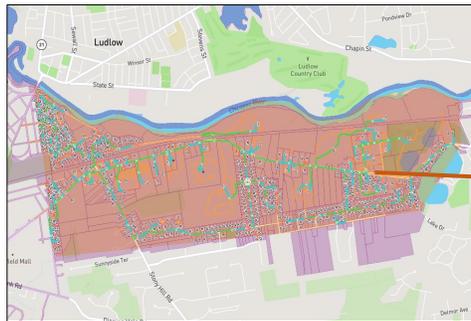
Digital Access Plan

Cost Analysis & Phasing

High-Level Network Design

A high-level network design was done for business and residential neighborhoods to build a cost model for the project. The Biarri Networks Fiber-Optic Network Design Tool was used to create the design and calculate materials costs for these designs. The main cost categories for deploying and operating broadband networks are separated to optimize the costs in each of the following categories:

- Infrastructure Capital Costs (Financed over 20 years)
- Network Maintenance & Operations
- Services





Digital Access Plan

Network Backbone

The cost modeling that follows assumes that the fiber infrastructure that was deployed to connect Town assets has sufficient fiber count so that it can be leveraged as part of a fiber-to-the-premise backbone.

Monthly Infrastructure Cost Modeled From 1,580 Premises

The first illustration of Infrastructure Capital Costs per premise assumes a 60% take-rate and a project that is 100% aerial. The data in the line items in this model comes from a combination of the Biarri Network Design Tool, actual bids for materials, and network buildout experience.

The second illustration of Infrastructure Capital Costs per premise assumes a 60% take-rate and a project that is 20% aerial and 80% underground. We can adjust these variables on a neighborhood-by-neighborhood basis as needed.

The third illustration of Infrastructure Capital Costs per premise assumes a 60% take-rate and a project that is 100% underground.

Take-rate is a variable that is critical to project success because the operational sustainability of a project depends on crossing a certain take-rate threshold and take-rate has a meaningful impact on the cost per premise.

Costs at 60% Take-Rate			
100% Aerial			
Description	Common	Drop	Total
Labor - Hours	7.08	5.63	12.71
Labor - Dollars	301.96	239.79	\$541.76
Labor - Equipment	92.37	47.96	\$140.32
Materials	282.91	94.00	\$376.91
Supplies	\$93.33	\$20.00	\$113.33
Restoration	\$33.33	\$0.00	\$33.33
Hut/Cabinet	\$116.67	\$0.00	\$116.67
Feeder Fiber	\$318.33	\$0.00	\$318.33
Engineering	\$33.75	\$15.00	\$48.75
Professional Services	\$83.33	\$16.00	\$99.33
Electronics	\$166.67	\$350.00	\$516.67
Subscriber Acquisition	\$0.00	\$0.00	\$0.00
Total	\$1,522.65	\$782.75	\$2,305.41
Backbone Cost per Premise			\$262.11
Total w/ Backbone			\$2,567.52
Short Term Interest			\$184.43
Total Capitalized			\$2,751.95
Monthly Infrastructure Per Premise Cost		\$15.41	



Digital Access Plan

Costs at 60% Take-Rate			
80% Buried 20% Aerial			
Description	Common	Drop	Total
Labor - Hours	12.75	10.13	22.88
Labor - Dollars	543.53	431.63	\$975.16
Labor - Equipment	166.26	86.33	\$252.58
Materials	509.24	169.20	\$678.44
Supplies	93.33	20.00	\$113.33
Restoration	33.33	-	\$33.33
Hut/Cabinet	116.67	-	\$116.67
Feeder Fiber	318.33	-	\$318.33
Engineering	33.75	15.00	\$48.75
Professional Services	83.33	16.00	\$99.33
Electronics	166.67	350.00	\$516.67
Subscriber Acquisition	0.00	0.00	\$0.00
Total	\$2,064.44	\$1,088.15	\$3,152.60
Backbone Cost per Premise			\$262.11
Total w/ Backbone			\$3,414.71
Short Term Interest			\$252.21
Total Capitalized			\$3,666.92
Monthly Infrastructure Per Premise Cost			\$20.54

Costs at 60% Take-Rate			
100% Buried			
Description	Common	Drop	Total
Labor - Hours	14.17	11.25	25.42
Labor - Dollars	\$603.93	\$479.59	\$1,083.51
Labor - Equipment	\$184.73	\$95.92	\$280.65
Materials	\$565.82	\$188.00	\$753.82
Supplies	\$93.33	\$20.00	\$113.33
Restoration	\$33.33	\$0.00	\$33.33
Hut/Cabinet	\$116.67	\$0.00	\$116.67
Feeder Fiber	\$318.33	\$0.00	\$318.33
Engineering	\$33.75	\$15.00	\$48.75
Professional Services	\$83.33	\$16.00	\$99.33
Electronics	\$166.67	\$350.00	\$516.67
Subscriber Acquisition	\$0.00	\$0.00	\$0.00
Total	\$2,199.89	\$1,164.51	\$3,364.39
Backbone Cost per Premise			\$262.11
Total w/ Backbone			\$3,626.51
Short Term Interest			\$269.15
Total Capitalized			\$3,895.66
Monthly Infrastructure Per Premise Cost			\$21.82



Digital Access Plan

Why Take-Rate is Important

The following table illustrates the impact of take-rate on total cost per premise with a rate of 60% as neutral on impact.

Take-Rate	Cost/Sub	Subscribers	Par= 60% Take-Rate
40.00%	\$4,184.82	2,087	(\$1,032.22)
45.00%	\$3,840.74	2,348	(\$688.15)
50.00%	\$3,565.48	2,609	(\$412.89)
55.00%	\$3,340.27	2,869	(\$187.68)
60.00%	\$3,152.60	3,130	\$0.00
65.00%	\$2,993.79	3,391	\$158.80
70.00%	\$2,857.68	3,652	\$294.92
75.00%	\$2,739.71	3,913	\$412.89
80.00%	\$2,636.49	4,174	\$516.11

Townwide Deployment Infrastructure Network Operations

The following table summarizes the anticipated cost structure for network maintenance and operations (M&O). This schedule produces a monthly M&O fee for the broadband utility at \$21.49 per month. The Town would need to subsidize network operations until enough scale is established to achieve sustainability.

Residential M&O	Subscriber	Monthly	Annual	Percentage
Power	\$0.99	\$3,099	\$37,187	4.61%
Co-Lo Fees	\$0.25	\$783	\$9,391	1.16%
Labor	\$7.00	\$21,911	\$262,937	32.57%
Office	\$0.41	\$1,283	\$15,401	1.91%
Vehicles	\$0.53	\$1,659	\$19,908	2.47%
Tools	\$0.15	\$470	\$5,634	0.70%
Equipment	\$0.83	\$2,598	\$31,177	3.86%
Supplies	\$0.08	\$250	\$3,005	0.37%
Dig-line	\$0.13	\$407	\$4,883	0.60%
Maintenance	\$0.83	\$2,598	\$31,177	3.86%
Call Center	\$0.25	\$783	\$9,391	1.16%
Network Operations Monitoring	\$0.25	\$783	\$9,391	1.16%
Equipment Refresh (Reserves)	\$3.12	\$9,766	\$117,195	14.52%
Licenses Fees (SaaS, Etc.)	\$2.00	\$6,260	\$75,125	9.30%
Rentals	\$0.83	\$2,598	\$31,177	3.86%
Business Insurance	\$0.08	\$250	\$3,005	0.37%
Bad Debt	\$0.31	\$970	\$11,644	1.44%
Equipment Replacement	\$0.02	\$76	\$911	0.11%
Taxes and Fees (Property)	\$0.00	\$0	\$0	0.00%
Middle Mile	\$2.00	\$6,260	\$75,125	9.30%
Reserves	\$1.43	\$4,476	\$53,714	6.65%
Total	\$21.49	\$67,281	\$807,376	100.00%



Digital Access Plan

Network Management & Operations Cost Structure

The numbers and categories in this model are derived from many years of experience with actual costs for broadband projects. Labor costs are modeled to reflect Massachusetts wages.

