Makanda Township

Digital Access & Equity Plan

January 2023

Makanda Township

Digital Access & Equity Plan

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Vision Statement

Vision Statement

The Connect Makanda Township Committee was established with the goal of bringing state-of-the-art fiber optic network infrastructure to all Makanda Township's residents and businesses—improving lives and opening new economic opportunities.

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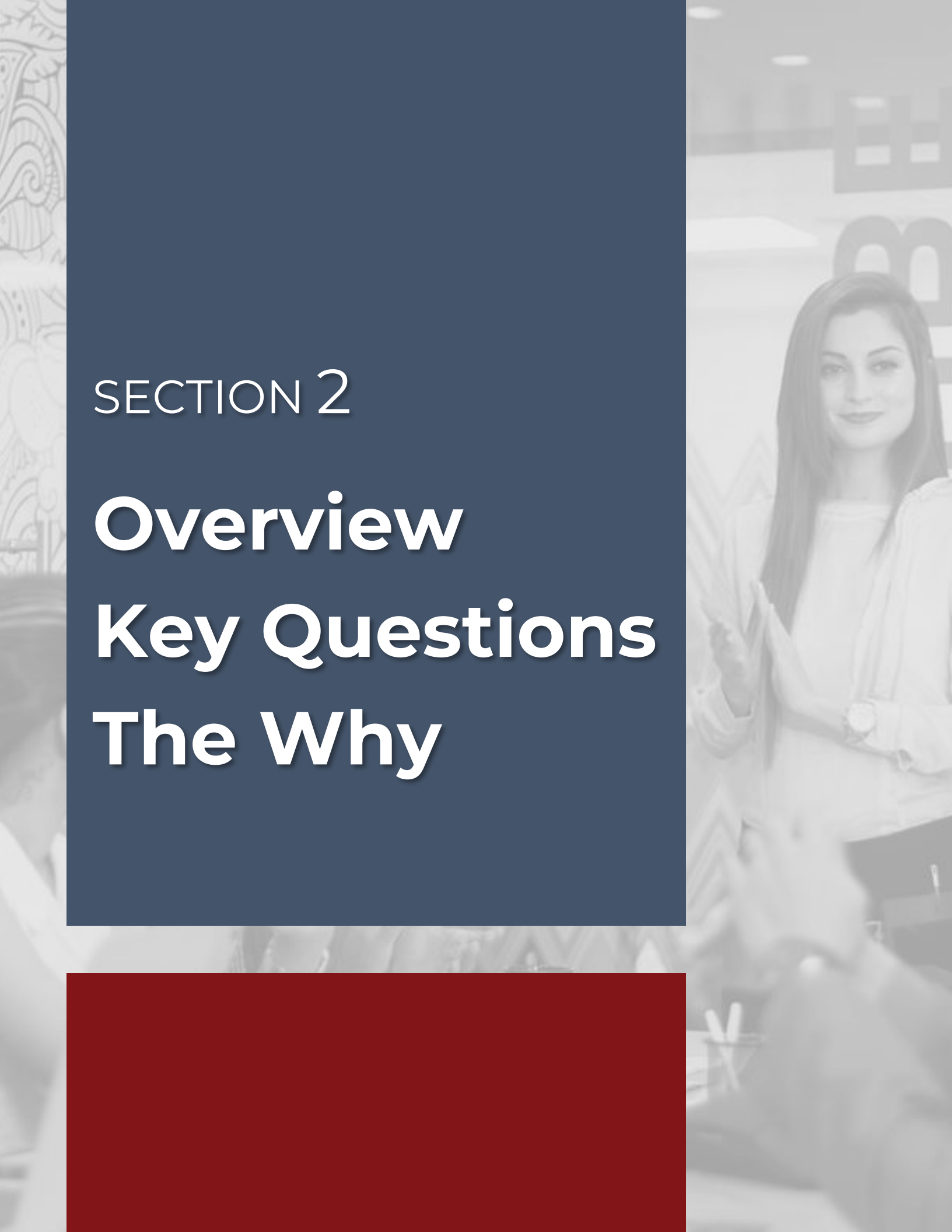
Overview
Key Questions
The Why



Makanda Township

Digital Access & Equity Plan

Overview

The Makanda Township Broadband Committee worked with Connect Humanity, Biarri Networks, and EntryPoint Networks from May – December 2021 as part of the Build Back Better (BBB) grant program to develop this Digital Access & Equity Plan. This Plan is designed to help Township leaders determine whether it is feasible and advisable to deploy and operate a municipally owned fiber network for the residents and businesses in Makanda Township. This report seeks to assist Township leaders in understanding the operational implications, important risk factors, and a realistic cost framework for developing and operating Township-owned fiber optic infrastructure.

This Digital Infrastructure Access & Equity Plan is a living document. If Township leaders determine that the project has sufficient merit, the planning process will continue toward a potential fiber deployment throughout the Township.

Connect Humanity provided the grant funding that paid for this study. Biarri Networks created a Township-wide fiber optic network design, and EntryPoint authored this report.

Key Questions

This Plan is organized around two key questions:

1) Why should Makanda Township consider building a municipal fiber optic network?
2) What would a sustainable financial model look like for building a municipal fiber network?

Why Should Makanda Township Consider Building a Municipal Fiber Network?

Digital infrastructure is the road system in a digital economy and is critical to nearly every function of a township. A reliable digital infrastructure is a critical necessity to fully enable participation in the economy, education, governance, and healthcare. For local jurisdictions, a reliable and robust digital infrastructure is a basic requirement for the functioning of city or township services and operations, from finance to transportation to emergency services. Similarly, businesses require reliable and fast digital infrastructure to connect with customers, ensure their supply chain and continue to operate. The education and healthcare systems require digital infrastructure to connect with students or patients, to communicate between facilities, and ensure timely and appropriate services. Connecting to individuals from disadvantaged groups, either because of income race, age, or language abilities, is even more critical to ensure these groups have full access and availability to benefit from today's digital society.

The incumbent model is intended to optimize profit for private companies rather than optimizing affordability, equity, and accessibility for all. As additional fiber deployment takes place in Makanda Township, there is limited incentive for multiple private operators to install fiber in the same locations, leading to more limited choices going forward. Due to the critical nature of digital infrastructure, ensuring a reliable and equitable network is a clear public policy concern. This places cities, townships, and counties in a unique position to deploy an infrastructure asset that can have a far-reaching impact on all the systems that are important in local government.

Key limitations of the dominant incumbent model include:

1. The infrastructure is treated as an amenity or luxury item rather than as essential in modern life.
2. The infrastructure and services are bundled together. This conceals the actual cost of infrastructure and services and adds to the lack of competition among service providers.
3. Competition happens at the infrastructure layer rather than at the services layer. This is very expensive and not financially sustainable. It also leads toward monopoly control over services.
4. As a critical infrastructure, a market-based model does not lend itself to optimal access. The interests of incumbent service providers are to charge the maximum price the market will bear, leading to disadvantaged communities being unable to access the services.
5. There is little to no local influence over the pricing, governance, or quality of digital infrastructure and services (internet).

Makanda Township is evaluating the feasibility of deploying a municipal fiber network to overcome these limitations.

What would a sustainable model look like for a municipal fiber network?

The following opportunities to improve digital infrastructure are unique to a municipal entity and may enable long-term benefits in education, health care, public safety, efficient delivery of government services, and the general economy. Commercial internet service providers (ISPs) are unlikely to pursue any of these opportunities because they are contrary to existing incentives.

1) Improved Affordability

The dominant national ISPs have developed a business model that is "rent seeking" and sustained by controlling the infrastructure. Network control allows incumbents to impose premium pricing on network rents (ISP fees). The actions below can effectively overcome these "rent seeking" practices and drive down the cost of access in a meaningful way. These include:

1. Apply established municipal utility operational models for funding, construction, operation, and fees and leverage established municipal utility powers, tax exemptions, and liability benefits to drive costs down.
2. Put downward pressure on price by enabling dynamic competition between service providers via an open access network model.
3. Separate and optimize the key cost components of digital access into the three main network categories: (1) Capital Infrastructure Investment, (2) Monthly Maintenance and Operations Expenses, and (3) Monthly Internet Access Free from ISP.
4. Allow households in multi-tenant buildings to share the infrastructure and maintenance and operations costs.
5. Allow subscribers to pay off the cost of infrastructure and eliminate that line item once the infrastructure debt has been retired.
6. Leverage automation to lower operational expenditures.
7. State and federal grants targeted to offset the cost of deploying new fiber optic infrastructure.

2) Fiber Optic Infrastructure Treated as a Public Utility

Fiber optic networks managed as a public utility makes sense because it is essential infrastructure in the modern economy. Utility frameworks, such as roads, water, and electricity, exist to support essential functions critical for societal success. Providing digital access as a public utility will result in maximum service at the lowest possible cost for residents, businesses, and anchor institutions. The current lack of adequate competition and the practice of treating this as an amenity rather than a utility affects affordability, ubiquity, equity, and quality of service.

