Digital Access Master Plan

April 2022

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Vision Statement

The City of Duluth recognizes that digital infrastructure is now essential in a digital economy and in modern society. The City will take an active role in digital access policy and infrastructure needs so that every Duluth resident can have affordable, reliable, and abundant digital access by 2028 to elevate Duluth's communities and accelerate economic development opportunities.

Public utility models are properly applied to the construction, operation, and delivery of essential infrastructure and services. These institutions exist to support essential functions critical for societal success. Applying these same frameworks to digital access will result in maximum service at the lowest possible cost, in contrast with the current market in Duluth, which lacks adequate competition and utility-based infrastructure to achieve the affordability, ubiquity, and service levels required to connect everyone. With historic funding available to solve specific problems, Duluth is launching a Pilot Project to evaluate whether applying these existing institutional authorities to the construction, maintenance, and operation of a municipal automated open access fiber optic infrastructure can enable private service competition to every address in Duluth as the cornerstone of a broader digital equity strategy.

Executive Summary

A lack of ubiquitous and reliable digital access in Duluth coupled with a lack of affordability are unacceptable in today's digital economy.

EDUCATION

The COVID pandemic has widened preexisting opportunity and achievement gaps, hitting historically disadvantaged students hardest.

Research done by The Education Policy Innovation Center in a paper titled Disrupted Learning, COVID-19, and Public Education in Minnesota recommended five policy interventions to repair the inequities exacerbated by COVID-19. Two of the five recommended interventions were to encourage districts to start preparing for future disruptions now and close the digital divide. (1)

A recent study by Boston Consulting Group and Common Sense looked at the "digital divide" in the U.S. in light of the move to distance learning and found that in Minnesota, 249,845 - or 28% of all students - lack an adequate high-speed internet connection. Eighteen percent, or 162,607, don't have the devices they need. (2)

We know from research in other states that students in low-income schools ended the year with between six-seven months of unfinished learning. High School students have become more likely to drop out of school, and high school seniors, especially those from low-income families, are less likely to go on to postsecondary education. The pandemic had an impact on not just academic achievement, but also the broader health and well-being of students, with more than 35 percent of parents very or extremely concerned about their children's mental health. (3)

Research has also shown that relying on subsidies and wireless devices does not effectively address the gap. Michigan State University's Quello Center found that the quality of home Internet access has an impact on outcomes. Students who do not have access to the Internet from home or are dependent on a cell phone perform lower on a range of metrics, including digital skills, homework completion, and grade point average. They are also less likely to attend a college or university. This deficit in digital skills compounds many of the inequalities in access and contributes to lower standardized test scores, and being less interested in careers related to science, technology, engineering, and math. (4)

HEALTH

Telehealth usage surged early in the pandemic as people sought safer ways to access health care. Overall telehealth utilization for office visits and outpatient care was 78 times higher in April 2020 when compared with February of that same year. Telehealth utilization has since stabilized at levels 38 times higher than before the pandemic. Investments in virtual care and digital health have skyrocketed to a level 3 times greater than the levels seen in 2017. Virtual healthcare models and business models are evolving and proliferating, moving from purely "virtual urgent care" to a range of services enabling longitudinal virtual care, integration of telehealth with other virtual health solutions, and hybrid virtual/in-person care models, with the potential to improve consumer experience/convenience, access, outcomes, and affordability. (5)

Highlighting the essential importance of digital access, the Pew Research Center found that as of April 2021, most of those seeking COVID-19 vaccines had gone online to make appointments for themselves or others. (6)

The Centers for Disease Control (CDC) report on *Trends in the Use of Telehealth During the Emergence of the COVID-19 Pandemic* found that telehealth could have multiple benefits during the pandemic by expanding access to care, reducing disease exposure for staff and patients, preserving scarce supplies of personal protective equipment, and reducing patient demand on facilities. (7) Policy changes made to support increased telehealth access because of the pandemic will continue to drive adoption after the pandemic.

A National Bureau of Economic Research study from April 2020 found that people having reliable high-speed Internet at their homes appears to be crucial for them to stay at home. Research results suggest that the digital divide appears to explain much of the inequality we observe in people's ability to self-isolate. (8)

Now, more than ever, digital access, including reliable broadband Internet, must be recognized as a social determinant of health. Disparities in access should be treated as a public health issue because they affect "the health of people and communities where they live, learn, work and play." (9)

EMPLOYMENT

A Pew Research Study in 2015 found that 54 percent of Americans had gone online to look for information about a job, and 45 percent had applied for a job online. (10) Across U.S. metropolitan areas, we find that workers age 25–54 with a broadband enabled computer participate in the labor force at a much higher rate than workers without access. (11) The U.S. Bureau of Labor Statistics found that all industries have increased telework for some or all their employees due to the coronavirus pandemic. (12) Those without digital access are effectively locked out of these opportunities, emphasizing the essential nature of digital access for American job seekers and employees.

The COVID-19 pandemic will leave a lasting imprint on society, but whether it includes the fortification, or the eradication of systemic inequities depends on substantive changes in policies and practices that will support long term change.

The COVID-19 pandemic represents a watershed moment for digital access policy by furnishing incontrovertible proof that digital access is an imperative for modern societal success. Ignoring systemic digital access inequities in the face of public support for change is unacceptable.

PUBLIC OPINION

The coronavirus has driven normal everyday life online and changed our use of the internet, cementing a shift in public opinion for digital access. In June 2021, *Consumer Reports* conducted a nationally representative multi-mode survey of 2,565 adults administered by NORC at the University of Chicago. The survey found that three out of four Americans feel that municipal/community broadband should be allowed because it would ensure that broadband access is treated like other vital infrastructure such as highways, bridges, water systems, and electrical grids, allowing all Americans to have equal access to it. (13)

A 2021 Education Superhighway report found that 18.1 million unconnected households (46.9 million people) have access to Internet service but cannot afford to connect to even low-cost broadband plans, making the affordability gap the largest portion of the digital divide. (14)

Low income and elderly populations and people of color disproportionately lack broadband access. Studies show that 43 percent of adults with incomes below $30,000 a year report not having home broadband services, in comparison to 7 percent of adults with household earnings of over $100,000 a year. (15)

The Open Technology Institute's "The Cost of Connectivity 2020" report found that municipal networks offer faster, more affordable service. (16)

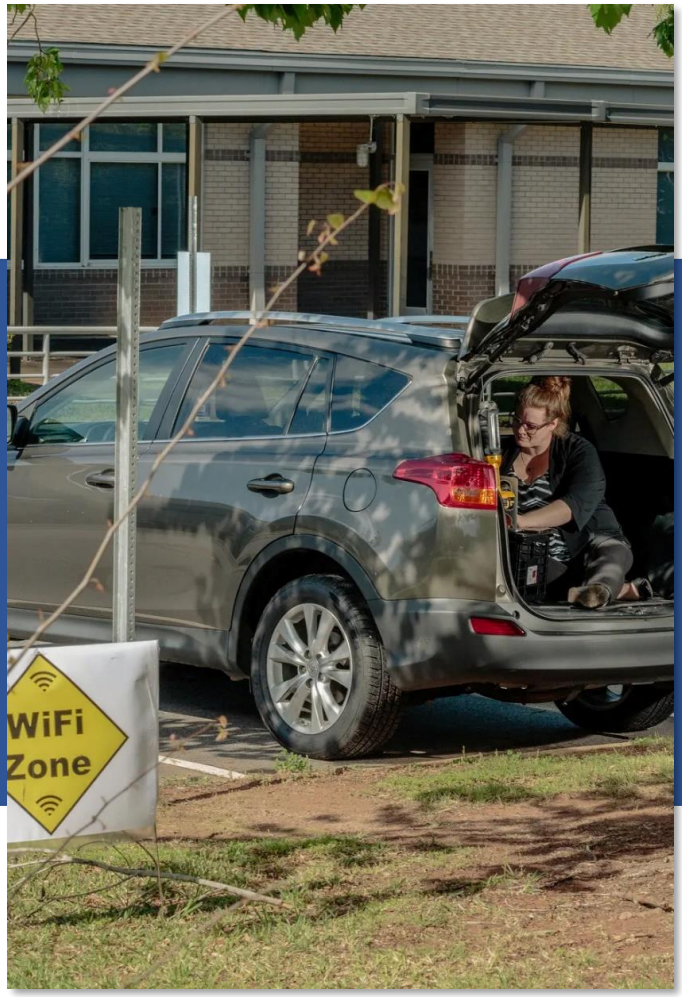
There is both public support and empirical evidence to plan and implement a policy shift towards open access municipal infrastructure. Duluth's digital divide serves as a microcosm of a larger national challenge. Through its Pilot Project, Duluth has the opportunity to model and test the possibility of transforming the digital access to eliminate the digital divide, bring the benefits of dynamic competition for access to the internet, and drive down the cost of access for all Duluth residents.

PUBLIC FUNDING

Unprecedented public funding is available for communities to close their digital divide. Over $128 billion in new public funding has been allocated for broadband improvements, with the majority directed to capital improvements. (17) Additionally, the Universal Service Fund provides $9 billion per year using regulatory frameworks and Congress has authorized four additional programs to administer over $13 billion more, effectively doubling the support offered under the Federal Communications Commission's Universal Service Programs. (18) Duluth's digital access policy will assure that any public monies result in public infrastructure for the public good.

The Federal Communications Commission's Broadband Deployment Advisory Council Working Group for 'Increasing Broadband Investment in Low-Income Communities' has recommended public-private partnerships that leverage public capital resources and private sector broadband expertise as a potential solution, noting

that it should be left up to 'individual communities to consider these recommendations, and other policies, that may help encourage broadband investment in their communities'. (19) Duluth's Pilot Project and preliminary policy aligns with these recommendations by providing a state of the art digital access infrastructure open to both our current broadband service providers as a no cost infrastructure upgrade, and to new providers desiring to serve the Duluth market with minimal upfront investment.



A lack of ubiquitous and reliable digital access in Duluth coupled with a lack of affordability are unacceptable in today's digital economy.

Duluth Declaration

Duluth recognizes that persistent access barriers to universal availability, affordability and adoption are public domain concerns. Relying on private industry solutions to address these critical public needs alone has only delayed the development of effective solutions and exacerbated inequalities. Solutions to these persistent inequities will require informed public policies coupled with targeted public investments.

Therefore, in the absence of effective private, federal, or state solutions, the City of Duluth will further evaluate the possibility of taking ownership of digital access policy and infrastructure needs in Duluth through its Digital Infrastructure Pilot Project and subsequent actions.

The Pilot Project will include evaluating whether open access infrastructure can enable the level of competition among service providers necessary to make digital access affordable for all.

Policy Statement

In pursuit of digital access equity, the City of Duluth will use a Pilot Project to test the efficacy of the following policies:

1. **Focus on universal access and affordability** for all Duluth residents as the two primary digital access concerns.
    a. Use public funds to invest in open public infrastructure to enable true competition and choice for private services.
    b. Codify an open access fiber optic infrastructure utility to hold and manage the infrastructure in a proprietary or enterprise fund for public benefit.
    c. Leverage established municipal utility operational models for funding, construction, operation, and fees.
    d. Leverage established municipal utility powers, tax exemptions, and liability benefits to drive costs down and service levels up.

2. **Focus on eliminating affordability and accessibility gaps rather than treatment of gaps**. The City will favor the use of public funding on investments in long term sustainable capital solutions, such as publicly owned digital access infrastructure, rather than short term unsustainable solutions, such as public subsidies made to private service providers.
    a. Separate public infrastructure investment and operation from private service investment and operation in law, ordinance, and practice.
    b. Recognize fiber optic media as the preferred infrastructure investment for fixed installations.
    c. Establish Ethernet as the infrastructure communications standard.

3. **Create local value for Duluth.**
    a. Improve property values through the installation of affordable fiber optic access to every address.
    b. Local control over infrastructure will make the network more responsive to local needs, including services that are directly available to Duluth residents for their use without requiring a commercial service or internet provider.

4. **Leverage existing investments and institutions for support.**
    a. Seamlessly fold this new municipal utility operation into all existing city operations for the benefit of all by requiring in policy that all intracity connectivity be performed by the fiber optic utility.

b. Implement joint powers and cost sharing agreements with any publicly funded entity either inside or outside the city when mutually beneficial and possible.

c. Use already established public assistance resources to provide municipal fiber optic utility training, support, and devices to improve adoption and digital literacy.

5. **Establish fiber optic utility fees that provide for sustainability** based on capital and operational cost recovery, not excessive reserve funding or profit.

   a. Fees shall be based on infrastructure costs which are agnostic to services consumed or provided.

   b. Fees shall be established, published, charged, and collected using already established municipal utility infrastructure, assets, and systems.