Staffing Modeling for Internal Network Operations

The following table models the cost structure for the positions needed for the Town of Wilbraham to operate the network as a department within the Town structure. The model is conservative in the staffing estimates needed to operate the network in a sustainable manner. The model does not include resources for construction. Assuming the Town builds the entire network over a 24-month period, the Town will need to subsidize this department for less than 30 months. After that, the investment will be paid back by operational surpluses as subscribers grow beyond the target of 3,130 subscribers. The work that will be done by a fiber network department includes network monitoring, network management, outside plant repairs, and new customer installations.

The Town has the option of operating the network with internal staffing resources or an outsource network operations partner. The following staffing model provides anticipated fully burdened salary information, years to profitability, and the revenues and expenses from the operation.

Staffing Projections			
Position	Fully Compensated Hourly Rate	Fully Compensated Monthly Cost	Fully Compensated Annual Cost
Network Admin	\$38	\$6,587	\$79,040
I.T. Technician	\$30	\$5,200	\$62,400
Outside Manager	\$28	\$4,853	\$58,240
Outside Plant Tech	\$22	\$3,813	\$45,760



Digital Access Plan

Subscriptions & Staffing Projections

Subscribers	Year 1	Year 2	Year 3	Year 4
New Subscribers	1,500	1,630	-	-
# of Subscriber at Year-End	1,500	3,130	3,130	3,130
Labor Allocation	\$7.00	\$7.00	\$7.00	\$7.00
Cash Flow from Labor	\$63,000	\$194,460	\$262,920	\$262,920
Staffing Projections	Year 1	Year 2	Year 3	Year 4
Network Admin	0.5	0.5	0.5	0.5
IT Technician	0.0	1.5	1.5	1.5
Outside Plant Manager	0.0	0.5	0.5	0.5
Outside Plant Laborer	1.0	1.0	2.0	2.0
Position	Year 1	Year 2	Year 3	Year 4
Network Admin	\$39,520	\$39,520	\$39,520	\$39,520
IT Technician	\$0	\$93,600	\$93,600	\$93,600
Outside Plant Manager	\$0	\$29,120	\$29,120	\$29,120
Outside Plant Laborer	\$45,760	\$45,760	\$91,520	\$91,520
Total	\$85,280	\$208,000	\$253,760	\$253,760
Net	-\$22,280	-\$13,540	\$9,160	\$9,160



Digital Access Plan

Project Pro-Forma

Financial Pro-Forma of Full Project Costs - 2 Year Build - Ethernet Architecture

Projected Backbone	Included
Projected Cost Per Premise (Common and Drop) ²	\$3,666
Estimated Subscribers	3,130
Total Cost (Common & Drop)	\$11,474,580
Professional Services	Included

Total Projected Project Costs **\$11,474,580**

²Assumes 80% buried / 20% aerial, 60% take-rate and short-term interest rate of 3% for 20 years.

Projected Subscription Cost

Projected Residential Services Monthly Costs **100% Aerial**

Infrastructure	\$15.41
Maintenance and Operations	\$21.49
ISP Services (Dedicated 1 GB Symmetrical)	\$9.99

Monthly Total **\$46.89**

Projected Residential Services Monthly Costs **80/20 Split**

Infrastructure	\$20.54
Maintenance and Operations	\$21.49
ISP Services (Dedicated 1 GB Symmetrical)	\$9.99

Monthly Total **\$52.02**

Projected Residential Services Monthly Costs **100% Buried**

Infrastructure	\$21.82
Maintenance and Operations	\$21.49
ISP Services (Dedicated 1 GB Symmetrical)	\$9.99

Monthly Total **\$53.30**

***Note:** The residential \$9.99 monthly ISP fee listed above is based upon current pricing from the list of ISPs interested in providing services.*



Digital Access Plan

Projected Income & Cash Flow

Timeline	Year 1	Year 2	Year 3	Year 4 +
Subscribers				
New Subscribers	1,500	1,630	0	0
# of Subscriber at Year-End	1,500	3,130	3,130	3,130
Income Statement (Revenue)				
Infrastructure Fees	\$184,855.84	\$570,588.37	\$771,465.05	\$771,465.05
Maintenance and Operations	\$193,448.25	\$597,110.27	\$807,324.03	\$807,324.03
Total Revenue	\$378,304.09	\$1,167,698.63	\$1,578,789.08	\$1,578,789.08
Operating Costs (Expenses)				
Maintenance and Operations	-\$152,498.25	-\$470,711.27	-\$636,426.03	-\$636,426.03
M&O Labor Difference	-\$22,280.00	-\$13,540.00	\$9,160.00	\$9,160.00
Equipment Refresh/Replacement	\$0.00	-\$4,095.00	-\$12,230.40	-\$31,733.52
Interest Reserve	-\$221,974.53	-\$205,549.24	\$0.00	\$0.00
Debt Service Reserve	-\$184,855.84	-\$200,876.68	\$0.00	\$0.00
M&O Reserve	-\$40,950.00	-\$122,304.00	-\$158,667.60	-\$139,164.48
Total Expenses	-\$622,558.63	-\$1,017,076.18	-\$798,164.03	-\$798,164.03
Net (Revenue vs Expenses)	-\$244,254.53	\$150,622.45	\$780,625.05	\$780,625.05
Loan Payment				
Backbone	\$0.00	\$57,354.40	\$57,354.40	\$57,354.40
Buildout	\$0.00	\$330,570.16	\$689,789.73	\$689,789.73
Total Loan Payments	\$0.00	\$387,924.56	\$747,144.13	\$747,144.13
Net	-\$244,254.53	-\$237,302.11	\$33,480.91	\$33,480.91
Cash Flow				
Capital Expenditures	-\$5,549,363.37	-\$5,138,730.94	\$0.00	\$0.00
Net Money Borrowed	\$5,549,363.37	\$5,327,886.68	\$205,549.24	\$0.00
Net	\$0.00	\$189,155.74	\$205,549.24	\$0.00
Revenue	\$378,304.09	\$1,167,698.63	\$1,578,789.08	\$1,578,789.08
Cash Expenses	-\$174,778.25	-\$484,251.26	-\$627,266.03	-\$627,266.03
Loan Payments	\$0.00	-\$387,924.56	-\$747,144.13	-\$747,144.13
Net Cash	\$203,525.84	\$295,522.80	\$204,378.91	\$204,378.91
Accrued Interest	-\$221,974.53	-\$205,549.24	\$0.00	\$0.00
Unrestricted Cash	-\$244,254.53	-\$44,051.37	\$251,260.55	\$65,214.43
Reserves				
Interest Reserve	\$221,974.53	\$205,549.24	\$0.00	\$0.00
Debt Service	\$184,855.84	\$200,876.68	\$0.00	\$0.00
Maintenance and Operations	\$40,950.00	\$122,304.00	\$158,667.60	\$139,164.48
Total Reserve	\$447,780.38	\$528,729.92	\$158,667.60	\$139,164.48
Total Cash	\$203,525.84	\$484,678.54	\$409,928.15	\$204,378.91