3) Increased Competition Through an Open Access Model

Open access is a model that divides the infrastructure and services into two separate systems and then shares the infrastructure between multiple service providers, like road systems and airports. A key goal of an open access system is to lower costs and improve service by increasing choice and competition. For an open access system to realize its potential, it is critical for the infrastructure owner to be a **neutral host of the infrastructure**. The role of a neutral host is to control and manage the infrastructure without privileging one service provider over another. A true open access network depends on enabling robust shared infrastructure that is operated on a non-discriminatory basis.

4) Unbundled Infrastructure and Services

The dominant national ISPs bundle the infrastructure and services together to insulate the infrastructure owner from outside service providers. An open access model depends on unbundling or separating the primary functions and network costs into three buckets: 1) Infrastructure Capital Deployment, 2) Ongoing

Network Operations, and 3) Services. To optimize each function and to enable Makanda Township to become a neutral host, it is important to unbundle the key network functions and costs.

5) Alignment with Users

Residents, business owners, and visitors of Makanda Township should receive maximum value for minimum cost. The Township has established goals of enhancing livability, increasing economic development, enabling important services like healthcare and education, and caring for natural and human resources. As digital infrastructure becomes increasingly important to each of these things, the significance of alignment with the network owner and operator also increases. Makanda Township is aligned with the interests of residents and business owners to support a network that delivers maximum value for the minimum cost.

6) Local Control Over Pricing and Reliability

Local control over critical infrastructure allows for the needs of residents and business owners in Makanda Township to drive policy and regulations. Today's dominant ISPs are nationwide companies that are not organized to align the network with local needs and interests. Digital infrastructure will be positioned to increase local value when it is owned and controlled by a local neutral host. The digital divide, education, economic development, public safety, and healthcare are all examples of local variables that can best be understood and addressed locally. Control over network infrastructure will allow Makanda Township to leverage the power of the network in advancing communication solutions for these issues.

7) Sustainable Solutions for the Digital Divide

The 2021 bipartisan Congressional infrastructure bill (H.R. 3684, Infrastructure Investment and Jobs Act(IIJA)) defines digital equity as "the condition in which individuals and communities have the information technology capacity that is needed for full participation in society and economy of the United States."

Persistent barriers to universal internet access, availability, affordability, and adoption are now public domain concerns. The internet has moved from being a luxury item to a necessary feature of modern life—like other utility infrastructure. The incentives for private industry are not aligned toward resolving persistent gaps and the solutions advanced by private industry have not addressed these critical public needs or provided effective sustainable solutions. Informed public policies coupled with targeted public investments are needed to provide lasting solutions. These public policies must be informed by the fact that reliable internet is now necessary for access to educational systems, economic activities, healthcare, public safety systems, and many other cultural and societal interactions.

8) New Economic Development Opportunities

We live in a digital economy. Communication infrastructure is now fundamental to commerce and economic development because it provides the foundation for the economy. Historically, economic development has followed investment in infrastructure for all major systems including transportation, water, sewer, or communications. Until now, municipalities have mostly remained independent of a governance role over digital infrastructure, allowing private companies to decide where they will build, what they will build, the cost of services, and the kind of innovation that will happen on these systems. However, the network is now so fundamental to modern life and commerce that municipalities are increasingly taking a more active role over governance of this infrastructure.

SECTION 3

Feasibility Analysis

Financial & Feasibility Analysis

Evaluating the feasibility of deploying broadband infrastructure requires comparing current market factors (pricing, customer satisfaction, services, speeds) to realistic projections for Township controlled infrastructure.

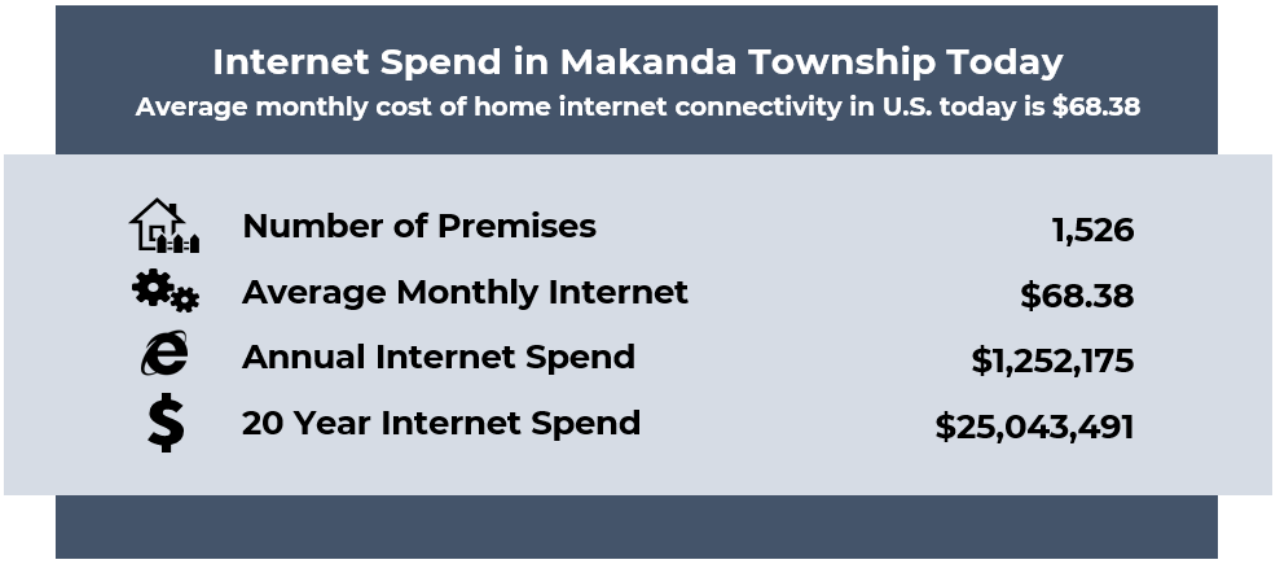
Financial Feasibility

A key objective of Makanda Township is that the infrastructure must be available to everyone at affordable rates. Makanda Township's pursuit of universal availability and affordability will lead to completely different outcomes than the current state for the businesses and residents of Makanda Township.

- Estimated Current Internet Spend in Makanda Township
- Projected Total Cost of Townshipwide Deployment
- Projected Cost per Household at 60% Take-Rate

Aggregate Internet Connectivity Cost in Makanda Township Today

The following table provides a reasonable estimate of the amount of money the residents of Makanda Township are paying for internet access today. This is based on a national average of $68.38 from the Cost of Connectivity report (New America – the cost of connectivity). **This estimate is meant to illustrate the current cash flow available to support a locally owned network. The estimate is likely to underestimate the expenditure as it does not include the current higher cost for business internet subscriptions.**



Projected Monthly Cost to Subscribers

The main cost categories for deploying and operating broadband networks are:

- Infrastructure Capital Costs (Financed over 20 years)
- Network Maintenance & Operations (Monthly Utility Fee)
- Services (Paid Directly to Service Providers)

To optimize the subscriber cost for each category, it is recommended that the costs are separated and transparent to each stakeholder (Subscriber, Network Operator, and Service Provider).

The monthly cost for subscribers is projected to be as follows:

Projected Subscription Cost at 60% Take-Rate

Projected Residential Services Monthly Costs	100% Aerial	60% Aerial / 40% Buried	100% Buried
Infrastructure	$46.90	$55.71	$68.90
Maintenance and Operations (M&O)	$21.00	$21.00	$21.00
ISP Services (Dedicated 1 GB Symmetrical)	$9.99	$9.99	$9.99
Monthly Total	**$77.89**	**$86.70**	**$99.89**

Note: The $9.99 assumes a competitive open access marketplace and is derived from experience with ISPs operating on other open access networks, which have expressed a desire to provide similar pricing in new open access networks.

Projected Townshipwide Infrastructure Capital Costs

The total projected construction costs for a townshipwide deployment are summarized in the table below. The table lists the capital cost for a 100% aerial network deployment, a 100% buried network, and a 60% / 40% of both aerial and buried construction, at a 60% take-rate and an interest rate of 4.5%.

Projected Capital Investment at 60% Take-Rate

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

	100% Aerial	60% Aerial / 40% Buried	100% Buried
Projected Cost Per Premise (Common and Drop)	$7,323	$8,695	$10,755
Estimated Subscribers	916	916	916
Total Projected Project Costs	**$6,704,868**	**$7,964,620**	**$9,851,580**

Note: *The modeled aerial costs do not include the possibility of pole replacement fees or other unexpected make-ready charges.*

Common: The shared fiber infrastructure in a neighborhood that runs from a drop to the closest aggregation hut.
Drop: The fiber that runs from the street to the premise (home or business).

Why Take-Rate is Important to Total Infrastructure Cost

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 to spread the common infrastructure costs across a broad number of subscribers, therefore translating into an attractive and affordable cost per premise. At this point, no formal analysis has been completed.

The following table illustrates the impact of take-rate on total cost per premise under a 60% aerial and 40% buried network with a take-rate of 60% as neutral on impact.