6. **Use the infrastructure as a platform for equity and innovation.**

   a. Establish models and funding to provide a basic level of connectivity for all at no cost.

   b. Develop and implement *Customer Affordability Programs* for the Fiber Optic Department.

   c. Encourage innovation through fee structures that focus on infrastructure costs agnostic to bandwidth.

   d. Present the open access infrastructure as a platform to enable new innovation by city residents.

   e. Seek to create and improve the digital opportunities available to all Duluth residents.

Achieving Duluth's objectives for affordability and accessibility will require the City to develop strategy and policy around more than digital access. Therefore, this Digital Access Policy and Strategic Infrastructure Plan represents an important and crucial first step in the development of a broader plan focused on making digital access affordable and available to every resident in Duluth. The Duluth plan is not designed to replicate current systems. Rather, the Pilot Project will test whether this can serve as an evolution that will transform costs and services. While the first step in any paradigm shift is often hardest, this is the right first step because only by owning the infrastructure can Duluth provide the necessary foundation to assure access and equity outcomes. It is also the right public investment because it avoids favoring any single private provider by eliminating monopoly infrastructure capital costs for both incumbent and new providers, while at the same time not preventing any provider from using Duluth's new infrastructure or continuing to use private infrastructure.

The financial and technical details outlined in this plan includes the data necessary to support these proposed public policies and may serve as a living call to action for the City and its residents to invest in a public open access digital infrastructure solution to create opportunity, achieve equity, drive success, and deliver digital prosperity for all.

Summary of Key Findings

Duluth's primary objectives are to –

1. **Make digital access affordable and available for all Duluth residents, and**
2. **Create a long term (50+ year) solution rather than incrementally improving the problem over time.**

There are seven primary tools to achieve these two objectives –

Based on the experience and data derived from other municipalities that have deployed fiber optic infrastructure, the City of Duluth can positively improve the cost of access for Duluth residents in the following ways:

1) **Apply established municipal utility operational models for funding, construction, and operations and leverage established municipal utility powers, tax exemptions, and liability protections 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 following categories:**
    a. **Infrastructure**
    b. **Network Operations**
    c. **Network Services**
4) **Allow subscribers to pay off the cost of infrastructure and eliminate that line item once the infrastructure debt has been retired.**
5) **Leverage automation to lower operational expenditures.**
6) **Apply for state and federal grants to offset the cost of deploying new fiber optic infrastructure.**
7) **Facilitate access to federal subsidies under the Affordable Connectivity Program.**

What will this cost?

To make sense of the cost, we need to understand what Duluth residents are paying today –

Internet Spend in Duluth Today

Average monthly cost of home internet connectivity in US today $68.38

Number of Premises (Home | Businesses)	**36,000**
Average Monthly Internet	**$68.38**
Annual Internet Spend	**$29,540,160**
20 Year Internet Spend	**$590,803,200**

This assumes 36,000 homes / businesses in Duluth have a wired connection

https://www.newamerica.org/oti/reports/cost-connectivity-2020/

The Path to $53 Gigabit Digital Access

Projected Residential Services Monthly Costs	75% Buried | 25% Microtrench
Infrastructure Costs	$22.65
Maintenance and Operations Costs	$20.50
ISP Services Costs [1,000 x 1,000 Mbps]	$9.99
Monthly Total	**$53.14**

Key Drivers

- Shift to utility model.
- Use public financing.
- Provide automated open access functionality to providers and subscribers.

Impact

Average of $15 in saving with a twenty times (20x) improvement in service level.

The Path to $43 Gigabit Digital Access

Projected Residential Services Monthly Costs	75% Buried | 25% Microtrench
Infrastructure Costs	$22.65
Maintenance and Operations Costs	$20.50
ISP Services Costs [1,000 x 1,000 Mbps]	$0.00
Monthly Total	**$43.15**

Key Drivers

- Eliminate the traditional ISP without requiring any outside subsidy by using Open Access innovations to provide essential connectivity where:
    1. Schools stretch their campus networks into the home at no cost.
    2. Libraries stretch their internet connectivity into the home at no cost.
    3. The city provides a Lifeline plan.
    4. ISPs offer Lifeline Plan (Lifeline services can be delivered through connectivity to the city's internet service and/or connectivity in libraries and schools).

Note: This would provide direct fiber access between the school and the home for a student. This model will result not only in a completely different cost model, but a different user experience as a local fiber optic school operated network could be used for remote campus or virtual classroom applications. The same could be true for extending a library network.

The Path to $31 Gigabit Digital Access

Projected Residential Services Monthly Costs	75% Buried | 25% Microtrench
Infrastructure Costs	$10.33
Maintenance and Operations Costs	$20.50
ISP Services Costs [1,000 x 1,000 Mbps]	$0.00
Monthly Total	**$30.83**

Key Drivers

- Federal Grants
- State Grants
- Philanthropic Contributions
    1. Pilot Project Funding (ARPA and other) - $7 million of infrastructure cost.
    2. Grant Utilization - $39.9 million or 50% of infrastructure cost in grant funding.

    Note: Grant utilization is an aspirational goal and has not yet been secured.

- Eliminate the traditional ISP without requiring any outside subsidy by using Open Access innovations to provide essential connectivity where:
  1. Schools stretch their campus networks into the home at no cost.
  2. Libraries stretch their internet connectivity into the home at no cost.
  3. The city provides a Lifeline plan.
  4. ISPs offer Lifeline Plan (Duluth could require some free offerings as part of market participation).

The Path to No Cost ($0) Gigabit Digital Access

Projected Residential Services Monthly Costs	75% Buried | 25% Microtrench
Infrastructure Costs	$10.33
Maintenance and Operations Costs	$20.50
ISP Services Costs [1,000 x 1,000 Mbps]	$0.00
Monthly Total	**$30.83**
Affordable Connectivity Program	**- $30.00**

Key Drivers

- Affordable Connectivity Program – $30.00 subsidy program funded through the FCC for qualifying applicants.
- The ACP could effectively reduce the cost for a qualifying household to zero for the term of the program. Duluth will need to complete the process to become an approved provider for the ACP program.

Allow Subscribers to Pay off Infrastructure

Under the dominant incumbent model, the cost of services does not go down when the infrastructure is paid off. An important part of optimizing the cost categories is to allow subscribers to pay off the cost of infrastructure over time and eliminate that line item once the infrastructure debt has been retired.

The following table illustrates the impact of this as a long term and sustainable strategy:

Network Type	Infrastructure	Operations	ISP Service	Cost
Traditional Network with Infrastructure Debt	$22 (32%)	$20 (29%)	$27 (39%)	$69
Traditional Network with Retired Infrastructure Debt	$22 (32%) [No Change]	$20 (29%)	$27 (39%)	$69
Open Access with Infrastructure Debt	$22 (42%)	$20 (38%)	$10 (19%)	$52
Open Access with Retired Infrastructure Debt	$0 (0%)	$20 (67%)	$10 (33%)	$30

Cost Per Megabit Comparison

Below is a comparison of per megabit per second (Mbps) cost of service using the standard packages and advertised cost published on each providers website.

Network Provider >>>	Spectrum	CenturyLink	Duluth Fiber Network
Cost Per Mbps – Plan 3	**No Offering**	**$16.66** 3/.5 Mbps Plan	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 6	**No Offering**	**$8.33** 6/.5 Mbps Plan	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 10	**No Offering**	**$5.00** 10/.75 Mbps Plan	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 20	**No Offering**	**$2.50** 20/1.5 Mbps Plan	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 100	**$.69** 300/10 Mbps Plan	**No Offering**	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 400	**$.23** 400/20 Mbps Plan	**No Offering**	**$.05** 1000/1000 Mbps Plan
Cost Per Mbps – Plan 940	**$.14** 900/35 Mbps Plan	**No Offering**	**$.05** 1000/1000 Mbps Plan

Commercial and Other Institutions

All modeling in this report is focused on making access affordable for all residential subscribers. The Pilot Project will help validate the cost model for commercial and anchor institutions. An open marketplace will have a meaningful and positive impact on the cost of access for Duluth's residents, businesses, and anchor institutions. Additionally, participation from businesses and anchor institutions will lower the cost of network operations for all subscribers.

Overview

The mechanisms are in place for Duluth to put in place long term solutions to lower costs and connect all Duluth residents. The key enabler to connect everyone is for Duluth to own and control its digital infrastructure. Once Duluth is the infrastructure owner, the city can use other tools to drive desired outcomes.

Those seeking to preserve the status quo may use fear, uncertainty, and doubt to dissuade Duluth's leaders from building and owning its own digital infrastructure destiny. Private market solutions are incentivized to deliver the least service for maximum price. True utility models are incentivized to deliver the maximum service for the least cost. Duluth must apply this utility model to optimize the desired outcomes.

A lack of broadband competition and investment in Duluth has resulted in affordability gaps and digital redlining, which is a practice that privileges some neighborhoods and leaves others unserved or underserved. These shortcomings have existed for 25+ years and new entrants have faced significant barriers to enter the market because of the cost of building new infrastructure and incumbents operate networks that are closed to outside service providers. These barriers have resulted in one or two legacy wireline options for most Duluth properties. Nationally, the legacy cable infrastructures provide significantly greater bandwidth than DSL solutions. This has led to monopoly or near monopoly status for many cable companies and untenable bandwidth for areas with DSL only options. These national outcomes closely resemble the current state in Duluth.

The lack of competition negatively impacts availability and affordability in two important ways. First, the infrastructure costs are higher as redundant infrastructures must be constructed and maintained for service competition because the services are bundled with the infrastructure. This market situation would never have arisen naturally, except that the two competing infrastructures were originally built for analog voice and cable. Today they compete for digital access, something that was not imagined when they were originally constructed. Second, the service costs are driven higher by both real and artificial market scarcity for services, effectively driving up demand and costs. As a result, many Duluth residents are either subject to a monopoly or do not have viable digital access. Understanding these market conditions and their origins is essential to the development of an effective solution, as they demonstrate that any infrastructure investment that continues to bundle infrastructure and services will have a negative impact on affordability and availability.

NETWORK FUNDING

The current convergence of technology, infrastructure funding, and public demand creates a singular opportunity for the City of Duluth to provide affordable access to every property. Technology advances make it possible to separate or 'unbundle' services from the core infrastructure. This allows the city to build one publicly owned fiber optic infrastructure capable of fostering dynamic competition. Fiber optic networks have the capacity to meet the needs of concurrent service providers without requiring any redundant infrastructure.

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 Duluth with a fiber optic access utility capable of providing maximum service for least cost.

Investing in an open access fiber optic utility available to every property in Duluth will cost approximately $79.9 million dollars. Financing the entirety of this improvement would result in annual payments of approximately $5.5 million dollars.

Making this investment is not only necessary, but also affordable. There are an estimated 36,000 homes in Duluth with over 80% subscribing to a wireline internet service. The average monthly cost for residential connectivity in the U.S. is $70. More than $29 million dollars is currently going to Duluth's ISP's for wireline access. This does not include the cost of commercial and industrial access.

More importantly, every city in the U.S. will get fiber optics either through public infrastructure or a private infrastructure developer as fiber optic becomes the standard for wireline connectivity. The cost of this upgrade to fiber will be borne by the residents and businesses of Duluth. The important question is whether this infrastructure will be closed and operated by a single provider applying a bundled services model, or open infrastructure? The city is positioned to improve speed and lower costs by funding a single improvement capable of supporting desired competition.

The city also can apply for federally funding for digital infrastructure.

UTILITY MODEL

Several utility models provide examples of separating core infrastructure from the services available over the infrastructure.

Water pumping or treatment systems can be separate from the distribution systems. Power distribution and transmission infrastructure is often separate from generation. Wastewater treatment plant operations can be separated from collection system(s) to serve more than one collection system as a service.

It is also important to note that these separations are not only possible, but fundamental for the electric grid. The national gird is interconnected. The electricity received by an end customer could be coming from any generation point, as demonstrated by outages where one generation point can affect service in a separate distribution system. These same types of outcomes are experienced in digital transport and access systems where the services are now supported outside of the core monopoly infrastructure. Ethernet/IP has allowed for technical unbundling. It is now time to follow suit with business models.

Scale often determines the value of separating these systems. Digital access is now global, so the scale would indicate that there is clear economic value in creating and maintaining separation between infrastructure and services in digital infrastructure. Fiber optic infrastructure is a natural monopoly (i.e., no new value is gained by having multiple infrastructures because fiber offers nearly infinite speed and capacity). However, significant value will flow to subscribers by exposing service providers to competition.