Digital Access Plan

Projected Capital Expenditures & Funding

Timeline	Year 1	Year 2	Year 3	Year 4 +	Total
Capital Costs					
Backbone	\$820,469.87	\$0.00	\$0.00	\$0.00	\$820,469.87
Subscriber Drops	\$1,632,231.75	\$1,773,691.84	\$0.00	\$0.00	\$3,405,923.59
Subscriber Common	\$3,096,661.75	\$3,365,039.10	\$0.00	\$0.00	\$6,461,700.85
Interest Reserve (Drops)	\$189,155.74	\$205,549.24	\$0.00	\$0.00	\$394,704.98
Interest Reserve (Backbone)	\$32,818.79	\$0.00	\$0.00	\$0.00	\$32,818.79
Total	\$5,771,337.90	\$5,344,280.17	\$0.00	\$0.00	\$11,115,618.07
Short Term Financing (Build Out)					
New Backbone	\$820,469.87	\$0.00	\$0.00	\$0.00	\$820,469.87
Retired		-\$820,469.87	\$0.00	\$0.00	-\$820,469.87
Total	\$820,469.87	-\$820,469.87	\$0.00	\$0.00	\$0.00
New Build	\$4,728,893.50	\$5,138,730.94	\$0.00		\$9,867,624.44
Retired	\$0.00	-\$4,728,893.50	-\$5,138,730.94	\$0.00	-\$9,867,624.44
Total	\$4,728,893.50	\$409,837.44	-\$5,138,730.94	\$0.00	\$0.00
Long Term Funding					
New Backbone		\$853,288.66	\$0.00	\$0.00	\$853,288.66
New Build		\$4,918,049.24	\$5,344,280.17	\$0.00	\$10,262,329.41

Financial Modeling Validation

EntryPoint consulted with a local contractor to validate its financial projections. This contractor is familiar with both existing infrastructure and the Town's geography.

The financial analysis is based on the following demographic information for the Town of Wilbraham:

- » 14,749 Residents
- » 5,217 Households
- » 7,266 Housing Units
- » Unknown Number of Businesses
- » 606.3 Residents per Square/Mile
- » 22.4 Square/Miles

The two main variables that are not known at this time that can have a material impact on project costs are 1) take-rate and 2) the cost of make-ready to access the utility poles for any aerial construction.



Digital Access Plan

Legal Structure & Financing Considerations

The legal structure for financing is organized around the following assumptions:

1. Nobody will be forced to participate as a subscriber to the network. Rather, subscription will be on a voluntary, opt-in basis.
2. Taxes will not be increased to finance the network.
3. The ongoing operation of the network must be self-sustaining and not dependent on any kind of subsidy from the Town.
4. The Town may contribute to get the network started but will be paid back over time.

Voluntary Participation – The alternative to taxing all residents is to deploy a business model that allocates network costs to voluntary participants. Allowing residents to voluntarily opt-in to network participation honors individual preferences for residents and businesses, eliminates political risk, and can increase public support for the network. This approach is less efficient and more expensive than a model that mandates universal participation. However, voluntary participation may exacerbate the digital divide.

Ongoing Operations – The Town views its roles as enabling the development and implementation of the network and may choose to either outsource or use internal resources to operate the network on behalf of Wilbraham residents. However, an important planning assumption is that the network must become self-sustaining during the first two years of operations.

Legal Authority

The Town Counsel and the Bond Counsel for the Town of Wilbraham prepared legal summaries describing the Town's authority to build, own, and operate broadband infrastructure under Massachusetts State law. The Town's Bond Counsel confirmed the findings of the Town Counsel that the Town has the authority to own and operate the proposed infrastructure.

Both legal memos point to a Municipal Light Plant as the structure under which the Town has the authority to finance, build and operate the proposed infrastructure. Wilbraham has a Municipal Light Plant in place currently which is currently under the supervision of the Board of Selectmen.

Funding Considerations

As the Town evaluates which model is optimal for Wilbraham, the following funding issues should also be considered:

Tax Non-Participants – If Wilbraham decides to pursue a municipally controlled network, an important funding question is whether the Town should pursue a General Obligation Bond to deploy broadband infrastructure ubiquitously to every premise in the Town. Today, most cities and towns do not have the



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political will or inclination to build broadband infrastructure through a funding mechanism that taxes all residents, essentially mandating participation, regardless of whether the resident chooses to participate as a consumer of network services. A Betterment is an example of this funding model.

Voluntary Participation – The alternative to taxing all residents is to deploy a business model that allocates network costs to voluntary participants. Allowing subscribers to voluntarily opt-in to network participation honors individual preferences for residents and businesses, eliminates political risk and can increase public support for the network. Allowing subscribers to voluntarily opt-in or opt-out of network participation is less efficient and more expensive than a model that mandates universal participation. Wilbraham’s Town leaders are making a recommendation to the Board of Selectmen that the Town pursue a model that allows for voluntary participation. A Municipal Light Plant structure allows for voluntary participation.



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Risk Analysis

10

***Risk Factors >
Likelihood
Impact
Mitigation***

The following is an analysis of the main risk factors facing the Town of Wilbraham as it pursues its fiber-to-the-premise deployment. Nine Risk Factors are analyzed:

1. Subscriber Churn Risk
2. Take-Rate Risk
3. Project Execution Risk
4. Equipment and Technology Risk
5. Community Engagement Risk
6. Cost Modeling Risk
7. Timeline Risk
8. Regulatory Risk
9. Middle Mile Risk
10. Pole Attachments & Make Ready

Subscriber Churn Risk

Subscriber Churn is the risk that customers sign up and then do not remain subscribers to the network.

Likelihood: Today customers are primarily driven by cost, speed, and customer service. Churn is possible and is a consequence of the customers pursuing an option to get better value from an alternative solution. The likelihood of churn is high if a new market solution simply replicates the incumbent model. The likelihood of churn goes down under a business model where 1) the customer is financially responsible for the drop to their property and 2) the value proposition is strong enough to make the customer voluntarily commit to the network.

Impact: The impact of churn on the network is potentially catastrophic if it reaches a level where the capital and operational cost of the abandoned infrastructure cannot reasonably be shared by remaining subscribers.

Mitigation: Churn can be mitigated by implementing a business model that makes customers voluntarily committed to the network and by assigning financial responsibility to customers for their lateral connection.

Take-Rate Risk

Take-Rate Risk is the risk that the Town builds out the network and ends up with a lower take-rate than expected.



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Likelihood: Take-rate risk is possible and is a function of the value proposition of the network and how well that value proposition gets communicated and managed before construction starts. High take-rates lead to lower network costs for subscribers. This creates a virtuous cycle where lower costs lead to higher take-rates. The reverse is also true.

Impact: The worst-case scenario is one where lower take-rates lead to higher costs and churn which create a death spiral that negatively compounds until the network is not sustainable.

Mitigation: Manage demand aggregation before construction begins and give consumers a value proposition that makes them voluntarily committed to the network infrastructure.