Take-Rate Modeling

Take-Rate	Cost/Sub	Subscribers	vs. 60% Take-Rate
40.00%	$12,643	610	($3,947)
45.00%	$11,327	687	($2,632)
50.00%	$10,274	763	($1,579)
55.00%	$9,413	839	($718)
60.00%	$8,695	916	$0
65.00%	$8,088	992	$607
70.00%	$7,568	1,068	$1,128
75.00%	$7,117	1,145	$1,579
80.00%	$6,722	1,221	$1,974

Network Management and Operations

The work required for network operations includes network monitoring, network management, outside plant repairs, and new customer installations. The Makanda Township Committee is recommending that the Township own the network and outsource operations to a third-party. Our recommendation is that the open access partner provide customer support, the network operations center (NOC) support, monitoring, and troubleshooting. We suggest utilizing a public process to select a local group to manage the outside plant—which includes physical repairs, splicing, new customer connections, maintenance of the physical asset, and emergency response for the physical plant. **We have budgeted $21.00 per subscriber per month to cover the cost of maintenance and operations (M&O).**

Take-Rate

Take-rate is a key consideration with financial feasibility. Take-rate is the percentage of potential subscribers who are offered the service who actually subscribe. Feasibility is a function of take-rate. Take-rate is a function of creating value and effectively communicating that value to subscribers. Higher take-rates lead to lower shared infrastructure costs.

Based upon your specific geography, projected costs are provided for both an aerial and buried implementation. The aerial projections do not include an analysis or cost projection for pole make-ready work.

If Makanda Township can achieve the projected take-rate of 60% (the number used for financial modeling), the projected monthly aerial rate of $77.89 per month for 1,000 / 1,000 Mbps would represent a savings of $62.11 per month over the premium cable offering from MediaCom of 940 / 50 Mbps.

Ultimately, feasibility will depend on the quality and effectiveness of community engagement to educate residents on the value proposition of a locally controlled and municipally sponsored network.

Financial Modeling Assumptions

Financial modeling analysis is based on the following demographic information for Makanda Township:

Total Potential Premises: 1,526
(Households and Businesses)

Subscribers @ 60%: 916

SECTION 4

Market Analysis

Market Analysis

Incumbent Offers and Pricing

In Makanda Township, most residents and businesses currently subscribe to one of several cable and telephone internet providers. The content below comes from the websites of these incumbent providers.

RESIDENTIAL

MediaCom

MediaCom advertises the following residential ISP services in Makanda Township on their website:

Speed (Mbps) [Down / Up]	Promotional Rate [Conditions Apply]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet* [Billings]
100 / 5	N/A	$49.99	$119.99	ID
200 / 10	N/A	$89.99	$119.99	$69.99
400 / 30	N/A	$109.99	$119.99	$92.99
940 / 50	N/A	$139.99	$119.99	ID

**Data from current customer bills, ID = Insufficient Data*

Taxes and fees often represent an additional (20% - 30%) of standard pricing
Shared Network – Speeds are "up to" and are not guaranteed
Speeds are not symmetrical
Modem with Wi-Fi – Additional $13.00 per month
Cancellation charges may apply
Availability depends upon location – not available in all areas

Frontier

Frontier advertises the following residential services in Makanda Township on their website:

Speed (Mbps) [Down / Up]	Promotional Rate [Conditions Apply]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet* [Billings]
12 / 2	N/A	$59.99	$85.00	ID
500 / 500	1-year contract	$59.99	Included	ID
940 / 800	1-year contract	$84.99	Included	ID
1.1-3 / .25	N/A	$74.99	Included	$51.98

**Data from current customer bills, ID = Insufficient Data*

Taxes and fees often represent an additional (10%-15%) of standard pricing
Speeds are "up to" and are not guaranteed
Speeds are not symmetrical
Availability depends upon location – not available in all areas

ClearWave

ClearWave advertises the following residential services in Makanda Township on their website:

Speed (Mbps) [Down / Up]	Promotional Rate [Conditions Apply]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet* [Billings]
100 / 30	N/A	ID	ID	$329.13
250 / 250	N/A	$65.00	N/A	ID
500 / 500	N/A	$75.00	N/A	ID
1000 / 1000	N/A	$85.00	N/A	ID

**Data from current customer bills, ID = Insufficient Data*

Taxes and fees often represent an additional (10%-15%) of standard pricing
Speeds are "up to" and are not guaranteed
Speeds are not symmetrical
Modem with Wi-Fi – Additional $10.00 per month
Availability depends upon location – not available in all areas

BUSINESS

MediaCom Business

MediaCom advertises the following business ISP services in Makanda Township on their website:

Speed (Mbps) [Down / Up]	Standard Pricing [+ Taxes and Fees]	Equipment [Required]	Install [Fee]	Internet* [Billings]
60 / 5	$169.95	Included	$99.95	ID
100 / 10	$209.05	Included	$99.95	ID
300 / 10	$269.95	Included	$99.95	ID
940 / 30	$369.95	Modem upgrade required	$99.95	ID

**Data from current customer bills, ID = Insufficient Data*

Taxes and fees often represent an additional (20%-30%) of standard pricing
Shared Network – Speeds are "up to" and are not guaranteed
Speeds are not symmetrical
Three-year contract required
Availability depends upon location – not available in all areas

Frontier Business

Frontier advertises the following business services in Makanda Township on their website:

Speed (Mbps) [Down / Up]	Standard Pricing [+ Taxes and Fees]	Equipment [Required]	Install [Fee]	Internet* [Billings]
300 / 270	$49.99	N/A	Included	ID
700 / 630	$89.99	N/A	Included	ID
940 / 880	$149.99	N/A	Included	ID

**Data from current customer bills, ID = Insufficient Data*

Taxes and fees often represent an additional (10%-15%) of standard pricing
Speeds are "up to" and are not guaranteed
Speeds are not symmetrical
Availability depends upon location – not available in all areas

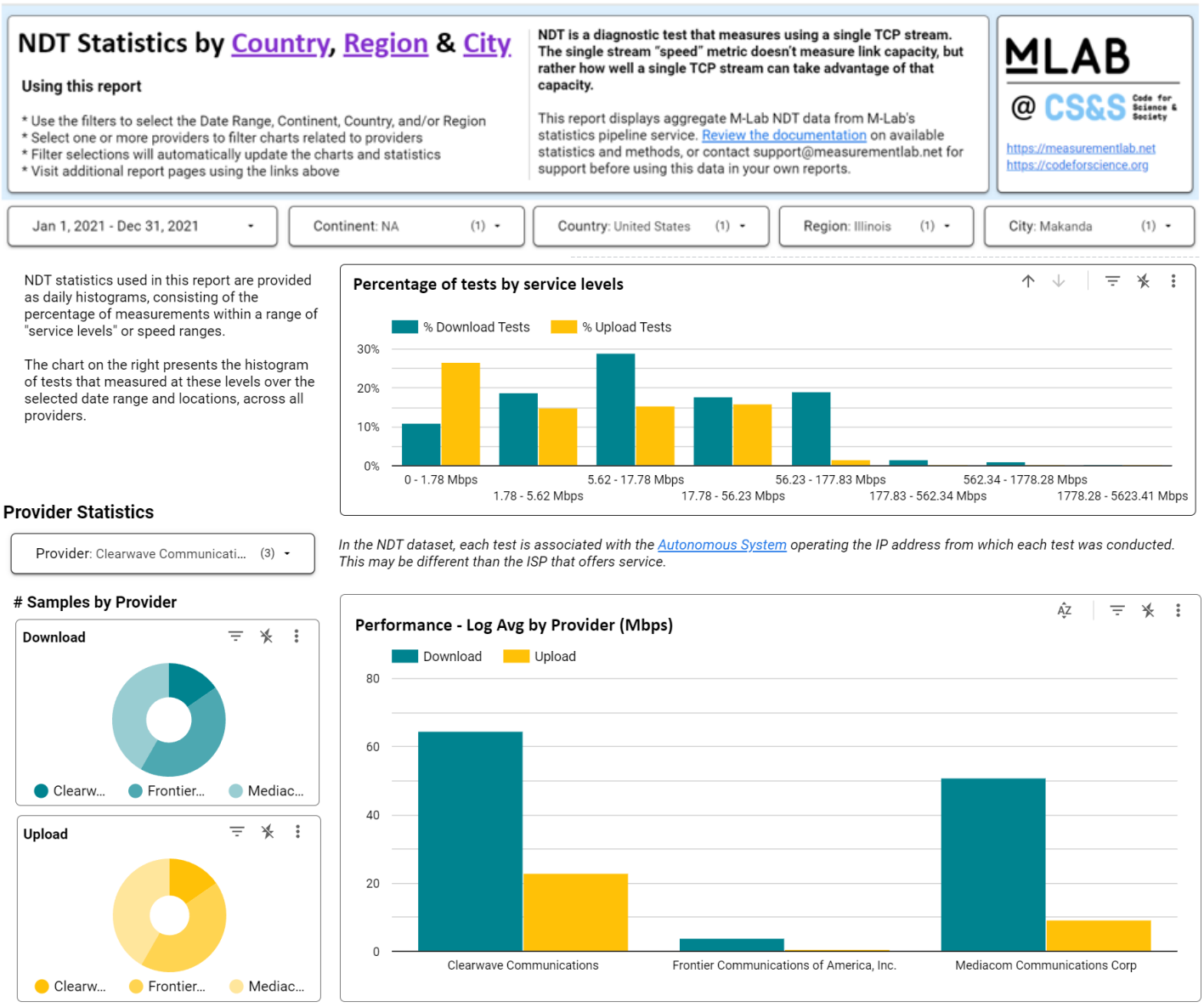
Note: *Market research conducted in June 2022*

Speed Test Data

M-Lab is a research consortium that provides open data from speed tests across the United States. Academic, scientific, and public interest research organizations rely on M-Lab's open data. Every time an individual runs a speed test through an open source integration of M-Lab's tools, the data is saved in Cloud Storage hosted by Google and made available to the public via BigQuery. The data below is the speed test results for Makanda Township from January 1, 2021, to December 31, 2021.