Therefore, it is logical to use utility frameworks to support one robust locally owned digital infrastructure and foster commercial competition across that infrastructure. This will not only improve affordability, but will also lead to choice, innovation, and competition.

The differences in economics between private industry and public utility operations will also improve affordability and availability.

CATEGORY	INDUSTRY	UTILITY
Capital Costs (CAPEX)	Equal	Equal
CAPEX Financing	5 – 8 YR return with market interest	20–30 YR return with low interest
Operational Costs	Equal	Equal with automation
Services (Closed or Open)	Negative impact	Positive impact
Profits (Paid to investors)	Negative impact	Positive impact

Summary

In summary, it must be remembered that the key digital access objective and downstream policy of Duluth is that the infrastructure must be available to everyone at affordable rates. For this reason, the city will apply public utility models to the construction and operation of an automated open access fiber optic system. The application of these frameworks will result in models completely different from industry models. The modeling used in this Digital Access Master Plan focused on internet speeds, quality and affordability.

Duluth should expect the industry to view this infrastructure as competitive to their interests because they understand that their control and profit models depend on their ownership of the infrastructure. This is not competition because incumbents will be invited to deliver their services across this infrastructure. Existing service providers will see the opportunity over time and shift from their legacy infrastructure to the city's state-of-the-art fiber system and will be able to do so at virtually no upfront or capital costs. However, they will face competition from other private providers.

The technology innovations offered by Automated Open Access will enable users to access local private networks at no additional cost. The value of this is not well understood but it will enable any number of local digital providers, like telehealth, energy management, and local security monitoring to enhance current capabilities. There will also be opportunities for national service providers like Netflix, Amazon, or Disney to create local connections and direct relationships with Duluth customers without the additional expense of a third-party internet service provider. These local connections would also come with much better speed/reliability performance due to the direct point to point fiber optic access.

Cost Analysis & Phasing – Pilot Project

Lincoln Park District

Please Note – The financial modeling in this section does not include the benefit of ARPA funds, state or federal grants, Community Investment Trust Funds (CITF), philanthropic contributions, or the $30 subsidy under the Affordable Connectivity Program in developing infrastructure capital costs.

However, it is anticipated that Duluth will qualify for and receive governmental grants and other funds that would offset a significant portion of the infrastructure costs outlined in this report. This is reflected in the financial modeling on pages 22 and 23.

This section provides cost modeling for a potential pilot project deployment. The main cost categories for deploying and operating broadband networks are:

- Infrastructure Capital Costs
- 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).

Monthly Infrastructure Cost Model

The cost modeling for the infrastructure construction is based on Minnesota wage rates. A take-rate of 60% (This means that 60% of homes and businesses subscribe) was used in the model. The variables in the cost model can be adjusted on a neighborhood-by-neighborhood basis as needed. A 60% take-rate may seem aggressive given the strong market position of the incumbent cable operator. However, the survey data suggests a strong desire among residents to see competition, choice, better pricing, and the reliability of a fiber optic network.

The data in the line items in this model comes from actual bids for materials and network buildout experience. It should be noted that supply chain pressures have made the network materials market volatile for conduit, electronics, and some other network components.

The first illustration of Infrastructure Capital Costs per premise assumes a project that is 75% Buried and 25% Microtrenched. The second illustration of Infrastructure Capital Costs per premise assumes a project that is 100% Buried. The combined solution of 75% Buried / 25% Microtrenched also serves as a proxy cost for an Aerial deployment fiber solution which may require pole replacements associated with make ready work. The actual deployment strategy will be determined during detailed design. The combined (75% Buried / 25% Microtrenched) costs serve as conservative capital costs for the fiber infrastructure deployment and will be used for simplicity through the rest of this report.

Costs at 60 % Take Rate			
75% Buried | 25% Microtrench			
Description	Common	Drop	Total
Labor	$1,074	$258	$1,332
Equipment & Materials	$1,668	$658	$2,326
Professional Services	$186	$30	$216
Backbone Cost	$0	$0	$0
Short Term Interest	$0	$0	$0
Total	**$2,928**	**$946**	**$3,874**

Monthly Infrastructure Per Premise Cost	**$21.70**

Costs at 60 % Take Rate			
100% Buried			
Description	Common	Drop	Total
Labor	$1,146	$275	$1,421
Equipment & Materials	$1,744	$678	$2,422
Professional Services	$186	$30	$216
Backbone Cost	$0	$0	$0
Short Term Interest	$0	$0	$0
Total	**$3,076**	**$983**	**$4,058**

Monthly Infrastructure Per Premise Cost	**$22.73**

Take-Rate *is the percentage of premises that sign up for services out of the total number of homes that have the infrastructure available to them.*

The Infrastructure Cost *is the cost to build the network to the premise and includes the connection cost. In this model, this line item goes away once the infrastructure is paid off.*

The Maintenance and Operations *cost is an ongoing cost which is structured as a fiber optic utility.*

ISP Services *– Customers will shop for an ISP in much the same way they shop for other goods and services online. Five to Ten ISP's will be available in a portal.*

Total Infrastructure Costs

The total projected construction costs for a Lincoln Park deployment are summarized in the table below. The projections assume that 75% of the network will be Buried and 25% will be Microtrenched with a 60% take rate and short-term interest at 5% and a long-term interest rate of 3% for 20 years.

Project Pro-Forma

Financial Pro-Forma of Full Project Costs - 1 Year Build - Ethernet Architecture	
Projected Cost Per Premise (Common and Drop)	$3,874
Estimated Subscribers	1,929
Total Projected Project Costs	**$7,472,391**

Lincoln Park Pilot Network Operations

The following Table summarizes the anticipated cost structure for Network Maintenance & Operations (M&O) on a city-wide basis. This schedule produces a projected monthly M&O fee for the Broadband Utility at $24.50 per month. This will likely be managed by a contracted 3rd party operator.

Depending on the speed of the buildout, the city may need to subsidize network operations until enough scale is established to achieve sustainability. An accelerated deployment schedule will minimize a subsidy needed by the city. The model illustrates that any subsidy required from the city would be paid back over time.

Network Management & Operations Cost Structure

Residential M&O	Subscriber	Monthly	Annual	Percentage
Labor	$8.00	$15,432	$185,184	32.65%
Office Expense	$6.14	$11,844	$142,129	25.06%
Equipment & Supplies	$2.90	$5,602	$67,228	11.85%
Operations Expense	$2.41	$4,649	$55,787	9.84%
Reserves	$5.05	$9,741	$116,897	20.61%
Total	**$24.50**	**$47,269**	**$567,224**	**100.00%**

The numbers and categories in the above model are derived from many years of experience with actual costs for Broadband projects. Labor costs are modeled to reflect wages from the Duluth region.

Staffing Modeling for Internal Network Operations

The Table below models the cost structure for the positions needed for the City of Duluth to operate the network as a department within the city structure. The model is conservative in projecting the staffing estimates needed to operate the network in a sustainable manner. The model is for operations only and does not include resources for construction. The analysis assumes that the city will build the network over a 12-month period. This timeline would mean that the city will need to subsidize this department for less than 12 months. After that, the investment will be paid back by operational surpluses as the number of subscribers grows beyond the target of 1,929 premises.

The work that will be done by a Fiber Network Department includes network monitoring, network management, outside plant repairs, and new customer installations. As stated earlier, the city has the option of operating the network with internal staffing resources or a 3rd Party network operations partner. EntryPoint expects M&O costs will be 25% - 30% more expensive with a 3rd party operator due to changed incentives from service to profit and reductions in efficiencies.

The following staffing model provides anticipated fully burdened salary information, years to profitability, and the revenues and expenses from the operation.

Staffing Projections

Position	Fully Compensated Hourly Rate	Fully Compensated Monthly Cost	Fully Compensated Annual Cost
Manager	$53	$9,187	$110,240
Network Admin	$42	$7,280	$87,360
I.T. Technician	$33	$5,720	$68,640
Outside Manager	$31	$5,373	$64,480
Outside Plant Tech	$24	$4,160	$49,920

Subscriptions & Staffing Projections

Subscribers	Year 1	Year 2	Year 3	Year 4	Year 5 +
New Subscribers	1,929	-	-	-	-
# of Subscriber at Year End	1,929	1,929	1,929	1,929	1,929
Labor Allocation (From M&O Fees)	$8.00	$8.00	$8.00	$8.00	$8.00
Cash Flow from Labor	$92,592	$185,184	$185,184	$185,184	$185,184

Staffing Projections	Year 1	Year 2	Year 3	Year 4	Year 5
Manager	0.0	0.0	0.0	0.0	0.0
Network Admin	0.0	0.0	0.0	0.0	0.0
IT Technician	1.0	1.0	1.0	1.0	1.0
Outside Plant Manager	0.0	1.0	1.0	1.0	1.0
Outside Plant Laborer	1.0	1.0	1.0	1.0	1.0

Position	Year 1	Year 2	Year 3	Year 4	Year 5
Manager	$0	$0	$0	$0	$0
Network Admin	$0	$0	$0	$0	$0
IT Technician	$68,640	$68,640	$68,640	$68,640	$68,640
Outside Plant Manager	$0	$64,480	$64,480	$64,480	$64,480
Outside Plant Laborer	$49,920	$49,920	$49,920	$49,920	$49,920
Total	**$118,560**	**$183,040**	**$183,040**	**$183,040**	**$183,040**
Net	**-$25,968**	**$2,144**	**$2,144**	**$2,144**	**$2,144**

Subscriber Costs

The table below summarizes the projected costs to subscribers of the Lincoln Park Pilot Project. The summary breaks this down into the three main cost categories.

Projected Subscription Cost

Projected Residential Services Monthly Costs	
Infrastructure – 100% Funded by ARPA and CITF	$10.00*
Maintenance and Operations	$24.50
ISP Services (Dedicated 1 GB Symmetrical)	$9.99
Monthly Total	**$44.49**

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

*Infrastructure cost is set at $10.00/month (debt service proxy) vs. $21.70/month assuming all or majority of capital is secured by grant sources with no debt service.

Financial Modeling Assumptions – Lincoln Park Pilot Project

EntryPoint based its analysis on the following demographic information for the Lincoln Park District:

Potential Subscribers: 3,215
(Households and Businesses)

Subscribers @ 60%: 1,929

Pilot Project Income Statement and Balance Sheet

The following two tables represent a projected Income Statement and Balance Sheet covering the first 5 years, during the initial network deployment stage. These tables assume the full $7.4 million build cost is funded with debt at a 0% interest rate.

Projected Income Statement

Timeline	Year 1	Year 2	Year 3	Year 4	Year 5 +
Subscribers					
New Subscribers	1,929	-	-	-	-
# of Subscriber at year end	1,929	1,929	1,929	1,929	1,929
Income Statement (Revenue)					
Infrastructure Fees	$115,740	$231,480	$231,480	$231,480	$231,480
Maintenance and Operations	$283,612	$567,224	$567,224	$567,224	$567,224
Gross Income	$399,352	$798,704	$798,704	$798,704	$798,704
Maintenance & Operating Costs (Expenses)					
Labor	-$118,560	-$183,040	-$183,040	-$183,040	-$183,040
Office Expense	-$71,064	-$142,129	-$142,129	-$142,129	-$142,129
Equipment & Supplies	-$33,614	-$67,228	-$67,228	-$67,228	-$67,228
Operating Expenses	-$27,893	-$55,787	-$55,787	-$55,787	-$55,787
Premise Equipment Refresh/Replacement	$0	-$11,690	-$11,690	-$11,690	-$11,690
Total M & O Expenses	-$251,131	-$459,873	-$459,873	-$459,873	-$459,873
Interest Expense	$0	$0	$0	$0	$0
Depreciation Expense	$0	$0	$0	$0	$0
Total Expenses	-$251,131	-$459,873	-$459,873	-$459,873	-$459,873
Net (Revenue vs Expenses)	$148,221	$338,832	$338,832	$338,832	$338,832
	37.12%	42.42%	42.42%	42.42%	42.42%

Projected Balance Sheet

Timeline	Year 1	Year 2	Year 3	Year 4	Year 5 +
ASSETS					
Cash	$148,221	$487,052	$825,884	$1,164,716	$1,503,547
Reserve Account	$58,449	$151,967	$245,485	$339,002	$432,520
TOTAL ASSETS	**$206,669**	**$639,019**	**$1,071,369**	**$1,503,718**	**$1,936,068**
LIABILITIES & CAPITAL					
Reserves Payable	$58,449	$151,967	$245,485	$339,002	$432,520
Retained Earnings	$0	$148,221	$487,052	$825,884	$1,164,716
Net Income	$148,221	$338,832	$338,832	$338,832	$338,832
TOTAL LIABILITIES & CAPITAL	**$206,669**	**$639,019**	**$1,071,369**	**$1,503,718**	**$1,936,068**

Cost Analysis & Phasing – City-Wide

Please Note – The financial modeling in this section does not include the benefit of ARPA funds, state or federal grants, philanthropic contributions, or the $30 subsidy under the Affordable Connectivity Program except for the amounts utilized in the proposed Lincoln Park Pilot.