Project Execution Risk

Project Execution includes strategy, planning, project management and fulfillment of the project plan and operational execution.

Likelihood: Project execution failure is possible and is a function of the effectiveness of project planning, management, controls, and execution.

Impact: The severity of impact is in proportion to the effectiveness of project management and execution. A worst-case scenario is one where project execution affects the value proposition, which in turn affects take-rate and churn.

Mitigation: Hire or partner with skilled project managers and key strategic partners. Create alignment among key team members on the project plan and operational plan. Develop project controls that are monitored and reported to senior leadership monthly.

Equipment & Technology Risk

Equipment & Technology Risk includes software and hardware solutions and is the risk that equipment failure rates are higher than expected, major software bugs are unresolved, operational reliability is lower than expected, and/or that the technology lifecycle leads to faster obsolescence than is expected.

Likelihood: Solutions with short deployment histories, unreliable references, unclear quality control and test procedures, weak professional teams, and poorly architected scalability abstractions present increased equipment and technology risk.

Impact: The impact of this risk category is moderate because it is possible to vet both software and hardware systems to assess this risk. The base technology of the network will be fiber-optic cable and that has sufficient history to present a minor risk to the project. Remaining risks include electronics and software systems.

Mitigation: Implement thorough due diligence processes with trained professionals to scrutinize references, architecture, software abstractions, quality control systems and the professional histories of vendors being considered.



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Community Engagement

Community Engagement is the marketing, education, and communication processes and strategies used to inform residents and businesses about the value proposition offered by the network.

Likelihood: Community engagement risk is possible but nonetheless a risk that can be managed and monitored. Poor planning, management, and execution increases the level of risk. Community engagement can be handled by internal Town staff, but the risk increases if staff member resources are inadequate for a project of this size. There is an abundant supply of marketing professionals available to assist with community engagement processes.

Impact: Community engagement is a key driver of project success due to the relationship between community engagement and take-rate.

Mitigation: Leverage the skills of competent marketing professionals and provide sufficient resources to make it easy for every resident to learn the basic value proposition for the network in comparison to alternatives through a variety of marketing, education, and communication strategies.

Cost Modeling Risk

Cost Modeling Risk is the risk that cost modeling significantly underestimates the actual design, construction, and/or operational costs.

Likelihood: There is enough industry data to reasonably validate cost estimates.

Impact: Cost overruns can have a moderate to disastrous impact on network sustainability.

Mitigation: Validate financial assumptions against industry assumptions, market conditions, and account for local economic variables. The clearest way to mitigate this risk is to conduct an RFP process for network engineering and construction.

Timeline Risk

EntryPoint consulted with a local contractor. They indicated that they believe a Townwide network can be constructed in 12 – 24 months, depending on the underground to aerial construction. The benefits of building the network in an accelerated pace include the following:

- 1) Building the network with fewer phases will lower the overall transaction costs for the project.
- 2) Building at a faster pace will result in an accelerated period to breakeven.
- 3) An accelerated timeline reduces the potential for unexpected movement in interest rates.

Likelihood: Costs are certain to be higher for an extended buildout period. However, there may be execution risks for accelerating the buildout, depending on the experience and capacity of the construction partner, and these trade-offs need to be weighed by Town leaders.



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Impact: Costs will be incrementally higher for an extended buildout schedule and M&O will have a longer ramp to sustainability.

Mitigation: The Town can control the buildout schedule following a cost / benefit analysis of the options. An important consideration is alignment with construction partners. If the Town is going to outsource construction, it should consult with potential construction partners about the alternative construction schedules to make sure that the Town's strategy is amenable to key construction partners.

Regulatory Risk

Regulatory Risk is the risk that state or federal regulations become an impediment or barrier to the Town successfully building or operating a municipal network. Legal counsel has provided a memo to the Town addressing legal authority under Massachusetts State Law.

Likelihood: Historically, incumbent operators have taken legal action to stop a municipality from building a competing network. According to Town Counsel and Bond Counsel, Massachusetts State Law provides explicit authority for the Town to own and operate a fiber network as a Municipal Light Plant. This makes the likelihood relatively low.

Impact: If a claim were to be brought against Wilbraham, the likely process is that it could take an extensive amount of time and some cost to contest the claim.

Mitigation: According to Town and Bond Counsels, Massachusetts State Law provides explicit authority for the Town to own and operate a fiber network as a Municipal Light Plant.

Middle Mile Risks

Middle Mile risks include the following:

- 1) Lack of redundant options on divergent paths,
- 2) Pricing risk, and
- 3) The risk of being stranded or isolated without a viable path to an internet exchange point.

Likelihood: The closest internet exchange points are in Boston and Providence. Wilbraham does have divergent middle mile path options to Boston via middle mile providers already identified.

The risk of getting isolated or cut off from internet access is possible but has a low likelihood of occurring.

Impact: The most likely risk for Wilbraham is the lack of divergent paths back to Springfield.

Mitigation: The Town can mitigate and possibly eliminate middle mile risk by working with multiple middle mile carriers establishing connections into Springfield, which then opens up divergent paths to Boston, Hartford, and Albany. The risk will have to be measured against the cost of redundancy.



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Pole Attachment & Make Ready Risk

This is the risk that pole owners cause unexpected and significant impact on costs or timeline due to delays in make ready and pole attachment work if the Town has some or significant aerial construction. In a 2018 national survey, wired pole attachments had a mean rate of \$17.58 and a median rate of \$15.56.

Source: [ad-hoc-committee-survey-04242018.pdf \(fcc.gov\)](https://www.fcc.gov/record/ad-hoc-committee-survey-04242018.pdf)

Likelihood: Because Wilbraham does not own the utility poles within Town limits, this risk is a potential problem and will have to be actively managed if the Town pursues a full or partial aerial deployment.

Impact: Make-ready work for pole attachment can have a meaningful impact on costs and on the timeline if the pole owners drag their feet or want the Town to replace old poles.

Mitigation: The Town can mitigate this risk by putting fiber infrastructure underground where possible, and by assigning a project manager to actively manage the make ready work.



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Next Steps

The objective of this section is to provide a roadmap to Town leaders for actions to take once the initial Digital Access Plan is complete. Town leaders must be aligned with the vision for the overall project to be successful.

Current Strategy

The growing number of municipally owned networks is a response to the misalignment between private incentives and the essential nature of access in modern society. Incumbent operators have been free to establish most of the rules governing their infrastructure and services, including service levels, maintenance standards, network reinvestment, and service territories. Alternatively, public entities are perfectly positioned to be a neutral host of fiber-optic infrastructure organized to enable competition and lower costs.

THE IMPORTANCE OF STRATEGY

As state and federal grant opportunities evolve, municipalities are positioning themselves as favorably as possible to attract funding into their jurisdictions to enable meaningful change.

Three key questions will provide direction to subsequent phases of the decision-making process. These require careful consideration before endorsing a specific implementation model for expanding broadband access.

KEY DECISIONS

- 1) **Ownership / Control:** Decide the degree to which the Town wants to control or influence the outcomes it desires for digital access.
- 2) **Governance:** Determine the governance structure that is appropriate to advance the Town's objectives.
- 3) **Business / Operational Model:** Decide whether a vertically integrated (single ISP) or an open access model aligns with the Town's objectives.