The average speeds delivered by the ISPs in Makanda Township are:

- ClearWave Communications = 64.61 download / 22.83 upload
- MediaCom Communications = 50.90 download / 9.29 upload
- Frontier Communications = 3.72 download / 0.56 upload



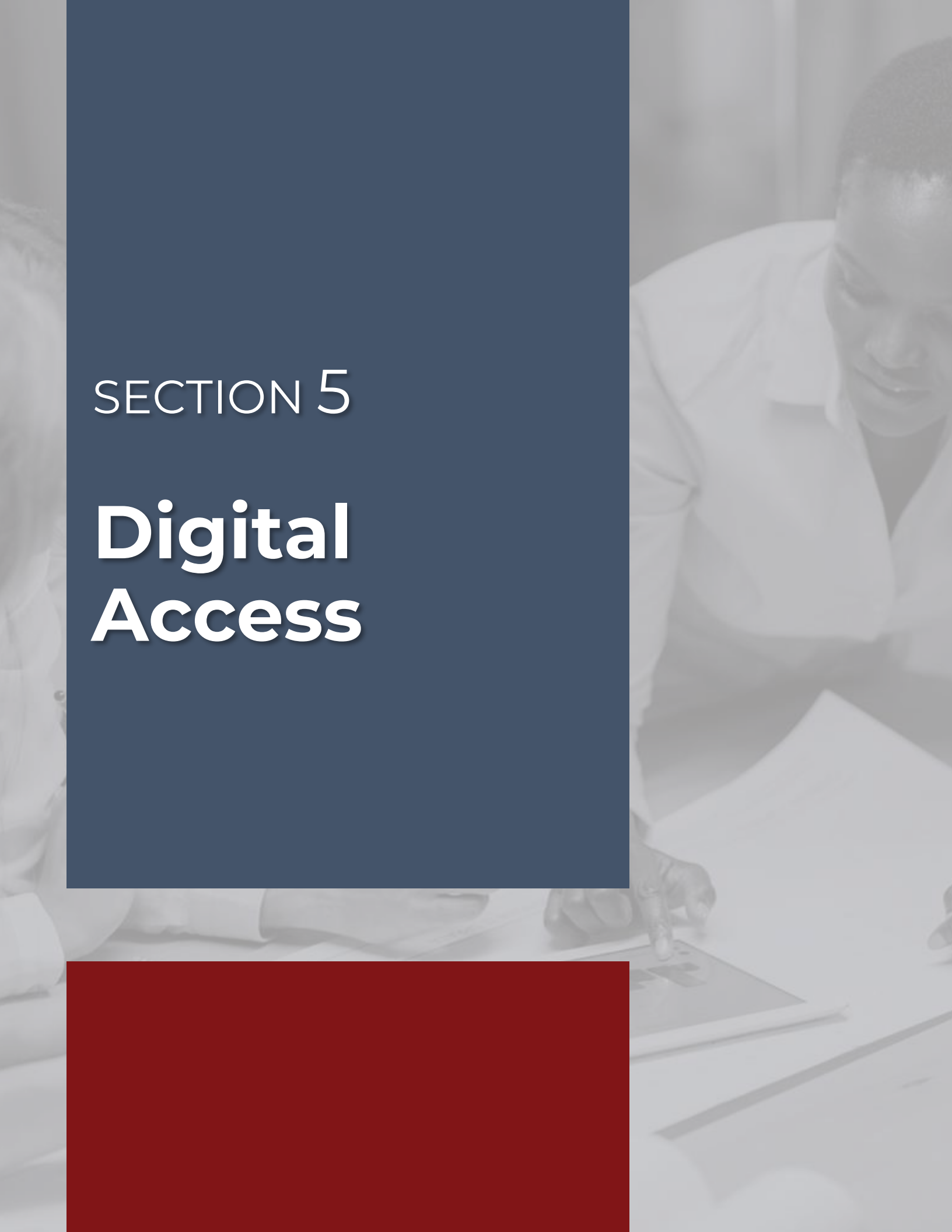
Makanda Township Broadband Survey Results

From May 1 – September 20, 2022, Makanda Township conducted a survey of residents and business operators to assess the sentiment regarding existing internet services and the level of support for a municipal fiber network. The survey was not developed by professional survey administrators. Key findings from the survey include the following:

Total Responses	**103**		
Respondent Category			
	103	Residential	100%
	0	Commercial	0%
Primary Use of Internet			
	85	Entertainment	82.52%
	89	Email	86.41%
	59	Work	57. 28%
	88	Shopping	85.44%
	27	School	26.21%
	74	Social Media	71.84%
	25	Gaming	24.27%
	25	Business	24.27%
	16	Other	15.53%
Current Internet Access			
	62	Fixed Wire / Wireless Connection	60.19%
	38	Cellular Connection Only	36.89%
	3	Do Not Have Internet	2.91%
Type of Internet Connection			
	16	Cable (MediaCom)	25.81%
	33	DSL (Frontier)	53.23%
	4	Fiber (ClearWave)	6.45%
	1	Satellite	1.61%
	7	Point-to-Point Wireless (BLIP)	11.29%
	1	Don't Know	1.61%
Current Internet Reliability			
	19	Poor	20.65%
	27	Fair	29.35%
	18	Good	19.57%
	18	Very Good	19. 57%
	7	Excellent	7. 61%
	3	No Internet	3.26%
	46	**Poor/Fair**	**50%**

Current Internet Speed		
28	Poor	30.43%
25	Fair	27.17%
21	Good	22.83%
10	Very Good	10.87%
5	Excellent	5.43%
3	No Internet	3.26%
53	**Poor/Fair**	**57.60%**
Current Internet Affordability		
27	Poor	29.35%
40	Fair	43.48%
16	Good	17.39%
3	Very Good	3.26%
3	Excellent	3.26%
3	No Internet	3.26%
67	**Poor/Fair**	**72.83%**
Average Monthly Cost of Internet		
92	Residential	$102.93
0	Business	ID
Affordable Residential Internet		
0	$0 - $20	0%
17	$21 - $40	18.48%
34	**$41 - $60**	**36.96%**
23	$61 - $80	25%
11	$81 - $100	11.96%
4	$101 - $120	4.35%
3	$121 - $140	3.26%
0	$141+	0.00%
Township-Sponsored Broadband — Closed Network or Open Network?		
8	Closed Access	8.7%
84	**Open Access**	**91.3%**
How Important are Fast Internet Speeds?		
0	Not Important	0. %
7	Somewhat Important	7.61%
32	Important	34.78%
53	Very Important	57.61%
85	**Important/Very Important**	**92.39%**
How Important are Choice and Competition Among ISPs?		
3	Not Important	3.26%
21	Somewhat Important	22.83%

39	Important	42.39%
29	Very Important	31.52%
68	**Important/Very Important**	**73.91%**



SECTION 5

Digital Access

Digital Access

Funding

To organize the governance structure and financing tools available, Makanda Township will seek the advice of Bond Counsel and Financial Advisors to understand the options under Illinois statute. The Township will also apply for state and federal grants when appropriate.

Construction & Operations

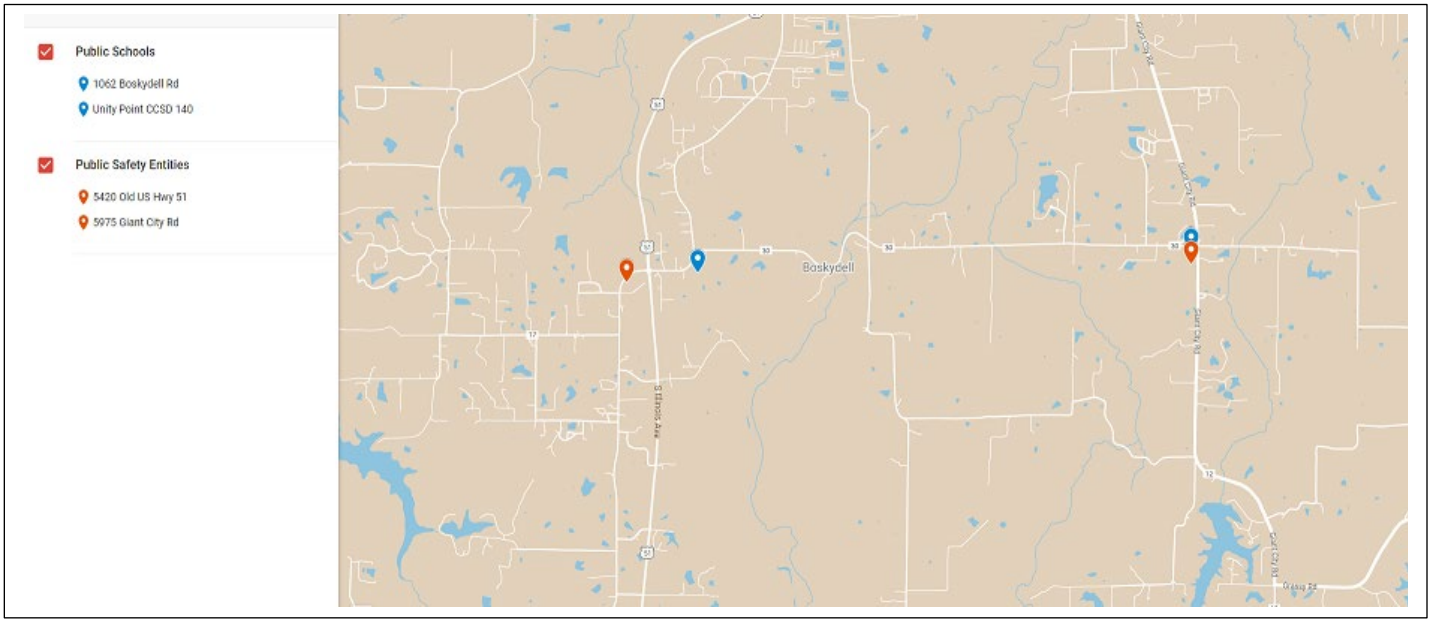
Makanda Township would conduct a public process to contract with a third-party construction firm to build the network. Network maintenance and operations would also be contracted to a third-party.