It is anticipated that Duluth may qualify for and receive governmental grants and other funds that would offset a portion of the infrastructure costs outlined in this report.

This section provides cost modeling for a potential City-wide deployment. 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).

Monthly Infrastructure Cost Model

The cost modeling for the infrastructure construction is based on Minnesota wage rates. A take-rate of 60% (This means that 60% of homes and businesses subscribe) was used in the model. The variables in the cost model can be adjusted on a neighborhood-by-neighborhood basis as needed. A 60% take-rate may seem aggressive given the strong market position of the incumbent cable operator. However, the survey data suggests a strong desire among residents and businesses in Duluth to see competition, choice, better pricing, and the reliability of a fiber optic network. Additionally, existing open access networks that leverage the business model Duluth is considering consistently achieve a take-rate exceeding 60%.

The data in the line items in this model comes from actual bids for materials and network buildout experience. It should be noted that supply chain pressures have made the network materials market volatile for conduit, electronics, and some other network components.

The first illustration of Infrastructure Capital Costs per premise assumes a project that is 75% Buried and 25% Microtrenched. The second illustration of Infrastructure Capital Costs per premise assumes a project that is 100% Buried.

Costs at 60 % Take Rate			
75% Buried | 25% Microtrench			
Description	Common	Drop	Total
Labor	$1,074	$258	$1,332
Equipment & Materials	$1,668	$658	$2,326
Professional Services	$186	$30	$216
Backbone Cost	$25	$0	$25
Short Term Interest	$145	$0	$145
Total	**$3,099**	**$946**	**$4,044**

Monthly Infrastructure Per Premise Cost	**$22.65**

Costs at 60 % Take Rate			
100% Buried			
Description	Common	Drop	Total
Labor	$1,146	$275	$1,421
Equipment & Materials	$1,744	$678	$2,422
Professional Services	$186	$30	$216
Backbone Cost	$25	$0	$25
Short Term Interest	$152	$0	$152
Total	**$3,253**	**$983**	**$4,236**

Monthly Infrastructure Per Premise Cost	**$23.73**

Take-Rate is the percentage of premises that sign up for services out of the total number of homes that have the infrastructure available to them.

The Infrastructure Cost is the cost to build the network to the premise and includes the connection cost. In this model, this line item goes away once the infrastructure is paid off.

The Maintenance and Operations cost is an ongoing cost which is structured as a fiber optic utility.

ISP Services – Customers will shop for an ISP in much the same way they shop for other goods and services online. Five to Ten ISP's will be available in a portal.

Total Infrastructure Costs

The total projected construction costs for a city-wide deployment are summarized in the table below. The projections assume that 75% of the network will be Buried and 25% will be Microtrenched with a 60% take rate and short-term interest at 5% and a long-term interest rate of 3% for 20 years.

Project Pro-Forma

Financial Pro-Forma of Full Project Costs - 4 Year Build - Ethernet Architecture	
Projected Cost Per Premise (Common and Drop)	$4,044
Estimated Subscribers (21,709 minus 1,929 from pilot project)	19,780
Total Projected Project Costs	**$79,996,164**

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 and take-rate has a meaningful impact on the cost per premise.

The following table illustrates the impact of take-rate on total cost per premise under a 75% Buried and 25% Microtrenched network with a take-rate of 60% as neutral on impact.

Take-Rate Modeling

Take-Rate	Cost/Sub	Subscribers	Difference	vs. 60% Take-Rate
5.00%	$37,461	1,648	-	($33,417)
10.00%	$19,234	3,297	$18,227	($15,189)
15.00%	$13,158	4,945	$6,076	($9,114)
20.00%	$10,120	6,593	$3,038	($6,076)
25.00%	$8,297	8,242	$1,823	($4,253)
30.00%	$7,082	9,890	$1,215	($3,038)
35.00%	$6,214	11,538	$868	($2,170)
40.00%	$5,563	13,187	$651	($1,519)
45.00%	$5,057	14,835	$506	($1,013)
50.00%	$4,652	16,484	$405	($608)
55.00%	$4,320	18,132	$331	($276)
60.00%	$4,044	19,780	$276	$0
65.00%	$3,811	21,429	$234	$234
70.00%	$3,610	23,077	$200	$434
75.00%	$3,437	24,725	$174	$608
80.00%	$3,285	26,374	$152	$759
85.00%	$3,151	28,022	$134	$893
90.00%	$3,032	29,670	$119	$1,013
95.00%	$2,925	31,319	$107	$1,119
100.00%	$2,829	32,967	$96	$1,215

Full City-Wide Network Operations

The following Table summarizes the anticipated cost structure for Network Maintenance & Operations (M&O) on a city-wide basis. This schedule produces a projected monthly M&O fee for the Broadband Utility at $20.50 per month. This could be staffed with city employees or a contracted 3rd party operator.

Depending on the speed of the buildout, the city may need to subsidize network operations until enough scale is established to achieve sustainability. An accelerated deployment schedule will minimize a subsidy needed by the city. The model illustrates that any subsidy required from the city would be paid back over time.

Residential M&O	Subscriber	Monthly	Annual	Percentage
Labor	$5.00	$98,901	$1,186,812	24.39%
Office Expense	$5.43	$107,406	$1,288,878	26.49%
Equipment & Supplies	$2.36	$46,681	$560,175	11.51%
Operations Expense	$2.21	$43,714	$524,571	10.78%
Reserves	$5.50	$108,791	$1,305,493	26.83%
Total	**$20.50**	**$405,494**	**$4,865,929**	**100.00%**

Network Management & Operations Cost Structure

The numbers and categories in the above model are derived from many years of experience with actual costs for Broadband projects. Labor costs are modeled to reflect wages from the Duluth region.

Staffing Modeling for Internal Network Operations

The Table below models the cost structure for the positions needed for the City of Duluth to operate the network as a department within the city structure. The model is conservative in projecting the staffing estimates needed to operate the network in a sustainable manner. The model is for operations only and does not include resources for construction. The analysis assumes that the city will build the network over a 48-month period. This timeline would mean that the city will need to subsidize this department for less than 14 months. After that, the investment will be paid back by operational surpluses as the number of subscribers grows beyond the target of 21,709 premises.

The work that will be done by a Fiber Network Department includes network monitoring, network management, outside plant repairs, and new customer installations.

As stated earlier, the city has the option of operating the network with internal staffing resources or a 3rd Party network operations partner. EntryPoint expects M&O costs will be 25% - 30% more expensive with a 3rd party operator due to changed incentives from service to profit and reductions in efficiencies. With 3rd party management the monthly M&O fee would likely be $22.00 - $23.00 per residential premise.

There are both regional and national firms available to provide 3rd party services at market competitive pricing. The M&O function includes both inside plant (Network Operations Center, IT Support, Network Monitoring, Troubleshooting) and outside plant (Fiber Splicing, Fiber Construction, Landscaping, etc.). These functions can be outsourced to a single contractor or to multiple contractors by function.

The following staffing model provides anticipated fully burdened salary information, years to profitability, and the revenues and expenses from the operation.

Staffing Projections

Position	Fully Compensated Hourly Rate	Fully Compensated Monthly Cost	Fully Compensated Annual Cost
Manager	$53	$9,187	$110,240
Network Admin	$42	$7,280	$87,360
I.T. Technician	$33	$5,720	$68,640
Outside Manager	$31	$5,373	$64,480
Outside Plant Tech	$24	$4,160	$49,920

Subscriptions & Staffing Projections

Subscribers	Year 1	Year 2	Year 3	Year 4	Year 5 +
New Subscribers	5,000	5,000	5,000	4,780	-
# of Subscriber at Year End	5,000	10,000	15,000	19,780	19,780
Labor Allocation (From M&O Fees)	$5.00	$5.00	$5.00	$5.00	$5.00
Cash Flow from Labor	$150,000	$450,000	$750,000	$1,043,400	$1,186,800

Staffing Projections	Year 1	Year 2	Year 3	Year 4	Year 5
Manager	0.0	0.0	0.5	1.0	1.0
Network Admin	0.0	0.5	1.0	1.0	1.0
IT Technician	1.0	2.0	3.0	4.0	5.0
Outside Plant Manager	0.0	1.0	1.0	1.0	1.0
Outside Plant Laborer	2.0	4.0	6.0	8.0	10.0

Position	Year 1	Year 2	Year 3	Year 4	Year 5
Manager	$0	$0	$55,120	$110,240	$110,240
Network Admin	$0	$43,680	$87,360	$87,360	$87,360
IT Technician	$68,640	$137,280	$205,920	$274,560	$343,200
Outside Plant Manager	$0	$64,480	$64,480	$64,480	$64,480
Outside Plant Laborer	$99,840	$199,680	$299,520	$399,360	$499,200
Total	**$168,480**	**$445,120**	**$712,400**	**$936,000**	**$1,104,480**
Net	**-$18,480**	**$4,880**	**$37,600**	**$107,400**	**$82,320**

Subscriber Costs

The table below summarizes the projected costs for two scenarios: 1) A deployment that is 75% Buried / 25% Microtrenched, and 2) a deployment that is 100% Buried. The summary breaks this down into the three main cost categories.

Projected Subscription Cost

Projected Residential Services Monthly Costs	75% Buried | 25% Microtrenched
Infrastructure	$22.65
Maintenance and Operations	$20.50
ISP Services (Dedicated 1 GB Symmetrical)	$9.99
Monthly Total	**$53.14**

Projected Residential Services Monthly Costs	100% Buried
Infrastructure	$23.73
Maintenance and Operations	$20.50
ISP Services (Dedicated 1 GB Symmetrical)	$9.99
Monthly Total	**$54.22**

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

Financial Modeling Assumptions

EntryPoint based its analysis on the following demographic information for the City of Duluth:

Potential Subscribers: 36,182
(Households and Businesses)

Subscribers @ 60%: 21,709

Income Statement and Balance Sheet

The following two tables represent a projected Income Statement and Balance Sheet covering the first 5 years, during the initial network deployment stage. These tables assume the full $79.9 million build cost is funded with debt at a 3% interest rate over 20-years.

Projected Income Statement

Timeline	Pilot Year	Year 1	Year 2	Year 3	Year 4	Year 5 +
Subscribers						
Pilot Subscribers	1,929	1,929	1,929	1,929	1,929	1,929
New Subscribers	-	5,000	5,000	5,000	4,780	-
# of Subscriber at year end	-	5,000	10,000	15,000	19,780	19,780
Income Statement (Revenue)						
Pilot Infrastructure Fees	$115,740	$231,480	$231,480	$231,480	$231,480	$231,480
Pilot Maintenance and Operations	$283,612	$567,224	$567,224	$567,224	$567,224	$567,224
Infrastructure Fees	$0	$679,594	$2,038,781	$3,397,968	$4,727,253	$5,376,944
Maintenance and Operations	$0	$615,000	$1,845,000	$3,075,000	$4,277,940	$4,865,880
Gross Income	$399,352	$2,093,298	$4,682,485	$7,271,672	$9,803,897	$11,041,529
Maintenance & Operating Costs (Expenses)						
Labor	-$118,560	-$351,520	-$628,160	-$895,440	-$1,119,040	-$1,287,520
Office Expense	-$71,064	-$305,029	-$630,829	-$956,629	-$1,275,261	-$1,430,994
Equipment & Supplies	-$33,614	-$138,028	-$279,628	-$421,228	-$559,713	-$627,398
Operating Expenses	-$27,893	-$122,087	-$254,687	-$387,287	-$516,970	-$580,353
Premise Equipment Refresh/Replacement	$0	-$11,690	-$61,190	-$94,190	-$126,464	-$142,238
Total M & O Expenses	-$251,131	-$928,354	-$1,854,494	-$2,754,774	-$3,597,448	-$4,068,502
Interest Expense	$0	-$738,821	-$1,334,099	-$1,903,533	-$2,417,653	-$2,219,223
Depreciation Expense		-$484,214	-$1,452,642	-$2,421,070	-$3,368,193	-$3,831,102
Total Expenses	-$251,131	-$2,151,389	-$4,641,235	-$7,079,378	-$9,383,294	-$10,118,827
Net (Revenue vs Expenses)	$148,221	-$58,091	$41,250	$192,295	$420,604	$922,702
	37.12%	-2.78%	0.88%	2.64%	4.29%	8.36%