KEY DECISION #1: INFRASTRUCTURE OWNERSHIP

Wilbraham's proposed digital infrastructure will be owned by a private company, a public entity (the Town), or a hybrid private-public partnership (PPP). Each of these is explained below.

Private Network Ownership

The easiest course for a town is to do nothing and allow private companies to continue to own and operate internet infrastructure. Private companies who own the infrastructure dictate which business model is used and typically select a model to maximize the company's return on investment rather than emphasizing public benefit. The dominant model used by most providers in the industry is a vertically integrated model with a single service provider operational model where consumers have access to privately owned infrastructure supporting one provider's services.



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Figure 1: The Existing Deployment and Operation Model



A single internet service provider often dominates rural areas because costs are higher due to greater distances and a lack of density. Consumers may have access to multiple internet service providers in denser urban areas. Still, these entities compete through facilities-based competition—by building siloed infrastructure that they use exclusively.

Public Network Ownership

Public ownership of network infrastructure can produce many tangible benefits for individuals and communities. Public owners have greater incentives to solve the digital divide. Costs can be lower if the network is operated as a non-profit enterprise and the public entity increases competition through an open access system. It is more likely that the Town is aligned with residents on what they want from the network (e.g., low cost, high reliability, abundant bandwidth) than a third-party owner. Third-party owners will always be motivated first by the survival of their organization (e.g., profits, financial reserves), while the Town's focus is on making the system self-sustaining and adding value. The Town also has much broader and different interests related to broadband infrastructure. These include economic development, livability, public safety, education, healthcare, emergency communications, smart grid, efficient government services, environmental stewardship, universal access, and smart city applications. All these things are now network-dependent, and the value from the network to the Town aligns perfectly with the interests of constituents who subscribe to the network.

Figure 2: Municipal Infrastructure Ownership and Operation Model



Additionally, the public entity will not have to get permission or incur new expenses whenever it wants to connect the network to a new service or application. Furthermore, public ownership of the network will allow the Town to optimize the network for local needs rather than organizing the operation to serve a national market.

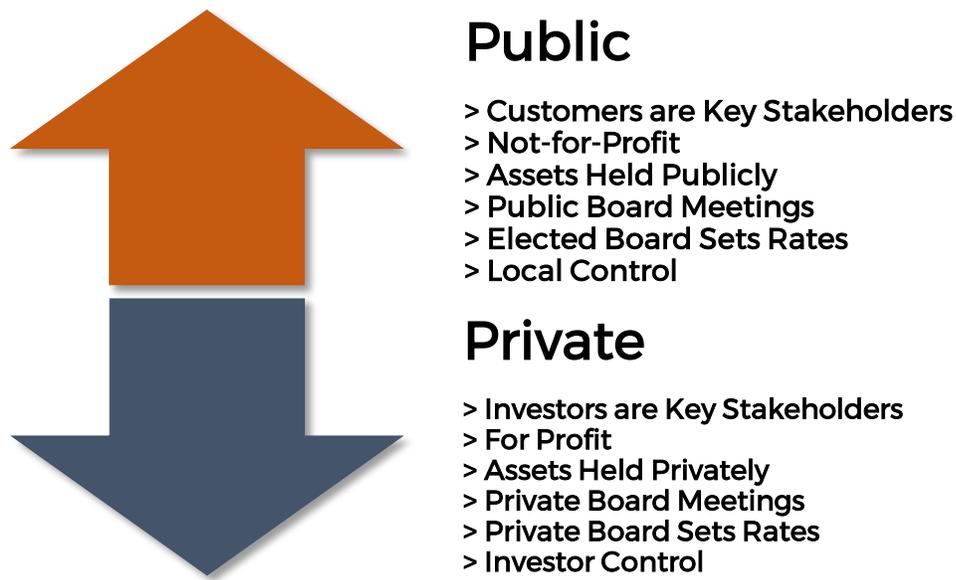


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Locally owned public infrastructure protects the community from a private owner operating as an unregulated monopoly or selling the network to a monopoly operator. It also makes the network operator accountable to subscribers via an election cycle where subscribers are empowered to influence outcomes. Finally, the network will have significant value once it is built. The local community can share that value.

The figure below summarizes some differences between privately owned and publicly owned infrastructure.

Figure 3: Public vs. Private Broadband Models Summary



Hybrid Ownership and Operations

Figure 4: Hybrid Deployment and Operation Model



Hybrid ownership and operational models are emerging but are now in their infancy. An example of this model is a special purpose entity or special purpose vehicle (SPV). An SPV is a legal entity established to separate an asset, subsidiary, or financial transaction from a larger corporation or government agency. These are typically created to help isolate risk in a transaction or manage the risks associated with the development of an asset. A special purpose entity can also be established for collaborations between a government agency and a privately owned company via a public-private partnership (PPP).



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An SPV may be a politically acceptable vehicle for managing risk for infrastructure projects. It can help local governments complete projects sooner since the private company may have the resources needed to complete an infrastructure project and may be less encumbered by public sector operational processes. SVPs can vary based on their founding legal and financial agreements. The specific role can be unique to the partnership between the government agency and the private entity.

Ownership Decision Making

The following guidelines may be helpful to the municipality as its leaders determine whether private, public, or hybrid ownership is right for them.

1. If the Town's key priorities are to limit ownership and operational responsibilities and is willing to forgo any level of control or ownership, then pure private models should be given favorable consideration.
2. If the Town's broadband goals include universal access for all residents and reliable digital access to providers and services, models that provide for public or hybrid ownership of the local infrastructure should be given favorable consideration.
3. If long-term municipal funding is available for construction of broadband facilities through a revenue bond or property assessment vehicle, then models that provide for public ownership of the local infrastructure should be given favorable consideration.
4. If the Town desires to limit ownership and operational responsibilities but would like to maintain some level of control and the possibility of future public ownership, then hybrid models should be given favorable consideration.
5. If the Town desires to facilitate a shift away from facilities competition to competition among service providers, then public or hybrid ownership should be given favorable consideration.

KEY DECISION #2: GOVERNANCE MODEL

Governance includes the statutory frameworks that define what is possible and not possible for a town that seeks to own and operate this infrastructure and the policies and operational processes that a town imposes on itself, third-party partners, and subscribers.

The State of Massachusetts allows the municipality to own, operate, and function as an internet service provider if desired.

The following information outlines statutory and non-statutory governance considerations as the Town determines how it would govern the infrastructure and services. The ownership and business model strategies the Board of Selectmen selects to increase broadband access will narrow the options for the governance structure. For instance, some structures will be more suitable for municipally owned infrastructure, while others will better support privately owned infrastructure.

If the Town pursues a hybrid ownership model, governance will be specified in the agreement between the parties.



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STATUTORY COMPARISON

The following is a summary of the two primary governance structures available to cities and towns in Massachusetts. The town should seek legal advice to determine which structure is best for its funding and operational strategy.