Anchor Institutions

Section I.C.f. of the BEAD Notice of Funding Opportunity (NOFO) defines a community anchor institution (CAI) as an entity such as a school, library, health clinic, health center, hospital or other medical provider, public safety entity, institution of higher education, public housing organization, or community support organization that facilitates greater use of broadband service by vulnerable populations, including, but not limited to, low-income individuals, unemployed individuals, children, the incarcerated, and aged individuals. An Eligible Entity (the State Broadband Office) may propose to NTIA that additional types of institutions should qualify as CAIs within the entity's territory. The City will seek these anchor institutions as customers, service providers, and locations to provide digital literacy education. A selection of these institutions is illustrated on the map below.

***Source**: Page 11 – https://broadbandusa.ntia.doc.gov/sites/default/files/2022-05/BEAD%20NOFO.pdf*

The map below illustrates the anchor institutions in Makanda Township. Click here to access the live map.



Makanda Township has not conducted a formal digital equity needs and inventory assessment and this project is the first effort by the Township to analyze and address digital gaps. The latest census reports that 81.2% of households have access to a computer in the home. 85.8% of the population has access to broadband. There has been no formal effort to assess digital access needs and barriers in the community.

The Township has not conducted a digital literacy, device access, digital skills, technical support, or digital navigator assessment but would incorporate a program if the Township decides to move forward with a fiber network. If the Township has not set up a formal Digital Equity and Inclusion Program to date, there are several organizations that can be consulted (e.g., Connect Humanity, Institute for Local Self Reliance (ILSR), National Digital Inclusion Association (NDIA)). These organizations and many others work with communities to bring a focus on digital equity, inclusion, and skills development. In addition to these non-profits, there are great examples of existing city programs (e.g., Boston) where cities are incorporating strong digital inclusion and equity programs in their communities. The reason for doing this is clear: to increase digital literacy, skills, improve work-force development, and prepare communities to focus on the key socio-economic advances that can be made by including a focus on digital equity and inclusion, particularly through partnerships with community anchor institutions, local non-profits, local government, and corporate social responsibility programs.

Demographics & Income

The following are key demographics and income statistics in Makanda Township:

- Total population – 4,167
- Total households – 1,643
- Race and ethnicity – White 86%, Hispanic 4%, Black 3%, Asian 4%, Two+ 4%
- Gender – 50% male, 50% female
- Median age – 45.9
- High school degree or higher – 97%
- Bachelor's degree – 51.8%
- Miles covered – 37.1
- People per square mile – 112.4
- Properties that are owner occupied – 74%
- Average household size – 2.5 people
- Median household income – $71,250
- Median county income – $39,689
- Median state income – $68,428
- Median national income – $67,521
- Households that have a computer – 81.2%
- Households have an internet subscription – 85.5%

Source: *https://censusreporter.org/profiles/06000US1707746227-makanda-township-jackson-county-il/*

- Number of Biarri premises – 1,526

Current Broadband Offerings

There are several different internet providers in the Township that provide a patchwork of coverage, with some areas of the Township with good coverage and other areas with poor coverage. As usage increases during the day, many individuals report slowdowns and buffering issues. It is anticipated that as work / school from home increases along with increased demand from connected appliances and entertainment, these issues will be exacerbated.

Readily found data on unserved and underserved citizens in cities, towns, townships, and municipalities is under dispute due to discussions about the latest information released by the Federal Communications Commission (FCC) in their broadband maps. According to FCC maps, the fastest typical speeds are 25 / 3 Mbps. Many communities are finding errors, and the information we include in this report is from official sources. Each municipality must validate it as it goes forward with official network development plans.

SECTION 6

Next Steps

Next Steps

The objective of this section is to provide a roadmap to Township leaders for actions to take once the initial Digital Access & Equity Plan is complete. Township 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 Township wants to control or influence the outcomes it desires for digital access.
2) **Governance:** Determine the governance structure that is appropriate to advance the Township's objectives.
3) **Business / Operational Model:** Decide whether a vertically integrated (single ISP) or an open access model aligns with the Township's objectives.

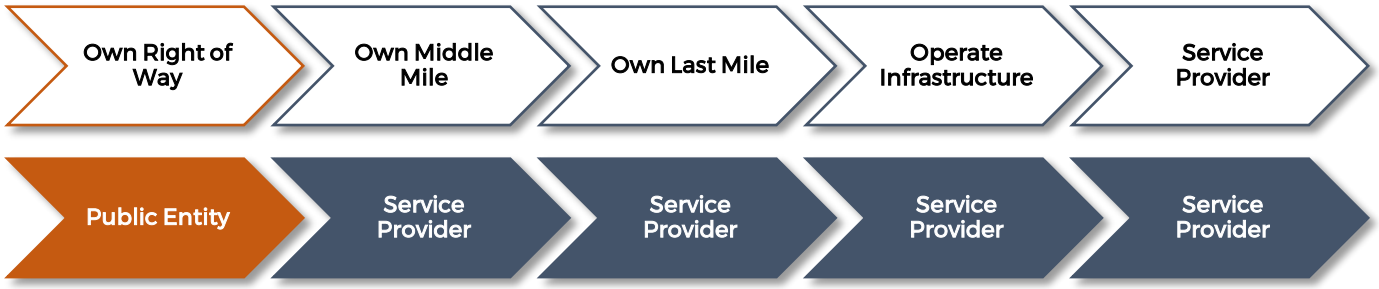
KEY DECISION #1: INFRASTRUCTURE OWNERSHIP

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

Private Network Ownership

The easiest course for a township or city 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.

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 Township 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 Township's focus is on making the system self-sustaining and adding value. The Township 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 Township aligns perfectly with the interests of constituents who subscribe to the network.

Figure 2: Municipal Infrastructure Ownership and Operation Model

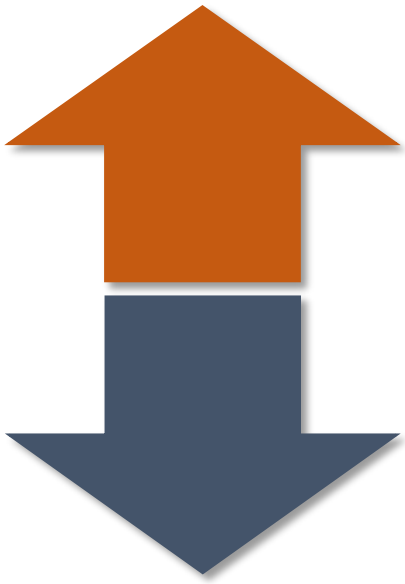
Additionally, the public entity will not have to get permission or incur new expenses whenever it wants to connect the network to a new service or application. Furthermore, public ownership of the network will allow the Township to optimize the network for local needs rather than organizing the operation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

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



Public

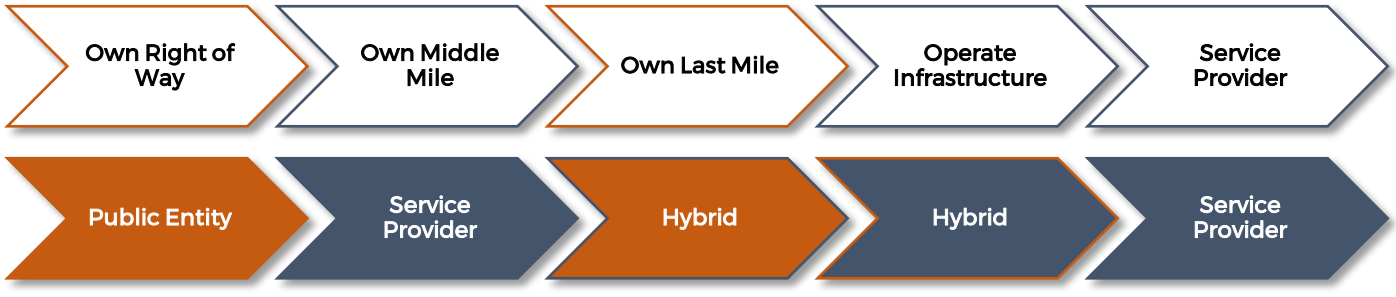
> Customers are Key Stakeholders
> Not-for-Profit
> Assets Held Publicly
> Public Board Meetings
> Elected Board Sets Rates
> Local Control

Private

> Investors are Key Stakeholders
> For Profit
> Assets Held Privately
> Private Board Meetings
> Private Board Sets Rates
> Investor Control

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).