Projected Balance Sheet

Timeline	Pilot Year	Year 1	Year 2	Year 3	Year 4	Year 5 +
ASSETS						
Cash	$148,221	$1,813,166	$3,269,702	$5,077,797	$7,238,093	$8,886,461
Reserve Account	$58,449	$891,352	$1,955,256	$3,283,159	$4,839,353	$5,872,047
Year 1 Fiber Build	$0	$19,368,563	$19,368,563	$19,368,563	$19,368,563	$19,368,563
Year 2 Fiber Build			$19,368,563	$19,368,563	$19,368,563	$19,368,563
Year 3 Fiber Build				$19,368,563	$19,368,563	$19,368,563
Year 4 Fiber Build					$18,516,346	$18,516,346
Total Fiber Build Assets	$0	$19,368,563	$38,737,125	$58,105,688	$76,622,034	$76,622,034
Accumulated Depreciation (Year 1 Build)	$0	-$484,214	-$1,452,642	-$2,421,070	-$3,389,498	-$4,357,927
Accumulated Depreciation (Year 2 Build)			-$484,214	-$1,452,642	-$2,421,070	-$3,389,498
Accumulated Depreciation (Year 3 Build)				-$484,214	-$1,452,642	-$2,421,070
Accumulated Depreciation (Year 4 Build)					-$462,909	-$1,388,726
Total Accumulated Depreciation	$0	-$484,214	-$1,936,856	-$4,357,927	-$7,726,120	-$11,557,221
Net Fiber Build Assets	$0	$18,884,349	$36,800,269	$53,747,761	$68,895,914	$65,064,812
TOTAL ASSETS	**$206,669**	**$21,588,867**	**$42,025,227**	**$62,108,717**	**$80,973,360**	**$79,823,321**
LIABILITIES & CAPITAL						
Year 1 Debt	$0	$20,607,384	$19,843,705	$19,056,798	$18,245,956	$17,410,452
Year 2 Debt			$20,094,884	$19,350,197	$18,582,860	$17,792,184
Year 3 Debt				$20,094,884	$19,350,197	$18,582,860
Year 4 Debt					$19,210,709	$18,498,789
Total Debt	$0	$20,607,384	$39,938,588	$58,501,879	$75,389,723	$72,284,286
Reserves Payable	$58,449	$891,352	$1,955,256	$3,283,159	$4,839,353	$5,872,047
Retained Earnings	$0	$148,221	$90,129	$131,380	$323,674	$744,278
Net Income	$148,221	-$58,091	$41,250	$192,295	$420,604	$922,702
TOTAL LIABILITIES & CAPITAL	**$206,669**	**$21,588,865**	**$42,025,224**	**$62,108,712**	**$80,973,354**	**$79,823,313**

Potential Sources of Capital

Grants, Loans & Philanthropic Opportunities

The city and its partners will pursue all available Federal and State broadband grant opportunities that may be a fit for Duluth's proposed project. The City will rely on advice from legal counsel and industry experts as it seeks and utilizes state and federal funding assistance.

Potential Capital Sources may include:

- Philanthropic Contributions
- Coronavirus State & Local Fiscal Recovery Funds (ARPA)
- Infrastructure Investment and Jobs Act
- NTIA - Connecting Minority Communities Pilot Program
- Affordable Connectivity Program
- Community Investment Trust Fund (CITF)
- State Grants
  > Border to Border Broadband Grant Program (Office of Broadband Development)
- Other

ARPA

The Final Rule for the Coronavirus State & Local Fiscal Recovery Funds will take effect on April 1, 2022. The US Treasury Department guidance states:

The final rule significantly broadens eligible broadband infrastructure investments to address challenges with broadband access, affordability, and reliability.

The Coronavirus State and Local Fiscal Recovery Funds 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.

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

Infrastructure Investment and Jobs Act

President Biden's Infrastructure Investment and Jobs Act 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/

The Connecting Minority Communities Pilot Program

The Connecting Minority Communities Pilot Program, which will direct $268 million for expanding broadband access and connectivity to eligible Historically Black Colleges or Universities (HBCUs), Tribal Colleges or Universities (TCUs), minority-serving institutions (MSIs), and consortia led by an HBCU, TCU, or MSI that also include a minority business enterprise or tax-exempt 501(c)(3) organization.

“Communities of color have faced systemic barriers to affordable broadband access since the beginning of the digital age,” said U.S. Secretary of Commerce Gina M. Raimondo. “The investments we make as part of the Connecting Minority Communities Pilot Program will help communities that are struggling with access, adoption and connectivity, and will inform our path forward as we seek to finally close the digital divide across the country.”

Source: https://www.ntia.doc.gov/press-release/2021/department-commerce-s-ntia-begin-accepting-applications-268-million-connecting

Affordable Connectivity Program

Congress created the Affordable Connectivity Program, a new long-term, $14 billion program, to replace the Emergency Broadband Benefit Program. This investment in broadband affordability will help ensure we can afford the connections we need for work, school, health care and more for a long time. The maximum monthly benefit will change from $50 per month to $30 per month for households not located on qualifying Tribal lands.

Source: https://www.fcc.gov/broadbandbenefit

Individual State Broadband Grants

Broadband Equity, Access and Deployment (BEAD) Program Funding includes $42.45 billion for a new Broadband Equity, Access and Deployment (BEAD) 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). In order 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.

Market Assessment

Incumbent Offers and Pricing

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

Spectrum

Spectrum advertises the following residential ISP services in Duluth:

Speed (Mbps) [Down / Up]	12 Month Rate [Contract Required]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet [Billings]	Double Play [Billings]
100 / 10	$50.00	$75.00	TBD	$68.74	$88.95
400 / 20	$70.00	$95.00	TBD	$91.99	$259.25
940 / 35	$110.00	$135.00	TBD	No Data	No Data

Information in the table above is from Spectrum's website Data from Spectrum Bills

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 WiFi - $5.00 per month
Availability depends upon location – not available in all areas

CenturyLink

CenturyLink advertises the following residential services in Duluth:

Speed [Down / Up]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet [Billings]	Double Play [Billings]
3 Mbps / .5 Mbps	$50.00	Self-Install	No Data	No Data
6 Mbps / .5 Mbps	$50.00	Self-Install	No Data	No Data
10 Mbps / .75 Mbps	$50.00	Self-Install	No Data	No Data
20 Mbps / 1.5 Mbps	$50.00	$99.00	No Data	No Data

Information in the table above is from CenturyLink's website Data from CenturyLink Bills

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 WiFi - $15.00 per month
Soft Data Caps apply to all service plans
Availability depends upon location – not available in all areas

Spectrum Business

Spectrum advertises the following business ISP services in Duluth:

Speed (Mbps) [Down / Up]	Promo Pricing [12 months rate]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet [Billings]	Triple Play [Billings]
200 / 10	$65.00	Not Disclosed	TBD	$97.98	$255.26
600 / 35	$115.00	Not Disclosed	TBD	$134.98	$234.96
940 / 35	$149.00	Not Disclosed	TBD	No Data	No Data

Information in the table above is from Spectrum's website

Data from Spectrum Bills

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
Availability depends upon location – not available in all areas

CenturyLink Business

CenturyLink advertises the following DSL business ISP services in Duluth:

Speed [Down / Up]	Standard Pricing [+ Taxes and Fees]	Install [Fee]	Internet [Billings]	Double Play [Billings]
3 Mbps / .5 Mbps	$50.00	Self-Install	No Data	No Data
15 Mbps / 1.5 Mbps	$50.00	Self-Install	No Data	No Data
20 Mbps / 1.5 Mbps	$50.00	Self-Install	No Data	No Data

Information in the table above is from CenturyLink's website

Data from CenturyLink Bills

Taxes and Fees often represent an additional (10%-15%) of Standard Pricing
Speeds are not Symmetrical
Modem with WiFi - $15.00 per month
Availability depends upon location – not available in all areas

[Market Research Conducted in October 2021]

Network Reliability

EntryPoint is recommending the following to improve network reliability in Duluth:

1) Build a fiber optic network
2) Follow an ethernet (non-Shared) architecture rather than a PON (Shared) architecture
3) Deliver symmetrical speeds to subscribers.

The existing networks in Duluth do not have any of these three attributes for residential customers. Current speed test data for Duluth underscores the gaps in speed and reliability and the need for a high speed, high reliability network.

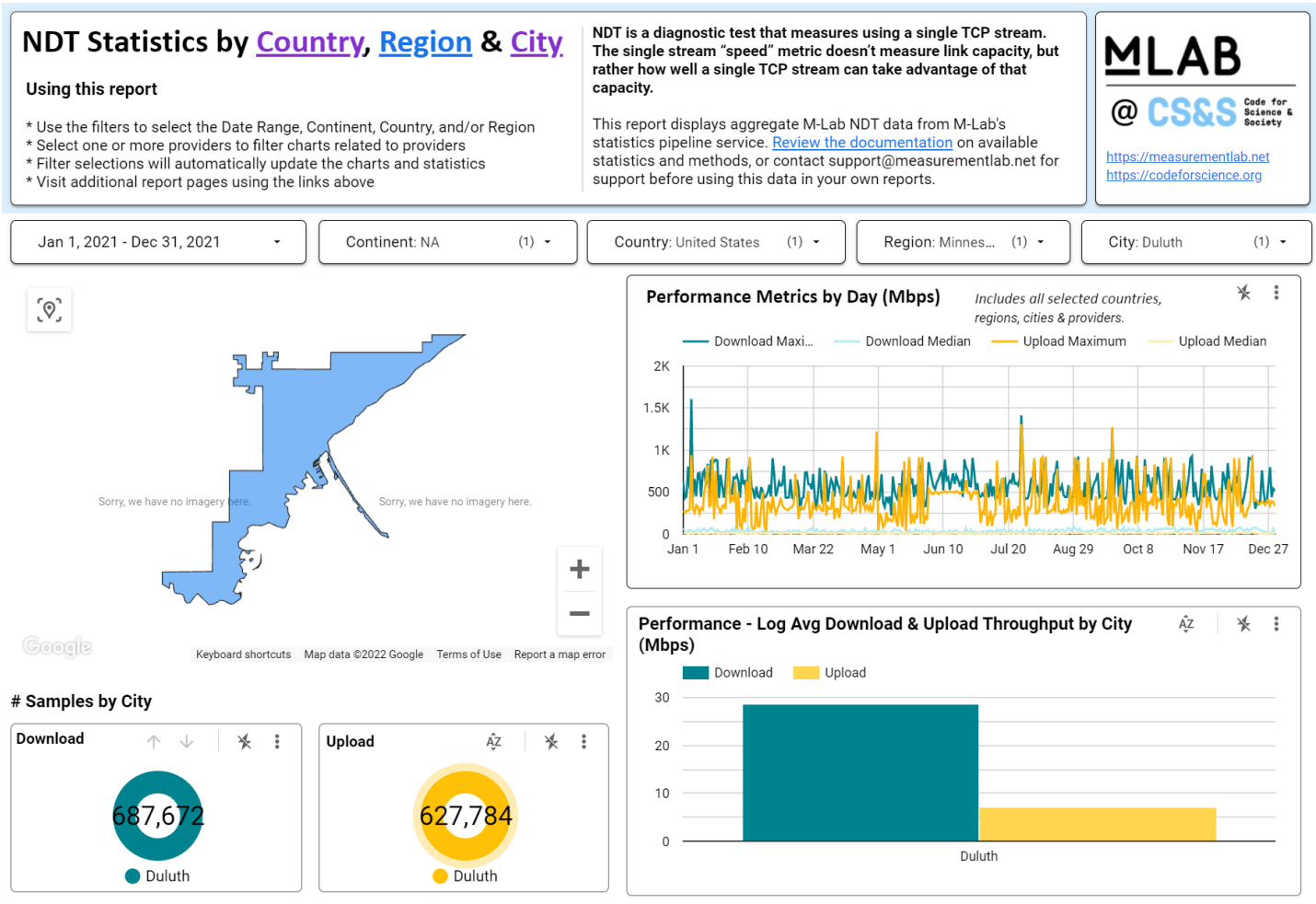
Market Assessment Conclusion

Based on the survey response data, it appears that **Spectrum has close to an ISP monopoly** in residential neighborhoods throughout Duluth. A strategy to change the monopolistic conditions in Duluth is a key focus of this Broadband Plan.