CONSIDERATION	ENTERPRISE FUND	MUNICIPAL LIGHT PLANT (MLP)
MGL specifically allows operation of fiber-optic utility	No	Yes
Books and audit	Accounts are separate from general fund but still within Town books and audited with Town accounts	Separate set of books; audited separately from Town accounts
Budget approval, including use of business income	Board of Selectmen	MLP manager under the direction of the MLP board
Long-term contract approval	Board of Selectmen	MLP manager under the direction of the MLP board
Depreciation reserve	Held within enterprise fund accounts under control of the Board of Selectmen	Held within MLP accounts under control of MLP manager and MLP board
Income and expenses	All gross income and expenses must be entered into accounts	May subcontract out to Coop or third-party and only include net income in books
Budget approval, including use of business income	Board of Selectmen	MLP manager under the direction of the MLP board
Long-term contract approval	Board of Selectmen	MLP manager under the direction of the MLP board
Regulation / Oversight	DLS, however, G.L.c. 25C, § 6A prohibits regulation of internet and VOIP	Normally DPU or DTC, however, both declined, citing that G.L. c. 25C, § 6A prohibits regulation of internet and VOIP

OTHER CONSIDERATIONS

The following considerations may be relevant to the Town’s governance decision-making.

Maximizes Funding Opportunities

Successful models can draw from multiple funding sources that maximize opportunities, including the ability to apply for state and federal grants and loans and leverage other funding mechanisms such as bonds should be given critical consideration.

Long-Term Stability

The long-term stability of the selected model is essential. Sustainable and predictable long-term outcomes are critical when selecting the preferred model(s).



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Required Authorities

The legal authorities of the selected model are critical. The ability to carry out the required actions must be explicitly provided in statute to avoid legal challenges and the financial losses they incur.

Risk Mitigation

Each model has a level of risk associated with a combination of unique participants. Risks related to the various models include subscriber churn (when customers stop using a reoccurring service), take-rate (percent of the available market that subscribes to a service), technology, community engagement, cost models, timeline, and design risks depending on the model.

Flexibility

Models with flexible statutory requirements have implementation advantages over more rigid models. Short-term flexibility can provide the ability to change and adapt as needed or desired resulting in better outcomes than less flexible models.

Required Initial Investment

Some models can achieve sustainable outcomes with minimal investment(s). This will have the effect of minimizing risks while at the same time creating a safety net for future investments.

Implementation Simplicity

Models that reduce implementation complexity related to design, installation, maintenance, and operation will improve efficiencies and result in more successful outcomes.

Cross-Jurisdictional Collaboration

The digital divide is agnostic to borders. In many cases, having a model that allows for regional collaboration is beneficial. The ability to encourage and develop regional consensus should be considered in determining effective governance models. Regional project paths require that projects can span across unincorporated and incorporated territories. Some models natively have this ability, while others will require a combination of two structures to provide regional project paths. Regional projects will require stakeholder consensus, influencing the Board of Selectmen's ability to affect regional outcomes.

POLICY & OPERATIONAL CONSIDERATIONS

Opt-In (Voluntary Participation)

Will residents be able to voluntarily participate, or will the infrastructure be treated like other utilities where connection to the infrastructure is mandatory? Voluntary participation is more politically tenable.

Billing

Does the Town have other utility billing processes, and can broadband be added to those mechanisms? If not, how will billing be handled for the capital cost, the maintenance and operations cost, and the ISP services? Also, how will billing be handled for residents that may not have a banking relationship or are not connected to modern digital financial transaction systems?



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Treating the Infrastructure as an Improvement to Property

When a resident connects to municipal water, sewer, or other utility infrastructure, the connection is treated as an improvement to the property. The resident is obligated to pay off the infrastructure upfront or overtime. However, the incumbent facilities-based competition model does not impose a commitment to the infrastructure.

Customer Premises Equipment

It is common for the initial cost of the equipment that goes into the customer’s home to be included in the initial capital cost. Will the replacement cost of that equipment be the customer’s responsibility, or will it be financed through the maintenance and operations budget?

Customer Support

If the Town pursues an open access model, how will support be handled to minimize frustration for the subscriber?

KEY DECISION #3: OPERATIONAL MODEL

Choosing the right operational model depends on the roles of the market participants in the broadband value chain. For this report, three possible roles are in focus:

1. The Physical Infrastructure Provider
2. The Network Operator
3. The Service Provider(s)

Different business models arise depending on which roles the market participants take within the operational model. The following summarizes key considerations for important network attributes for the main operational models.

Model → Attributes ↓	Vertically Integrated	Dark Fiber Leasing	Manual Lit Fiber	Automated Lit Fiber
Ownership	Same entity owns the infrastructure, operations, and services	A neutral host owns and operates the infrastructure to the curb; the ISP owns the drop	A neutral host owns and operates infrastructure but does not own services	A neutral host owns and operates infrastructure but does not own services
Closed vs. Open	Infrastructure is closed to outside service providers	Mixed—the backbone is open; the drop is closed	Infrastructure is open to outside service providers	Infrastructure is open to outside service providers
Retail vs. Wholesale Services	A single ISP is offered on a retail basis	Multiple ISPs are offered wholesale	Multiple ISPs are offered wholesale	Multiple ISPs are offered wholesale
Bundling of Roles – Are the three primary roles separated?	All three roles are bundled together—vertically integrated	Mixed	Ownership and operation of the infrastructure is	All three roles are unbundled



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			unbundled from the services	
Neutral Host	No	Mixed—the backbone is owned by a neutral host; the drop is owned and operated by the service provider	Yes	Yes
Facilities-Based Competition vs. Services-Based Competition	Facilities-Based Competition	Mixed—backbone network is open to multiple services; the drop is not open	Services-Based Competition	Services-Based Competition
Provisioning	The owner / operator manually provisions services	The service provider manually provisions services	The operator manually provisions services	The subscriber provisions services via automation
Virtualization	Each service requires a physical fiber	Each service requires a physical fiber	Each service requires a physical fiber	Many services can be delivered across a single fiber strand
Multiple Services Simultaneously	One service at a time	One service at a time	One service at a time	Multiple services at a time
Hardware-Defined vs. Software-Defined	Hardware	Hardware	Hardware	Software
Examples	Comcast, Charter, AT&T, Frontier, Verizon	Huntington, AL, Westminster, MD	Utopia SiFi Networks	Ammon, ID, Chico, CA, Eagle, ID, Mountain Home, ID

Definitions

Ownership: Digital infrastructure will be owned by a private company, a public entity (the Town), or a hybrid private-public partnership (PPP).

Closed vs. Open: Open access combines a business model and architecture that creates a single shared infrastructure operated by a neutral host, which gives service providers open, wholesale access at fair, reasonable, and equal terms. A town is perfectly positioned to function as a neutral host. **Closed** infrastructure does not allow outside service providers onto the infrastructure. This results in a single ISP offering with facilities-based competition.

Open infrastructure allows for third-party service providers which typically leads to services-based competition.

Facilities-Based Competition: Industry incumbents always follow a facilities-based model. This means that every service provider is required to construct their exclusive infrastructure to compete in a market. This increases the barriers to entry, puts more infrastructure in crowded infrastructure channels, and results in higher consumer costs. Incumbent industry models almost follow a vertically integrated model with single ownership for the infrastructure and services offered to end users.



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The alternative to facilities-based competition is services-based competition. This occurs when service providers compete on a single shared infrastructure, preferably owned, and operated by a neutral host that treats all service providers equally. An important goal of a neutral host should be to lower the barriers to entry to accelerate competition.

Provisioning: The provisioning of new services can either be done by the network owner/operator, the service provider, or the subscriber. The concerns for the subscriber include whether alternative services are available, how long a new service takes to be provisioned, and whether an appointment with a technician is required.