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 Township'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 Township'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 Township's 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 Township's 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 township that seeks to own and operate this infrastructure and the policies and operational processes that a township imposes on itself, third-party partners, and subscribers.

The following information outlines non-statutory governance considerations which may be relevant to the Township's decision-making process for governance of infrastructure and services. The ownership and business model strategies the Township Council 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 Township pursues a hybrid ownership model, governance will be specified in the agreement between the parties.

Note: If the Township Board chooses to forgo the owner/operator model that benefits the Township, at minimum they need to work with the County to insist on some governance mechanism for the Township and other municipalities. This will help ensure that any private company that the County chooses to provide service would have to work with the Township to 1) build out to the unserved first and then the underserved and 2) work with and report to the Township on progress. Otherwise, the Township is left to the decision-making of others and the lack of more oversight created by NTIA/FCC rules and funding.

GOVERNANCE CONSIDERATIONS

The following considerations may be relevant to the Township's governance decision-making.

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).

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 Township Council'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 Township 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?

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 over time. 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 Township 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 unbundled from the services	All three roles are unbundled
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 Township), 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 township 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.

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 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.

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. Frontier, MediaCom, and Clearwave operate in Makanda Township 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/gigabit/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, it 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 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 Makanda Township. This will require stepping through the formal process of presenting the options outlined in this report to the broader committee and Township 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 Township 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 Township is pursuing a single ISP model or an open access model, this is an appropriate next step because the partner needs to advise the Township 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 Township'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 Makanda Township 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 Makanda Township 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.

- **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 Township is going to handle project management internally, the business model partner can be an advisor to assist internal project leadership. If the Township 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 optics projects and budgets, directing construction in accordance with the approved design, and coordinating work with other staff and design team members.
  - Interfacing with Township 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

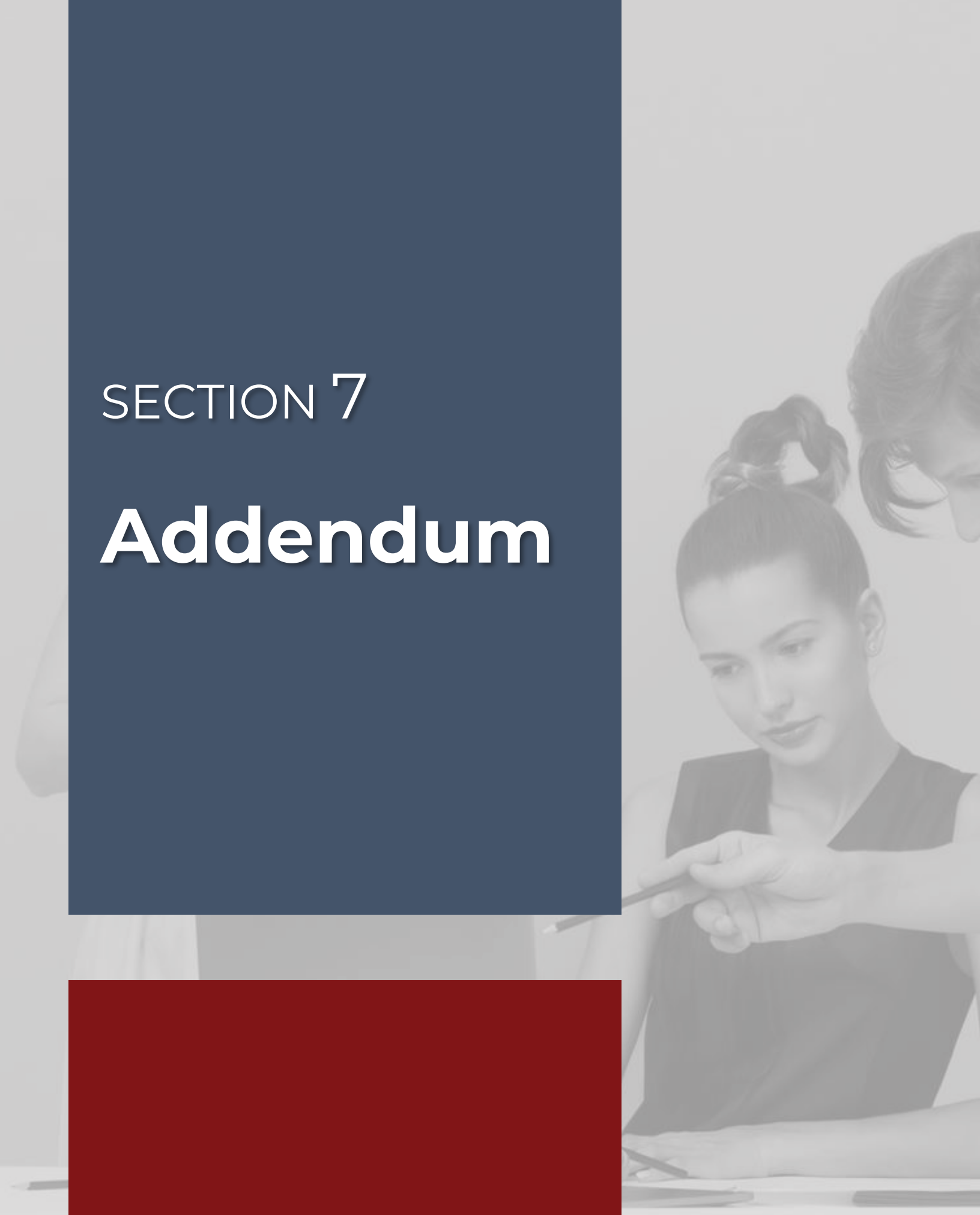
Developing a budget that can be trusted requires a process of moving from projected costs to hardened costs. This process includes a collaboration between Township staff, the business model partner, and the engineering / design partner working together to develop a construction-ready design. This construction-ready 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.

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.

SECTION 7

Addendum



Addendum

The content in the Addendum provides additional detail related to:

- > Infrastructure Grants
- > Network Architecture
- > Media Comparison
- > Business Model Options
- > Risk Assessment
- > Community Engagement

Infrastructure Grants

The Township and its partners should pursue all available federal and state broadband grant opportunities that may be a fit for Makanda Township's proposed project.

Potential supplementary capital sources may include:

- > Coronavirus State and Local Fiscal Recovery Funds (ARPA)
- > Infrastructure Investment and Jobs Act (IIJA)
- > State Grants
- > Other

Coronavirus State and Local Fiscal Recovery Funds (ARPA)

The Coronavirus State and Local Fiscal Recovery Funds (ARPA) may be used to make necessary investments in broadband infrastructure, which has been shown to be critical for work, education, healthcare, and civic participation during the public health emergency. The final rule broadens the set of eligible broadband infrastructure investments that recipients may undertake.

Source: *https://home.treasury.gov/system/files/136/SLFRF-Final-Rule-Overview.pdf*

Infrastructure Investment and Jobs Act (IIJA)

President Biden's Infrastructure Investment and Jobs Act (IIJA) seeks to ensure every American has access to reliable high-speed internet. Broadband internet is necessary for Americans to do their jobs, to participate equally in school learning, health care, and to stay connected. Yet, by one definition, more than 30 million Americans live in areas where there is no broadband infrastructure that provides minimally acceptable speeds—a particular problem in rural communities throughout the country. And, according to the latest OECD data, among 35 countries studied, the United States has the second highest broadband costs. The Bipartisan Infrastructure Law will deliver $65 billion to help ensure that every American has access to reliable high-speed internet through a historic investment in broadband infrastructure deployment. The legislation will also help lower prices for internet service and help close the digital divide, so that more Americans can afford internet access.

Source: *https://www.whitehouse.gov/bipartisan-infrastructure-law/*

Individual State Broadband Grants

Broadband Equity, Access, and Deployment (BEAD) Program Funding includes $42.45 billion for a new program focused on connecting underserved areas by funneling money through state grants. The legislation gives the National Telecommunications and Information Administration (NTIA) 180 days to establish the program and develop funding guidelines. It is unclear how long after those states will begin awarding broadband grants.

Each of the 50 states will receive an initial allocation of $100 million from the $42.45 billion pot, with additional funding to be distributed based on coverage maps that have yet to be put out by the Federal Communications Commission (FCC). To receive funding, each state must submit a five-year action plan that identifies locations that should be prioritized for support; outlines how to serve unconnected locations; and assesses how long it would take to build out universal broadband.