Speed Test Data

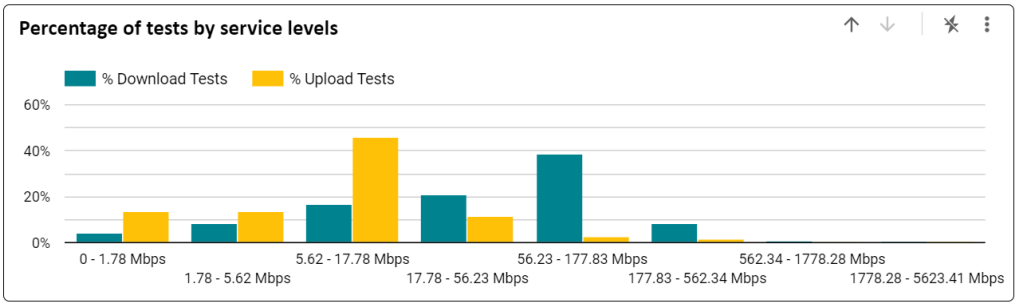
mLABS is an academic group that provides authoritative data from speed tests on a city-by-city basis across the United States. Academic and scientific research organizations rely on mLAB data. Every time an individual runs a speed test through an affiliate of mLABS, the data is saved in Cloud Storage hosted by Google and made available to the public. The data below is the speed test results in the City of Duluth from January 1, 2021 to December 31, 2021. The sample size for this 12-month period includes 687,672 speed tests.

The average speed delivered by Spectrum (Charter) in Duluth is 54.92 Mbps download / 7.03 Mbps upload. CenturyLink's average speed in Duluth is 8.45 Mbps download / .99 Mbps upload.



NDT statistics used in this report are provided as daily histograms, consisting of the percentage of measurements within a range of "service levels" or speed ranges.

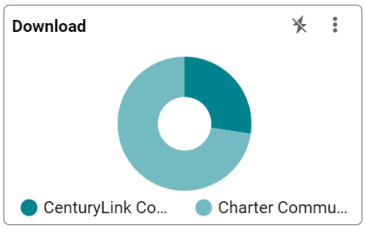
The chart on the right presents the histogram of tests that measured at these levels over the selected date range and locations, across all providers.

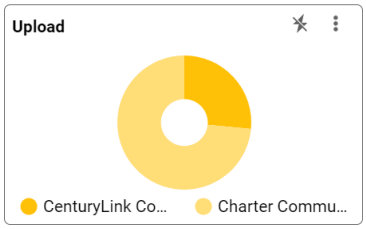


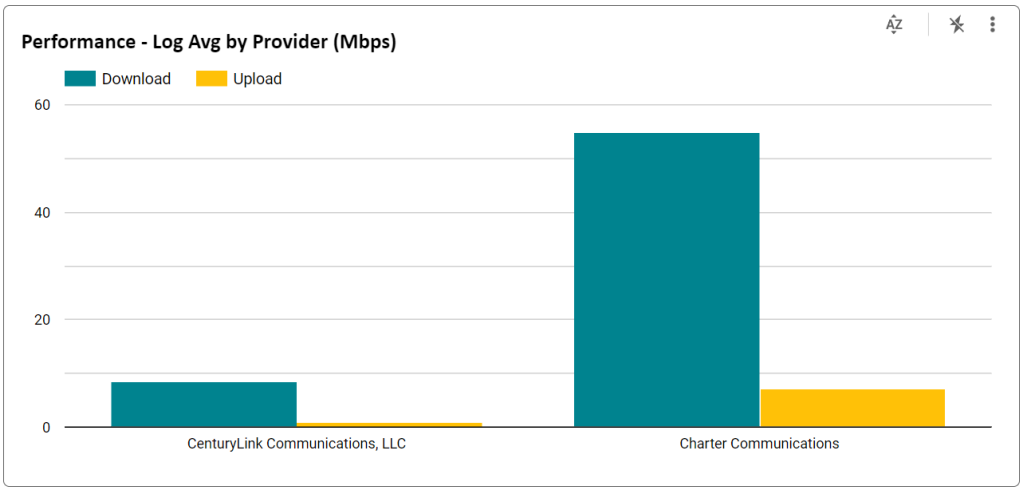
Provider Statistics

In the NDT dataset, each test is associated with the Autonomous System operating the IP address from which each test was conducted. This may be different than the ISP that offers service.

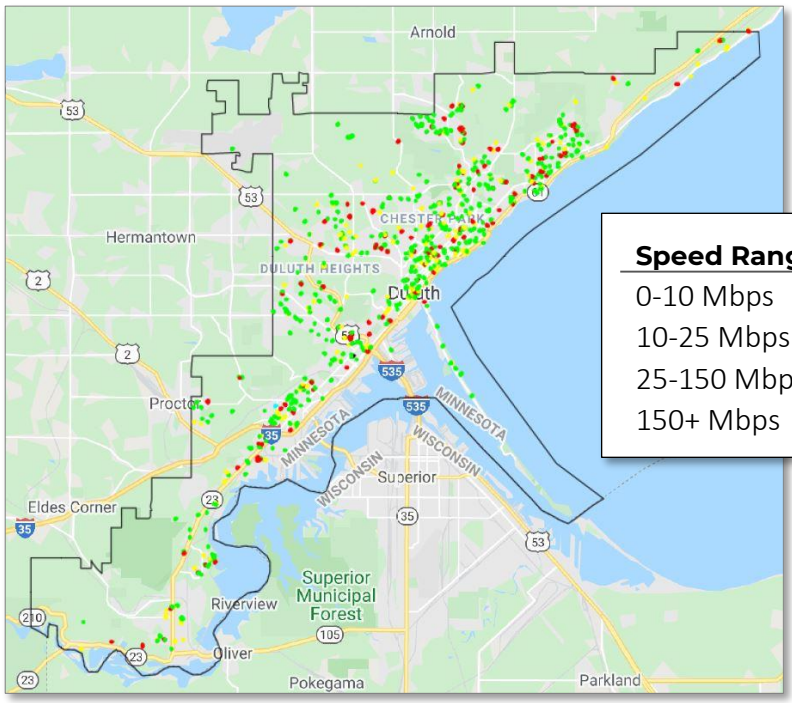
Samples by Provider







In addition to the mLAB speed test data above, RAMS (Range Association of Municipalities and Schools) conducted a Minnesota speed test initiative in the first part of 2021. The following is a summary of the Duluth dataset.



Speed Range	Downloads	%	Uploads	%
0-10 Mbps	142	19%	343	45%
10-25 Mbps	151	20%	369	49%
25-150 Mbps	420	56%	26	3%
150+ Mbps	31	4%	16	2%

Create a Network That is Responsive to Residents

Most US internet connections are provided by a large national ISP. While there are some benefits that are a consequence of the scale and resources of these large corporations, these ISP's are organized to operate at a national scale rather than to pay attention to or be responsive to local needs. Part of the value proposition offered by publicly owned broadband infrastructure is to create local control and ownership of network infrastructure which is responsive to local needs. Additionally, a locally owned and operated Open Access Network is more likely to offer local service providers to subscribers.

The interests of the City of Duluth 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 municipalities aligns perfectly with the interests of individual businesses, residents, and anchor institutions who subscribe to the network. The city and residents will benefit from a network that is locally owned, operated, and open to local service providers.

Foster Innovation & Economic Development

The economy is now an information economy, and the importance of digital infrastructure continues to grow in significance. In the next 10 – 15 years, the technologies that are in their infancy now will move from science projects to mainstream society. These are things like self-driving cars, the blockchain, a grid that is dominated by renewable energy, education and healthcare automation and virtualization, and virtual reality technologies. The construct that is "the internet" is going to look very different in 10 years than it looks today. Many of the large technology companies (Tesla, Apple, Facebook, and Google) are focused on a different set of fundamental technologies than we have today. An important question every city should be asking is what kind of network will be needed to support these emerging technologies and how can the City anticipate these emerging technologies?

Data Center networks are quite different than today's traditional Fiber to the Home networks. Because a data center stores, processes, and distributes enormous amounts of data, the efficiency, flexibility, automation, and resiliency of the operation is very important. As new technologies emerge, these same attributes will become increasingly important for Fiber to the Home networks for the same reasons that they are important in data centers.

The evolution of data centers provides important clues on what will become important for the future of city-wide networks and the potential for these networks to enable innovation and economic development. Significant Data Center trends include the following:

- Use of Virtualization (Including Network Virtualization).
- Software Defined Networking and Automation are increasingly ubiquitous and viewed as mandatory rather than a nice to have.
- White box switching is steadily gaining ground (the hardware and software are acquired separately from different vendors).
- Microservices and containers are increasingly used.

The technologies and models used in Data Centers have evolved significantly over the past 30 years. Alternatively, the technologies and models used in city-wide networks have seen very modest changes in the past 20 years. As noted earlier, most FTTH networks built today still follow a shared infrastructure (neighbors share a network connection), are asymmetrical (much slower upload than download speed), use very little network automation and virtualization, suffer from vendor lock-in, and are hardware defined rather than software defined. Why have our city-wide networks not evolved faster over the past 30 years? Because these networks are organized for profitability rather than utility and the lack of a competitive threat has allowed incumbents to settle for the status quo.

Further, in legacy hardware-defined networks, the network is siloed, and you must build a new physical silo for every problem you want to solve. With a Software Defined Network, problems get solved in software at a much lower cost and much faster speed. In 2011, Marc Andreessen said “software is eating the world.” The simple explanation for why “software is eating the world” is that it is less expensive, faster, and more efficient to solve problems with software. Software will also eat networks because software solutions are less expensive, faster to implement, and more efficient.

A key economic development value differentiator for networks going forward will be resilience to future technology. It is important to note that the point of deploying advanced technologies is not to have the best technology. The point is to have network attributes and tools that add value for subscribers and communities.

Networks that are software defined, open to any service or innovation, organized as utility infrastructure, and designed with a data center architecture will likely offer distinct economic development advantages over static networks missing these attributes.

The mechanisms are in place for Duluth to put in place long term solutions to lower costs and connect all Duluth residents. The key enabler to connect everyone is for Duluth to own and control its digital infrastructure. Once Duluth is the infrastructure owner, the city can use other tools to drive desired outcomes.

Duluth Broadband Survey Results

From October 1st – December 17th, 2021, the City of Duluth 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:

And the Survey Says…

Total Responses	**1,716**		
Respondent Designation			
	1,648	Residential	96.04%
	35	Commercial	2.04%
	18	Student	1.05%
	14	Non-Profit	0.81%
	1	Religious Org	0.06%
Primary Use of Internet			
	1,329	Entertainment	77.40%
	1,159	Email	67.50%
	1,140	Work	66.39%
	990	Shopping	57.66%
	902	Social Media	52.53%
	535	Gaming	31.16%
	454	School	26.44%
	223	Business	12.99%
	152	Other	8.85%
Current Internet Access			
	1,546	Fixed Wire Connection	90.30%
	134	Cellular Connection Only	7.83%
	32	Do Not Have Internet	1.87%
Type of Internet Connection			
	183	DSL (CenturyLink)	12.11%
	1,248	**Cable (Spectrum)**	**82.60%**
	27	Fiber	1.79%
	11	Satellite	0.72%
	22	Other	1.46%
	20	Don't Know	1.32%
Current Internet Reliability			
	179	Poor	11.96%
	364	Fair	24.32%
	445	Good	29.73%
	353	Very Good	23.58%
	132	Excellent	8.81%
	24	No Internet	1.60%
	543	**Poor/Fair**	**36.28%**
Current Internet Speed			
	220	Poor	14.70%
	399	Fair	26.65%

447	Good	29.86%
292	Very Good	19.51%
115	Excellent	7.68%
24	No Internet	1.60%
619	**Poor/Fair**	**41.35%**
Current Internet Affordability		
678	Poor	45.39%
508	Fair	34.00%
199	Good	13.32%
61	Very Good	4.08%
23	Excellent	1.54%
25	No Internet	1.67%
1,186	**Poor/Fair**	**79.39%**
Average Monthly Cost of Internet		
1,372	Residential	$79.68
27	Commercial	$176.70
9	Non-Profit	$96.00
Affordable Residential Internet		
17	$0 - $10	1.14%
44	$11 - $20	2.94%
188	$21 - $30	12.57%
303	$31 - $40	20.25%
470	**$41 - $50**	**31.42%**
217	$51 - $60	14.51%
87	$61 - $70	5.82%
77	$71 - $80	5.15%
17	$81 - $90	1.14%
48	$91 - $100	3.21%
12	$101 - $110	0.80%
3	$111 - $120	0.20%
2	$121 - $130	0.13%
1	$131 - $140	0.07%
2	$141 - $150	0.13%
8	$150+	0.52%
Support City-Sponsored Broadband		
1,137	Very Likely	77.51%
296	Possibly	20.18%
34	Not Likely	2.31%
1,433	**Yes/Possibly**	**97.69%**