Virtualization: A technical term that describes using software to separate traffic to enable more than one service to be delivered across a single fiber strand. Virtualization is commonly used in data centers but is less common in fiber-to-the-home networks.

Multiple Services Simultaneously: A virtualized network can deliver multiple services simultaneously. A network that is not virtualized will not be able to deliver more than one service at a time. This capability will grow in importance as smart city applications gain traction.

Retail vs. Wholesale Services: The infrastructure is available to all market participants under equal conditions in an open access network. This requires a neutral party rather than a service provider to own and operate the infrastructure.

Bundling of Roles: If one market participant takes or bundles all three roles, it functions in a vertically integrated model. Unbundling or separating the three primary roles (infrastructure, operations, and services) is an enabling requirement for a true open access network. It is necessary to optimize the functionality and cost of each role. Unbundling allows the infrastructure to be operated by a neutral party (neutral host). The unbundling of roles does not necessarily result in the unbundling of subscriber costs. Establishing a clear separation of roles and responsibilities within the operational model requires successfully unbundling subscriber costs.

Hardware vs. Software-Defined Management: The distinction between hardware defined and software-defined is an emphasis on how resources are pooled and managed. For the subscriber, this translates into key concerns like how long it takes to make needed network changes, the cost for these changes, and whether the subscriber is captive to a single hardware vendor. In general, it is faster and less expensive to make changes in software than in hardware and a software defined network can be liberated from vendor lock-in.

Operational Model Summary

In January 1999, the City of Portland, and Multnomah County, Oregon, filed a lawsuit to block AT&T's acquisition of a local cable network. Oregon public officials said they would approve the transfer if AT&T agreed to open its broadband assets to competition. The 9th U.S. Circuit Court of Appeals ruled that providing high-speed internet access is very different from the cable television business and should not be subject to the same set of regulations, and AT&T and other large incumbents were not required to open their existing infrastructure to competing service providers.



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One result of this ruling has been a gradual decrease in regulations over telecommunication services over time. Another result has been that the vertically integrated model became entrenched as the de facto internet access model because legacy cable and telephone companies had the enormous advantage of existing infrastructure that could deliver the internet to the public. Spectrum, Verizon, and Granite operate in Wilbraham under this model.

The inherent limitation of the single provider model is that it gives customers few choices and naturally trends toward monopoly control for the provider that can offer the greatest bandwidth. Alternatively, open access networks are growing in popularity for public infrastructure owners because the model improves choice, competition, and affordability and works in rural and urban settings.

The most advanced open access networks support multiple service providers delivering services simultaneously over the network. End users can freely view the services and their associated costs and subscribe at any time. Service providers can create new categories of services, and subscribers can easily subscribe to them via an online marketplace without assistance. Additionally, the implementation is in software and can support rapid change and integration. The introduction of network automation enables self-service provisioning for stakeholders and creates a more open environment, improving adoption and reducing costs.

Source: <https://www.lightreading.com/qiqabit/fttx/debunking-the-open-access-myths/a/d-id/720514>

Identifying Service Providers

Identifying the best fit for service providers will depend on the ownership and operational models selected. Finding service providers will not be difficult regardless of the model selected, but the chosen partners should align with operational objectives.

Federal Policy and Opportunities

Numerous federal programs have demonstrated a clear preference for open access fiber.

The Reconnect Loan and Grant Program will not fund legacy copper or wireless systems, only fiber by listing a requirement for 100 Megabits symmetrical service. The program awards extra points for applications meeting public ownership and open access requirements.

Source: <https://www.usda.gov/reconnect>

The recent NTIA Middle Mile Grant Program was open to public entities, also requiring fiber and favoring open access in scoring.

Source: <https://broadbandusa.ntia.doc.gov/sites/default/files/2022-05/MIDDLE%20MILE%20NOFO.pdf>

NTIA's Broadband Equity, Access, and Deployment Program (BEAD) will open to applications from public entities, prioritizing the deployment of fiber and encouraging scoring that favors open access on the part of the state offices overseeing the application and award processes. For example, can be used to extend broadband service to multi-tenant buildings lacking high speed broadband, including those in low-income, urban areas. As part of their goal of broadband deployment to all unserved and underserved locations, Eligible Entities may fund deployment of Wi-Fi infrastructure to multi-family buildings that either entirely or partially lack high-speed broadband access (100 / 20). Eligible Entities must give priority to residential building that (1) have a substantial share of unserved households or (2) are in locations in which the



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percentage of individuals with a household income at or below 150 percent of the poverty line applicable to a family of the size involved is higher than the national percentage of such individuals.

Source: Page 41 – <https://broadbandusa.ntia.doc.gov/sites/default/files/2022-05/BEAD%20NOFO.pdf>

Formalize the Selection of an Operational Model

There are downstream architecture and business plan decisions that require model selection. This makes selecting the operational model an important next step for Wilbraham. This will require stepping through the formal process of presenting the options outlined in this report to the broader committee and Town leaders, providing technical support to inform the decision-making process. The final selection should be memorialized in the meeting minutes and properly documented to inform the procurement process that will follow.

BEYOND THE THREE KEY DECISIONS

Business Model RFP

Once Town leaders have decided on a preferred direction for (1) ownership, (2) governance, and (3) business model, we recommend conducting a public process (request for proposal (RFP), request for information (RFI), or request for qualifications (RFQ)) to select a solution partner for the selected business model. Whether the Town is pursuing a single ISP model or an open access model, this is an appropriate next step because the partner needs to advise the Town on network design, network architecture, equipment selection, quality control on construction, provisioning and turn-up of network electronics, selection of other key partners, and general project oversight. It will be appropriate to organize the RFP to identify a solution partner for the implementation of the business model as the owner's representative for the overall project.

It is important to select a partner with the demonstrated technical expertise necessary to guide and manage downstream procurement processes with the Town's oversight and approval.

Additional Procurement

Once selected, the business model partner can assist with organizing the specifications and solicitations for a public process (request for proposal (RFP), request for information (RFI), or request for qualifications (RFQ)) for the following:

- **Assume or Procure the Network Operator Role**

If Wilbraham selects an operational model where it will assume the network operator role, clear responsibilities will need to be assigned, and resources will need to be allocated within Wilbraham to establish the workforce and expertise necessary to perform network architecture, oversee design, select materials and equipment for cost modeling, and so forth.

If network operations are outsourced to a third-party, selecting a partner with the demonstrated ability to support the desired operational model and business plan at this stage is critical to achieving desired outcomes. The technical and economic ability to deliver desired functionalities will be directly related to the network provider's capabilities. Procuring this partner will be required to complete applications for state, federal, or private funding.



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- **Design / Engineering RFP**

Select a design / engineering firm. The design process includes developing construction-ready plan documents, refining cost modeling based on network design, and initiating the make-ready process for utility pole attachments for aerial portions of the network.

- **Materials RFP**

Provide technical assistance in organizing a solicitation for network materials.

- **Construction RFP**

Select a design / engineering firm and help prepare the technical specifications for the construction work

- **Project Management**

The business model partner will need to provide high-level project management for the project, but will not be onsite daily to manage timelines, project milestones, and work schedules to name a few. If the Town is going to handle project management internally, the business model partner can be an advisor to assist internal project leadership. If the Town outsources project management, the business model partner can assist in organizing the specifications for a public process (request for proposal (RFP), request for information (RFI), or request for qualifications (RFQ)) to select a project management partner and then collaborate with that partner throughout the construction process.