Affordable Connectivity Program (ACP)

The $14 billion Affordable Connectivity Program (ACP) is a targeted subsidy which provides up to $30 per month for qualifying households. However, analysis done by the City of Baltimore in 2021 found that only 40.7% of residents have access to a broadband subscription. This means that nearly 96,000 individuals citywide do not have access to a broadband subscription. Additionally, 33.3% or 75,000 residents do not have access to a computer. The federal subsidy program was designed to address both challenges. However, according to the FCC's data, only 34,734 households in the Baltimore area had registered for the federal subsidy at the time of the analysis. Three barriers identified by a Baltimore task force were that the subsidy seemed "too good to be true," and providers promoting the subsidy through marketing materials and sales representatives attempted to upsell customers. A key takeaway from the Baltimore task force that is relevant for Makanda Township and other towns and cities with a known digital divide gap was that a "trusted point of contact for community members to call made it easier to help wary residents enroll in the program." Additionally, having resources available to help overcome language barriers also made It easier to get residents enrolled.

Source: *https://www.benton.org/headlines/baltimore-and-emergency-broadband-benefit-program*

Overview of Network Financing Considerations

Historic levels of funding for digital infrastructure seek to close existing gaps, support public ownership, and encourage open access. Public opinion supports treating digital access just like roads, bridges, water, sewer, and power. Combining these key aspects will provide Makanda Township with a fiber optic access utility capable of providing maximum service for least cost.

Network Architecture

Network architecture has a meaningful impact on network reliability. The description below covers variables that should be considered for network reliability.

The two main network designs are Switched (Active) Ethernet and Passive Optical Networks (PON). The key difference between these two models is that PON is a shared infrastructure (32, 64, or 128 neighbors share a connection) and ethernet gives subscribers their own connection.

Switched Ethernet Network

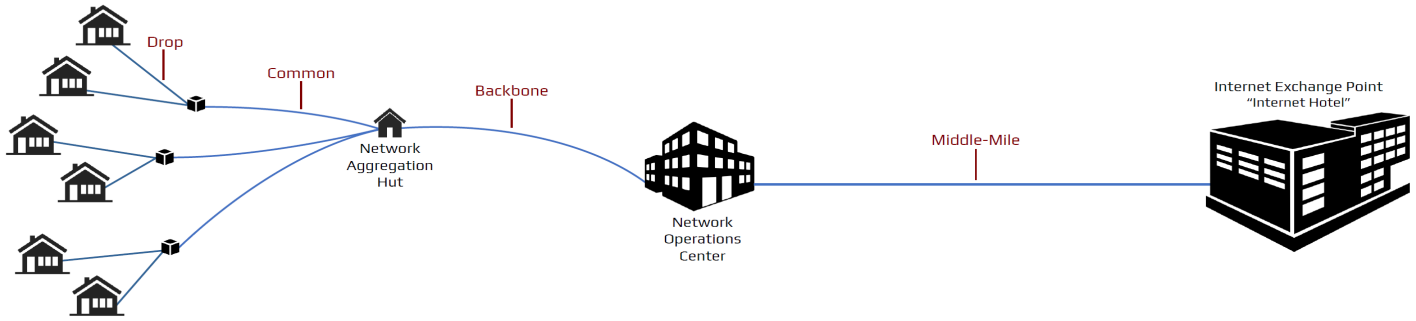
The switched ethernet architecture provides a dedicated connection for each customer rather than a shared connection and the customer experience is significantly better than in a shared architecture during periods of network congestion because the throughput of a switch-based architecture is superior.

Passive Optical Network (PON)

Passive Optical Networks (PON) make use of Time Division Multiplexing (TDM) technologies to create a bus or shared architecture with performance very similar to coaxial cable installations. In a PON network, splitters are placed in the field and a single fiber connection is shared between 32, 64, or 128 premises. This shared architecture may result in packet loss during periods of peak usage. Additionally, upgrading individual connections relies on complicated vendor specific solutions if possible. It can also be more difficult to isolate and troubleshoot faults in a PON network because of the topology. PON equipment suppliers also use proprietary management platforms to establish long term vendor lock-in.

Proponents of PON architecture will argue that PON is less expensive than an ethernet design. That was true historically. 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.

Network Segments – Definitions & Costs Allocations



Drop = The drop is the fiber that runs from the street to the premise (home or business).

Common = The common is the shared fiber infrastructure in a neighborhood that runs from a drop to the closest aggregation hut.

Backbone = The backbone fiber runs from an aggregation hut back to the network operations center.

Middle Mile = 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 maintenance and operations (M&O) utility fee and is borne by all network subscribers.

Internet Exchange Point = An internet exchange point is the central point where all internet traffic flows for routing. This is analogous to the role of a central post office for the U.S. postal system.

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 Makanda Township 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. Comcast / Xfinity is the incumbent cable company in the Makanda Township 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 Makanda Township 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.

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.

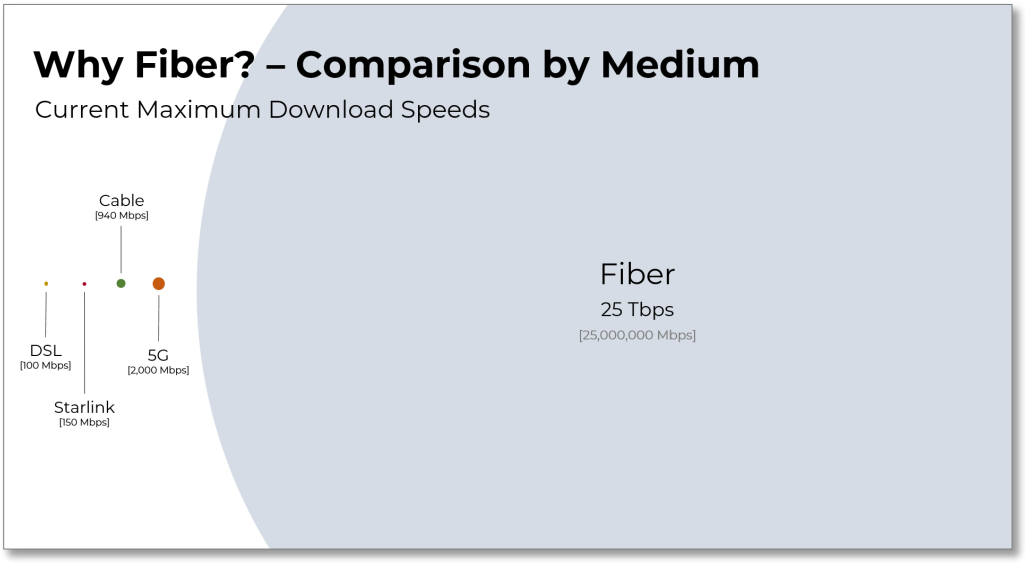
- **High-band 5G** is the band that is most commonly associated with 5G. Operating at 25-39 GHz, this is known as a "millimeter wave" spectrum and delivers gigabit speeds (currently tested as high as 3 Gbps). The millimeter wave transmitters have a very limited range and require the deployment of many 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.



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 Microsoft 365/One Drive, Google Docs, Dropbox, VoIP, FaceTime, Skype, Zoom, WebEx, Microsoft Teams video calls, hard drive backups, and in-house web hosting.

Municipal Network Models

Municipal Broadband Models Comparison

To compare the various models that exist in the United States today, the following model variables are important to understand:

Broadband Network Models

> Vertically Integrated – Privately Owned & Operated
> Publicly Owned & Privately Operated
> Publicly Owned & Operated

Access

> Closed Networks (Single ISP)
> Open Access Networks (Multiple ISPs)
  - Dark Fiber
  - Lit Manual
  - Lit Automated

A mix of prominent municipal fiber optic projects were selected to illustrate the types of models that have been deployed. 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	Open vs. Closed	Dark vs. Lit	Manual vs. Automated	Take-Rate	Cost of 1 Gig
Chattanooga, TN	179,139	Electrical Utility ISP	Closed	Lit	Manual	60%	$68.00
Lafayette, LA	126,000	Electrical Utility ISP	Closed	Lit	Manual	40%	$99.95
Westminster, MD	19,000	Township Fiber, Private ISP	Closed	Lit	Manual	20%	$89.99
Huntsville, AL	194,585	Dark Fiber Open Access	Closed	Dark	Manual	No Data	$70.00
Sandy, OR	10,000	Municipal ISP	Closed	Lit	Manual	60%	$59.95
Longmont, CO	86,000	Electrical Utility ISP	Closed	Lit	Manual	55%	$69.95
Ammon, ID	17,000	Automated Open Access	Open	Lit	Automated	65%	$47.50
Monmouth, OR	15,083	Municipal ISP	Closed	Lit	Manual	80%	$129.65
Lexington, KY	321,959	Private Partner Owned	Closed	Lit	Manual	No Data	$59.95
Santa Monica, CA	110,000	Dark Fiber Business Only	Closed	Lit	Manual	N/A	N/A
Fort Collins, CO	165,000	Electrical Utility ISP	Closed	Lit	Manual	No Data	$59.95
UTOPIA	150,000+	Manual Open Access	Open	Lit	Manual	15%	$70.00

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

Ownership Considerations

Vertically Integrated – Privately Owned & Operated

A private owner designs, builds and operates a network. The private builder and operator 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.