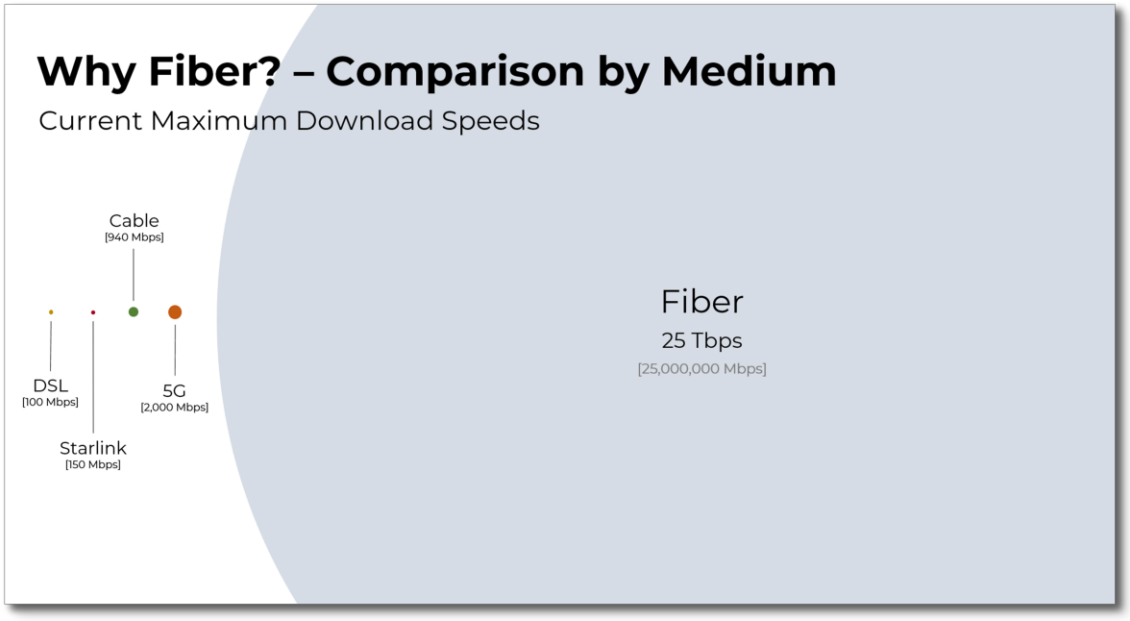
Comparison of Available Media

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. AT&T is the incumbent telephone company in Duluth and uses DSL technology. DSL is asymmetrical (the download speed is much faster than the upload speed), is a dedicated connection capable of download speeds up to 100 Mbps depending on the DSL standard, copper line age, and distance. Most consumers accessing the internet via DSL experience speeds between 5 – 25 Mbps.

Coaxial Cable uses copper cable designed with one physical channel that carries the signal surrounded by a layer of insulation and then another physical channel, both running along the same axis – hence the coaxial name. Coaxial cable is primarily used by cable TV companies to connect transmission facilities to customer homes and businesses to deliver cable TV and internet access. Spectrum is the incumbent cable company in the Duluth 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 Duluth is 3.1 and the maximum speed available is 940 Mbps. In addition to the limitation of sharing among a large number of 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 156 Tbps *(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 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 mobile device. Wireless Internet can be accessed directly through providers like AT&T Wireless, Verizon Wireless, T-Mobile, or by a Wireless Internet Service provider (WISP).

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. 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 "millimeter wave" spectrum and delivers gigabit speeds (currently tested as high as 3 Gbps). The millimeter wave transmitters have very limited range and requires the deployment of many small transmitters. Each transmitter connects to fiber optics.

  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.

Impact of Bandwidth on Applications

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

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. Applications that depend on good upload speeds include sending large files, cloud applications like Google Docs, Dropbox, VoIP, FaceTime, Skype, Zoom, WebEx, hard drive backups and In-house web hosting.

Network Architecture

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

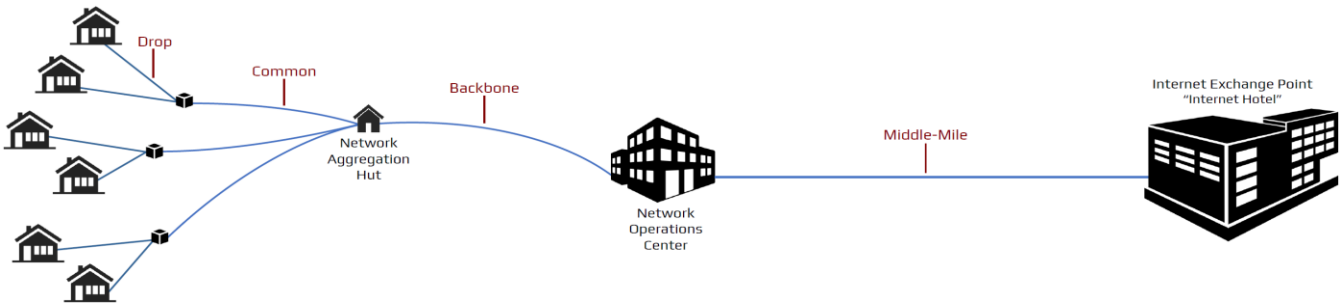
The Switched Ethernet architecture provides a dedicated connection for each customer rather than a shared connection and the customer experience is significantly better than in a shared architecture during periods of network congestion because the throughput of a switch-based architecture is superior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

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. The illustration below shows that the variable costs of a switched ethernet deployment is now equal to PON. This change in pricing differences was driven by the fact that all Data Center deployments use Switched Ethernet architectures and the enormous growth of Data Centers over the past 20 years has driven down the cost of Ethernet electronics.

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 3rd-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.

Municipal Network Models

Single ISP vs Open Access - Overview

The most prevalent model for internet access is the Single ISP model. The dominant incumbents which control 99% of internet access in the U.S. all run single ISP operations where they are both the infrastructure owner and the sole ISP available on the network. Most of the early municipal implementations have followed the Single ISP model where the City or Municipal Electric Utility became the ISP.

Open Access is a model which divides the infrastructure and services into two separate systems and the infrastructure is shared by multiple service providers. Open access is prevalent in Europe and there is a growing number of Open Access networks in the United States. The early Open Access implementations have been publicly owned but there is a growing presence of privately owned Open Access networks as banks and infrastructure lending institutions have recognized that consumers want more ISP options.

A recent study commissioned by the Electronic Frontier Foundation concluded that Open Access is "the key to broad US fiber to the premises (FTTP) coverage." The report provides evidence that open-access networks are "the most cost-effective and efficient way to end the digital divide that has left millions of people, particularly those in rural and low-income areas, with inadequate or no internet service."

https://www.benton.org/headlines/wholesale-fiber-key-broad-us-fiber-premises-coverage

Municipal Broadband Models Comparison

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

Duluth has considered the following models in its analysis. Single ISP models were eliminated from considerations because a single ISP does not significantly expand choice or competition. The city is essentially replicating the incumbent model and competing against the incumbent head-to-head. This model leaves the city vulnerable to the incumbent dropping their price to hurt the municipal take-rate and destabilize the municipal network. This model is vulnerable to vendor lock-in and makes it difficult for the city to adapt to change as the current internet paradigm evolves.

Municipality	Population	Model Type	Ownership	Take-Rate	Cost of 1 Gig
Chattanooga, TN	179,139	Electrical Utility, 1 ISP	Utility/Public	60%	$68.00
Lafayette, LA	126,000	Electrical Utility, 1 ISP	Utility/Public	40%	$99.95
Westminster, MD	19,000	City Fiber, Private ISP	Muni/Public	30%	$89.99
Huntsville, AL	194,585	Dark Fiber Open Access	Utility/Public	Not Published	$70.00
Sandy, OR	10,000	Single ISP	Muni/Public	60%	$59.95
Longmont, CO	86,000	Electrical Utility, 1 ISP	Public	55%	$69.95

Ammon, ID	17,000	Automated Open Access	Muni/Public	60%	$48.50
Monmouth, OR	15,083	Single ISP	Muni/Public	80%	$129.65
Lexington, KY	321,959	Single ISP	Private	Not Published	$59.95
Monticello, MN	14,455	Single ISP	Muni/Public	Not Published	$118.95
Santa Monica, CA	110,000	Dark Fiber Business Only	Muni/Public	N/A	N/A
Fort Collins, CO	165,000	Electrical Utility, 1 ISP	Utility/Public	Early Stage	$59.95
UTOPIA	150,000+	Manual Open Access	Quasi-Public	20%-30%	$75.00
Fullerton, CA	140,000	Privately Owned, 2 ISP's	Private	Early Stage	$79.00

Open Access Models Defined

Dark Fiber Open Access

Summary: Dark Fiber Open Access is a model where the city builds infrastructure to the curb. The subscriber then selects an ISP as its provider and the ISP finishes the connection to the home with its own infrastructure and electronics. The ISP selected by the subscriber lights the network.

Pros: Open Access increases choice for consumers. Operating a dark fiber network is less complicated than operating a lit network.

Cons: The Dark Fiber model gives 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 not be available through the ISP that controls the drop to the customer premise. The Dark Fiber Model may not scale easily due to difficulty in anticipating the required fiber count to meet the demand. This can create significant complications for the network operator.

Examples of this model are Huntsville, AL and Santa Monica, CA

Manual Open Access

Summary: Manual Open Access is a model where the network is lit end to end. This means that the network operator places and controls the electronics at both ends of the network. In this model, switching service providers can be requested from a web portal and may appear to be automated but provisioning new customers and switching ISP's is a manual function.

Pros: A Manual Open Access network increases choice for consumers.

Cons: Any increase in the number of service providers operating on the network adds to network complexity and the complexity is managed manually. The lack of automation negatively impacts operating expenses and scalability.

An example of this model is the UTOPIA Network. UTOPIA is the largest manual open access network in the United States with more than 20,000 premises connected. UTOPIA struggled under heavy debt obligations for

15 years but is now operating on a sustainable trajectory. In addition to UTOPIA, there are several Manual Open Access networks throughout Europe.

Automated Open Access™

Summary: Automated Open Access is a model where the network operator places electronics at both ends of the network (lit infrastructure) and subscribers can dynamically select service providers in real-time. Software Defined Networking is used to automate network management tasks.

Pros: 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. The automated provisioning creates a marketplace for services which includes ISP's and private networks for other services. The automation lowers the barriers to entry for ISP's and accelerates competition. A main benefit of this model is that the complexity of network management is automated for all stakeholders which translates into lower subscriber costs. This model also includes the ability to provide automated private networks and local network resilience via local communications if connections over the middle mile are down.

The model was first implemented in late 2016 in Ammon, ID. There are more than 25 cities that are in the planning, engineering, or construction phases of implementation of this model with homes connected in a handful of these cities. The populations of these cities range from 10,000 – 700,000.

Cons: Ammon is the only full implementation currently.

Examples: Ammon, ID; Elkhart, IN; NevCo Fiber, CA, Mountain Home, ID

Disclosure: EntryPoint Networks owns and operates an Automated Open Access Network Management solution and is the technology partner in Ammon.

Note Related to Private Ownership Models

Private Ownership of Infrastructure models were not considered because it is likely that many independent fiber networks will eventually be rolled up via an industry consolidation, just as Comcast, Charter, and Cox consolidated the cable industry over the last 30 years. This will leave many cities with a private monopoly network provider and although the network will get fiber optics, the problems inherent to monopolies will remain.

Risk Assessment

10

Risk Factors >

Likelihood
Impact
Mitigation

Strategy Statement

The city seeks to understand the primary risks of building and operating a municipal fiber optic network and to actively manage those risks during construction and then on an ongoing basis during network operations.

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

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

Subscriber Churn

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

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

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

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

Take-Rate Risk

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

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

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

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

Project Execution Risk

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

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

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

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

Equipment & Technology Risk

Equipment & Technology Risk includes both 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. For a network, the size of Duluth, an additional risk is scalability risk.

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

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

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

Community Engagement

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

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

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

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

Cost Modeling Risk

Cost Modeling Risk is the risk that cost modeling significantly underestimates 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.