Key project management skills and knowledge may include, but are not limited to:

- Managing fiber-optic projects and budgets, directing construction in accordance with the approved design, and coordinating work with other staff and design team members.
- Interfacing with Town staff, participants, and local government officials.
- Reviewing project design as needed and coordinating adjustments to support constructability and budget outcomes.
- Reviewing work products, quality control, and budgeting.
- Mentoring, developing, and supervising staff.
- Providing core project management functionality.

Project Budget

Developing a budget that can be trusted requires a process of moving from projected costs to hardened costs. This process includes a collaboration between Town staff, the business model partner, and the engineering / design partner working together to develop a construction-ready design. This construction-ready design will be the basis for the construction RFP. The design will be refined once a construction partner is selected., Still, the construction-ready design should be 98% accurate.



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Phasing

The business model partner can assist with refining the phasing options being considered and provide financial analysis on these options. The primary phasing decision will be whether to build as quickly as possible or pursue an extended process which may be necessary due to internal constraints. Potential internal considerations specific to Wilbraham may include:

- Leveraging planned road construction of Town water system and install conduit.
- Leveraging planned sidewalk construction of Town water system and install conduit.
- Building in conjunction with other large construction or public works projects in Wilbraham.
- Strategically selecting neighborhoods most impacted by affordability constraints.

The Town can do aerial or underground and is expressing a preference for a buried network, initially using conduit placement in conjunction with ongoing public works projects.

Work with State Agencies to Streamline Processes

Multiple touchpoints with various state offices and authorities represent opportunities for improving outcomes for potential network subscribers. These include procurement, regulatory, and financing processes. The Massachusetts Broadband Institute (MBI) could become a helpful partner in advancing these initiatives. The Town should work with state agencies to improve processes for at least the following processes and functions:

- Create a procurement vehicle that municipalities could use to qualify bidders.
- Provide structural advocacy and technical assistance in procurement, so municipalities aren't duplicating efforts and competing for limited resources.
- Pursue legislation to expand the statutory tools available to cities and towns to build municipal networks.
- Review and guide RFP documents.



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Glossary

Industry Terms and Abbreviations

Term	Description	Definition / Narrative
Aerial	Fiber-optic network cables installed on existing utility poles	Aerial fiber deployments are one of the most cost-effective methods of installing fiber cables. Rather than trenching and/or boring for underground installations, operators can simply use existing pole infrastructure to deploy the cables.
Asymmetrical	Broadband download and upload speeds are not the same	An asymmetrical connection does not have equal download/upload speeds. For example, 60 / 3 means 60 Mbps download and 3 Mbps upload speed.
Bit	Binary digit	The most basic unit of data in telecommunications and computing. Each bit is represented by either a 1 or a 0 in binary code.
Buried	Fiber-optic network cables installed underground in conduit	Buried fiber deployments, unlike aerial, are protected from weather damage by being buried below the freezing point in the ground.
Microtrenching	Fiber strands in conduit are placed in a 2"-3" wide trench that is usually cut in asphalt roadways or sidewalks.	Microtrenching is a fiber network construction technique that lays the protective conduit that houses the fiber strands below and at the side of a roadway. It requires much less digging and much less disruption than other network building methods.
Digital Divide	Digitally unserved and/or underserved neighborhoods and/or demographic - typically lower-income and rural communities	The gulf between those who have ready access and affordability to the internet, and those who do not.
DOCSIS	Data Over Cable Service Interface Specification	An international telecommunications standard that permits the addition of high-bandwidth data transfer to an existing cable television (CATV) system.
DSL	Digital Subscriber Line	A technology for the high-speed transmission of digital information over standard phone lines.
Fiber	Fiber-optic	Thin flexible fibers with a glass core through which light signals can be sent with very little loss of strength.
Gb or Gig	Gigabit = 1,000,000,000 bits or 1,000 megabits	A unit of information equal to one billion (10 ⁹) or, strictly, 2 ³⁰ bits.
Gbps	Gigabits per second	Billions of bits per second.
GHz	Gigahertz	One billion hertz, especially as a measure of the frequency of radio transmissions or the clock speed of a computer.



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Internet Exchange Point	IXPs or IXes or internet exchange hotel	Internet exchange points (IXes or IXPs) are common grounds of IP networking, allowing participant internet service providers (ISPs) to exchange data destined for their respective networks.
ISP	Internet service provider	A company that provides subscribers with access to the internet.
K or Kb	Kilobit(s)	A unit of computer memory or data equal to 1,024 (2 ¹⁰) bits.
Mb or Meg	Megabit = 1,048,576 bits	A unit of data size or network speed, equal to one million or 1,048,576 bits.
Mbps	Megabits per second	Millions of bits per second.
MHz	Megahertz	One million hertz, especially as a measure of the frequency of radio transmissions or the clock speed of a computer.
Middle Mile	Middle mile communications provider	In the broadband internet industry, the "middle mile" is the segment of a telecommunications network linking a network operator's core network (central office) to the nearest internet aggregation point.
mLAB	Measurement lab	M-Lab provides the largest collection of open internet performance data on the planet.
NTIA	National Telecommunications and Information Administration	NTIA is the Executive Branch agency that is principally responsible for advising the President of the United States of America on telecommunications and information policy issues.
PON	Passive optical network	A passive optical network, or PON, is designed to allow a single fiber from a service provider the ability to maintain an efficient broadband connection for multiple end users.
Symmetrical	Broadband download and upload speeds are the same	A connection with equal download and upload speeds. For example, with a 500 / 500 Mbps fiber internet connection you get 500 Mbps of download AND 500 Mbps of upload speeds.
Take-Rate	The percentage of subscribers in a network	A tabulation of broadband penetration rates. The calculation is determined by dividing the number of subscribers by the total number of potential subscribers in a network footprint.
Tbps	Terabits per second	Trillions of bits per second.
8K Video	Ultra-high-definition video	Television resolutions of 7,680 pixels horizontal x 4,320 pixels vertical.

Open Access Network Terms

Term	Description	Definition / Narrative
Backbone	Shared fiber infrastructure from aggregation point to network operations center	The backbone fiber runs from an aggregation hut back to the network operations center.
Common	Shared fiber infrastructure from drop to the closest aggregation point	The common is the shared fiber infrastructure in a neighborhood that runs from a drop to the closest aggregation hut.



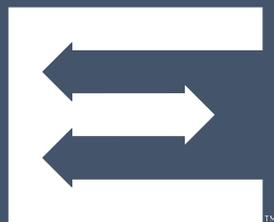
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Drop	Segment of the fiber network from the street into the home or business	Drop is the fiber that runs from the street to the premise (home or business).
Middle Mile	Shared fiber infrastructure from the network operations center to the internet exchange point	The middle mile is usually third-party fiber that runs from the network operations center to the closest internet exchange point. The cost of the middle mile is included in the monthly M&O utility fee and is borne by all network subscribers.
Network Operator	Department or company that manages the network physical infrastructure	The organization that manages the network physical infrastructure on a day-to-day basis. The network operator may or may not be the owner of the physical network infrastructure.
Service Provider	A company that offers services to consumers on the network	A company or organization that offers services (ISP and other) over the open access physical network infrastructure.
Subscriber	A customer/consumer on the network	Household or business that participates as a subscriber on the network.

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