Publicly Owned & Privately Operated

A community (e.g., township, 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 that 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 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 township 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 primarily 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, it is impossible to connect to other services that may be available through other service providers other than services running across the internet. 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 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.*

Risk Assessment

The Township seeks to understand the primary risks of building and operating a municipal fiber optic network and to actively manage those risks not only during construction but also on an ongoing basis during network operations.

The following is an analysis of the main risk factors facing Makanda Township if it pursues its fiber-to-the-premise deployment. Ten risk factors are identified:

1. Take-Rate Risk
2. Subscriber Churn 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 Attachment & Make-Ready Risk

Take-Rate Risk

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

Likelihood: Take-rate risk is an important risk factor and is a function of the value proposition of the network and how well that value proposition gets communicated and managed before, during, and after construction. 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: Positive take-rates and performance will compound to the benefit of all stakeholders. Negative take-rates lead to higher costs and churn which create a negative spiral that compounds until the network is not sustainable.

Mitigation: To mitigate take-rate risk, demand aggregation must be managed before, during, and after construction and give consumers a value proposition that makes them voluntarily committed to the network infrastructure.

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 motivated 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 higher if a new market solution simply replicates the incumbent model.

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

Mitigation: The risk of churn goes down under a business model where 1) the customer connection is treated as an improvement to the property, and 2) the value proposition is strong enough to make the customer committed to the network.

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: This risk is reduced by hiring or partnering with skilled project managers and key strategic partners and creating alignment among key team members on the project and operational plans. Further, it is important to 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 assurance 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.

Community Engagement Risk

Community Engagement Risk includes 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 something that can be managed and monitored through proactive engagement. Poor planning, management and execution increases the level of risk. Community engagement can be handled by volunteer community members. However, the risk increases if community engagement resources are inadequate for a project of this size. There are external marketing professionals available to assist with the 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 marketing professionals and provide sufficient resources to make it easy for residents to learn the basic value proposition through a variety of education and communication strategies.

Cost Modeling Risk

Cost Modeling Risk is the risk that the financial modeling performed significantly misstates actual design, construction, and / or operational costs.

Likelihood: There is enough industry data to reasonably validate cost estimates. However, there is significant market volatility currently due to supply chain disruptions and labor supply pressures.

Impact: Cost overruns can have a meaningful impact on network construction and sustainability.

Mitigation: Risk is reduced by validating financial assumptions by hardening costs through an RFP or other public process for all design, construction, and software partners.

Timeline Risk

The benefits of building the network at an accelerated pace and include the following:

1. Each phase requires legal, financing, and accounting transaction costs. 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 time to break-even.
3. An accelerated timeline reduces the potential for unexpected movement in interest rates.

Likelihood: Costs are likely to be higher for an extended buildout period. However, there may be execution risk exposure for accelerating the buildout, depending on the experience and capacity of the construction partner.

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

Mitigation: The Township can manage the buildout schedule following a cost / benefit analysis of the options. An important consideration is alignment with construction partners. If the Township is going to outsource construction, it should consult with potential construction partners about the alternative construction schedules to make sure that the Township'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 Township successfully building or operating a municipal network. The Makanda Township Attorney should prepare a separate analysis describing the Township's legal authority to build, own, and operate broadband infrastructure.

Likelihood: Historically, incumbent operators have taken legal action to stop some municipalities from building a competing network when they have a legal basis for doing so. The state broadband office has not responded to requests to provide information about the Illinois statute on municipal broadband.

Impact: If a claim were to be brought against Makanda Township, it could take a meaningful amount of time and cost to contest or appeal the claim—but this is unlikely.

Mitigation: It is important for Township legal counsel to summarize their findings under Illinois law in a legal memo to in the next phase of this project.

Middle Mile Risk

Middle Mile risks include the following:

1) Lack of redundant options on divergent paths
2) Pricing risk—the cost of connecting to middle mile carriers
3) The risk of being stranded or isolated without a viable path to an internet exchange point

Likelihood: Makanda Township will likely have multiple middle mile paths back to an internet exchange point in St. Louis, Champaign, or Chicago.

Impact: The middle mile risks listed above could have a significant impact on network success but all of them have a low likelihood of occurring because of Makanda Township's location.

Mitigation: The Township can mitigate and possibly eliminate middle mile risk by building in redundancy to the network by having multiple backhaul providers or multiple independent paths back to an internet exchange point.

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.

Likelihood: Because Makanda Township does not own the utility poles in its service area, this risk is important. If the network is partially or fully an aerial network, there may be poles that need replacement or repair which will add to the total cost of the project.

Impact: Make-ready work for pole attachments can have a meaningful impact on costs and timeline if the pole owners are non-responsive or want the Township to replace old poles.

Mitigation: The Township can manage the pole attachment process or pursue a buried network—which is more expensive up front but has many long-term maintenance advantages and should be considered.

Community Engagement

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 local utility that offers 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 an 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, Makanda Township 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.

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

Grassroots Engagement

Webinars & Open House Events

Makanda Township 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, Township 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 Makanda Township fiber program. Makanda Township leaders and community members 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.

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.

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.

Commissions for a door-to-door campaign can be funded by a sign-up fee or wrapped into the infrastructure installation cost.

SECTION 8

Glossary

Glossary

Industry Terms and Abbreviations

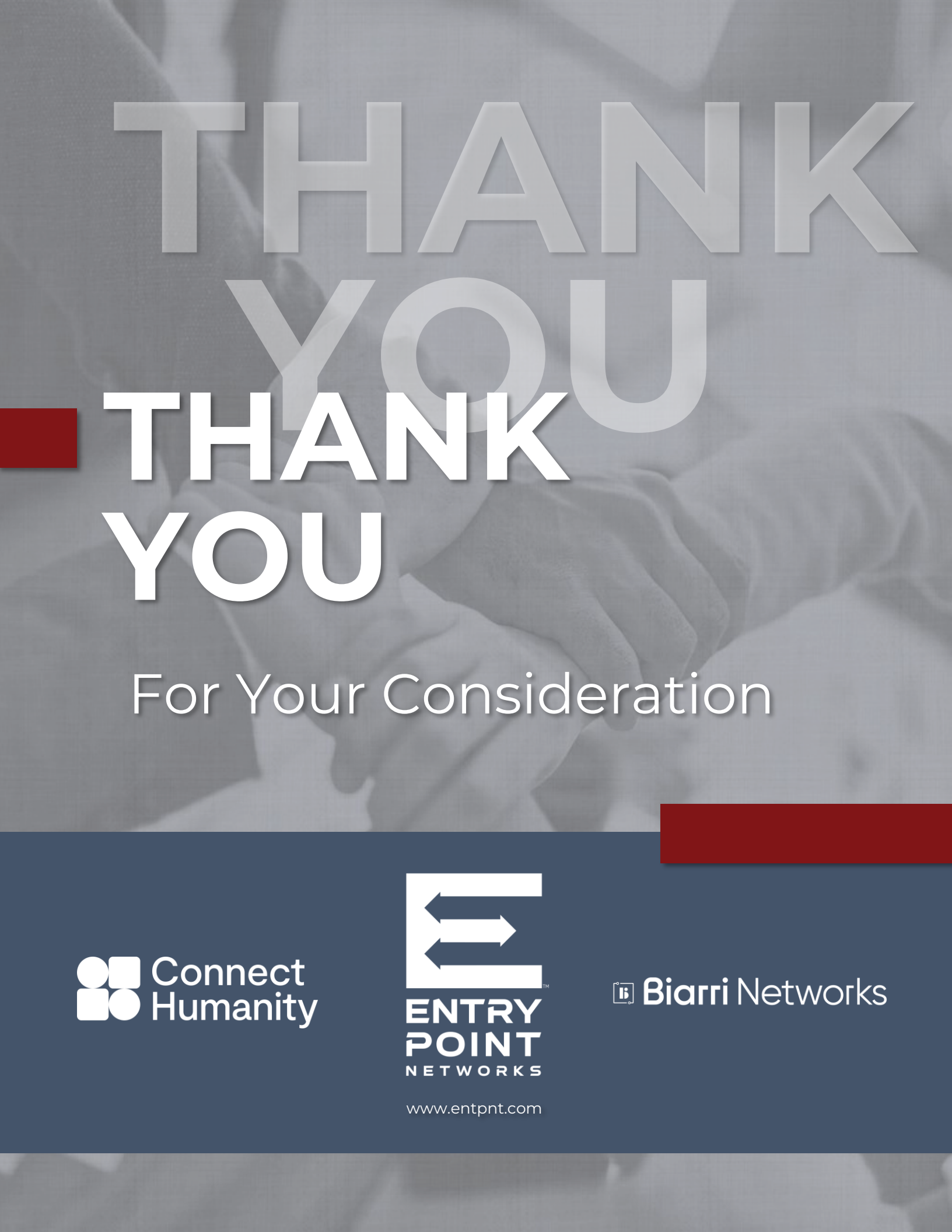
Term	Description	Definition / Narrative
Aerial	Fiber-optic network cables installed on existing utility poles	Aerial fiber deployments are one of the most cost-effective methods of installing fiber cables. Rather trenching and/or boring for underground installations, operators can simply use existing 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	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.

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.

Drop	Segment of the fiber network from street into a home or business	Drop is the fiber that runs from the street to the premise (home or business).
Middle Mile	Shared fiber infrastructure from 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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