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

Mitigation: Validate financial assumptions against industry assumptions, market conditions, and account for local economic variables.

Timeline Risk

The benefits of building the network in an accelerated pace 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 period to break-even.
3) Interest Rates are at an unprecedented low currently and building over an extended period may expose later project years to some interest rate risk.

Likelihood: Costs are certain 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. These trade-offs need to be weighed by City leaders.

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

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

Regulatory Risk

Regulatory Risk is the risk that State of Federal regulation become an impediment or barrier to the city successfully building or operating a municipal network. The Duluth Assistant City Attorney, Steve Hanke has prepared an analysis describing the legal authority to build, own, and operate broadband infrastructure as well as the legal structures that are available to cities in the State of Minnesota. *(See Legal Memo attached at the end of this document following the term definitions.)*

Minnesota Statues Chapter 237.190 outlines the process under which a municipality can own and operate a telephone exchange within its borders. The model contemplated by the City would not be subjected to the Municipal Telecommunications Services requirements because the City will not be owning and operating a telephone exchange as defined in statue 237.190. Instead, what the city will provide is a fiber optic infrastructure (platform) that are not, in and of themselves, a facility capable of providing a telephone exchange service to consumers.

Further, Duluth Assistant City Attorney also noted that Minnesota Statutes Chapter 429 does not apply to Duluth because it is a home rule charter city and city of the first class. Chapter 429 only applies to statutory cities and cities of the second, third, and fourth class. See Minn. Stat. 429.011, Subd. 2.

Likelihood: Historically, incumbent operators have taken legal action to stop municipalities from building a competing network whenever they have a legal basis for doing so. Based on the attached memo our interpretation is that there is a legal basis for Duluth to build this infrastructure as summarized previously.

Impact: If a claim were to be brought against Duluth, it could take an extensive amount of time and cost to contest or appeal the claim – but this is unlikely.

Middle Mile Risks

Middle Mile risks include the following:

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

Likelihood: Duluth will likely have multiple middle mile paths back to an Internet Exchange point in Duluth.

Impact: Each of 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 multiple connectivity options in the City of Duluth.

Mitigation: The way the city can mitigate and possibly eliminate Middle Mile Risk is by building in redundancy to the network by having multiple backhaul providers along independent paths back to an internet exchange point.

Pole Attachment & Make Ready Risk

This is the risk that pole owner cause unexpected and significant impact on costs or timeline due to delays in make ready and pole attachment work.

Likelihood: Minnesota Power (MP) owns approximately 60% of the poles, and Century Link (CL) owns the remaining 40% of the poles in Duluth. MP has communicated that likely up to 75% of the poles would need to be replaced if the city attempted to request access for our fiber deployment using an aerial delivery for the "last mile". The city may need to become an FCC qualified "attacher" and enter into a pole use agreement with MP and CL.

Impact: Make Ready work for Pole attachment can have a significant impact on costs and timeline if the pole owners are non-responsive or want the city to replace the majority of the poles.

Mitigation: The city will work to optimize the final detail design to leverage aerial deployment strategies where feasible but for the first two years will focus on providing 100% buried deployments via micro-trenching and directional boring. A buried network 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. Note: A Duluth Broadband Survey was conducted October – December 2021. The results of this survey are included in the Market Analysis section of this report.

Publish Educational Information

Leverage website content specific to the municipal fiber program to outline the core message of broadband as a utility lower cost, increase choice and subscriber control, and foster digital inclusion. Use customized videos to educate online visitors on the following:

a. Functionality of the community fiber network
b. Options for services
c. Frequently Asked Questions (FAQ's)

Mapping Community Interest

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

Marketing & Promotion

Utilize Press Releases and utility bill inserts to promote the municipal fiber program, driving traffic to the fiber website with the goal of educating community members and generating interest and encouraging community participation.

Use all available social media platforms (Facebook, Instagram, Twitter, etc.) to promote the fiber network.

Neighborhood Entrance and Yard Signs

As construction (fiber build) begins in a neighborhood, Duluth 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

Duluth can use Webinars and Open House events to educate residents and business owners about the fiber project, ask questions, become educated about the business model, infrastructure, and costs.

Webinars and Open Houses are promoted using utility bill inserts, press releases, public service announcements, local news reports, City websites, social media platforms, etc.

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 Duluth fiber program. Duluth leaders and employees provide support to the Fiber Champions in their efforts. Fiber Champions drive conversations and contractual commitments of neighbors via the Door-to-Door Sales and Education campaign.

Door-to-Door Campaign

Individuals (possibly college students from Duluth) representing the network contact residents and business operators within the planned footprint to answer questions and ascertain the potential subscribers' interest for 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 PR firms.

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

Community Resources

A citywide broadband project creates an opportunity to collaborate with business students and faculty at university students and college. University students can be effective representatives for a Duluth Network and gain real world marketing and business experience.

Summary of Next Steps

Financing

Refine strategy for financing subsequent phases of the project beyond the Pilot Phase.

Pursue state and federal grant opportunities.

Business Model

Conduct public process (Request for Proposal (RFP), Request for Information (RFI), or Request for Qualifications to select Open Access Partner. This partner will also assist with project oversight, including design, quality control on construction, and oversee provisioning and turn-up of electronics.

Design / Engineering

Conduct public process Request for Proposal (RFP), Request for Information (RFI), or Request for Qualifications to select Design / Engineering for a City-wide Design. Follow a public selection process to obtain construction ready design documents and refine cost modeling based on network design.

Launch make-ready process for utility pole attachments if some portion of the network is aerial.

Lincoln Park Pilot Project

Work with Advisors and the Broadband Committee to develop a Scope of Work for a pilot project. Some of the objectives of a Pilot Project will include:

1) Create a city owned fiber network to city properties for the purposes of reducing costs, taking ownership, and supporting improved internal operations, including public health and safety. As part of this portion of the project, establish locations to serve as fiber access points for fiber to the home and fiber to the business. From one or more of these locations construct to approximately 2,000 as a pilot area to demonstrate ability to close affordability gap.

2) Demonstrate the strategies advanced by the Broadband Committee with a real-world implementation.

3) Validate the cost structure that is modeled in the Broadband Master Plan.

4) Provide key team members at the city with firsthand exposure to design/engineering, construction, and operations for a fiber optic system.

5) Validate the ability of an Open Access system to positively address gaps in competition, choice, and to lower the cost of services.

Community Engagement

Collaboratively Refine Community Engagement Plan. Community Engagement is the most important sub-project to successfully deploy publicly owned fiber optic infrastructure.

1) Determine whether the city will use an outside professional marketing firm.
2) Develop Project Plan for participation from all external marketing resources.
3) Grassroots initiatives.
    - Implement Community Engagement and demand aggregation process.
    - Deploy a competitive process to establish initial take-rate.

Construction

A downstream decision will be made about whether the City will develop any internal construction resources to supplement 3rd party construction. We anticipate the city will at least have an individual who is a liaison with the Construction teams.

Identify Construction Manager. Key skills and knowledge include, but are not limited to:

1) Manage the fiber optics project and budget, direct construction in accordance with the approved design, and coordinate work with other staff and design team members.
2) Be a key point of contact with clients, contractors, and local government officials.
3) Review project design aspects as needed and coordinate adjustments to support constructability and budget outcomes.
4) Review work products, quality control, and budgeting.
5) Mentor, develop, and supervise staff.

Evaluate Construction Project Management software options.

Conduct RFP/RFQ for materials and labor for construction.

1) Create RFP/RFQ Documents.

City Leadership Approval

1) Prepare to advance full initiative to City Council for approval.
2) Deploy pilot project when approved by the City Council.

Frequently Asked Questions

Does the current state of digital access merit this action by Duluth?

Unequivocally, YES.

While the gaps in internet affordability, availability, and reliability don't feel like a crisis for the connected, these barriers are a crisis for the unconnected. Today's technology-based interactions link and mediate our culture, the economy, and society. Connectivity expands opportunities and enlarges possibilities when it is affordable and available to all. People are diminished and condemned to negative outcomes beyond their control by existing barriers to digital access. The City views digital infrastructure as essential infrastructure and is pursuing this Pilot Project as a next step toward its objective to extend access to every Duluth resident at prices they can afford.

Why fiber optic infrastructure?

Fiber's capacity, durability, lower installation costs, and lower maintenance costs compared to other media makes fiber optic cable a significantly better up-front investment with long-term payoffs. Any public capital investment in infrastructure must also consider its usefulness and capacity to handle the projected growth of consumption. Over the past 30 years, the amount of data created, captured, copied, and consumed has consistently increased. This trend will continue and the only real choice for long term investment is fiber optics.

Won't fiber cost too much?

A myth often pushed by those interested in maintaining the status quo and forestalling universal fiber is the "high cost" of fiber and the prevalence of cheaper alternatives. Fiber is affordable public infrastructure. The capacity of fiber optics is exponentially greater than all other media, including coaxial cable, DSL, or wireless solutions. The Pandemic demonstrated that asymmetrical (much slower Upload than Download speed) solutions are inadequate for today's business applications and a work from home economy.

The Up-front cost for wireless solutions may be less expensive than fiber but the life cycle of wireless infrastructure is 5-10 years and effective wireless solutions depend on fiber optic backhaul.

Consider the costs associated with other public infrastructure projects. Using a $15 million dollar investment, a city could build ¼ mile of light rail, or make 3 miles of bridge repairs, or mill and resurface 12 miles of a 4-lane road, or replace 15 miles of water pipes and meters, OR build 87 miles of an underground, urban, fiber network.

Why Open Access?

Open access provides an effective and scalable solution for enabling multiple providers sharing the same physical infrastructure.

Publicly owned, open access infrastructure creates a vibrant and innovative market for digital services. Municipalities build the physical infrastructure (fiber-optic lines) and independent Internet Service Providers (ISPs) operate in a competitive market using shared physical infrastructure. In this competitive marketplace, ISPs compete for customers and have incentives to innovate rather than simply locking out competitors with a de facto monopoly. Open access networks provide new value by enabling private sector competition across a shared infrastructure.

What is Automated Open Access?

In an Automated Open Access system, the experience of finding an ISP is like shopping for anything else online. Subscribers can sign up for an ISP in 60 seconds. Switching ISP's also happens in real time. Automation also lowers the cost of operating the network and interacting with the system can be any time of the day or night.

What about 5G or other technologies?

Wireless cannot serve as a foundational long-term investment like fiber optic cable can. The fastest 5G 'to the home' technologies operate in higher frequencies using millimeter wave (microwave) spectrum to achieve speeds like the slowest fiber technologies. This type of installation requires fixed antennas placed on every home with a line of sight to access point antennas installed about every 600' throughout the neighborhood. Each radio antenna installation would still require a fiber optic connection and power. The typical life cycle for wireless technologies is 10 years, with an expected device life span of 5 years. Satellite technologies provide shared connections that will never have the capacity to meet the needs of Duluth. These factors make installing fiber to every address the right public investment.

Can Duluth afford this investment?

The average cost of internet access in the U.S. today is $68.38 per premise. If 80% of Duluth's 45,000 residential and business units (approximately 36,000) are connected via a cable or telco ISP, then Duluth is currently paying the incumbents around $29 million per year and $590 million over a 20-year period. If the Pilot Project validates the assumptions for the project, Duluth residents and businesses will be able to both lower monthly payments in a meaningful way and increase speeds by 200%. This is possible by creating competition among ISP's and utilizing public infrastructure investment tools which include favorable interest rates and longer return on investment horizons.

Where will Duluth get the funding?

Unprecedented levels of Federal and State funding are being made available for broadband infrastructure over the next several years. This plan and Pilot Project will put Duluth in a strong position to receive federal and state funds. Further, the revenue from subscribers will cover the costs of infrastructure, operations, and services. The Pilot Project will be funded using ARPA and existing Enterprise funds.

What will this cost me?

The costs for the Pilot will be covered by the City during the experimentation phase. Once that phase has been completed, the residents in the Pilot area will have the option to subscribe based on the value proposition compared to other offerings.

Following the Pilot Project, if the City goes forward, there will be no cost to anyone who does not request an installation or service using City fiber.

This plan separates the costs for the final service into three (3) separate and distinct categories:

1. The cost of installation (capital costs)
2. The cost of operation (maintenance and operation of the fiber system)
3. The cost of service (provided via a private marketplace of services)

This plan will make the best use of available grant and low interest public bonds to drive the installation costs as low as possible. The City has a stated goal of a price point between $10-$25 per month for Gig (1,000 x 1,000) service after grants and subsidies. It is expected that robust, reliable internet access will be available from multiple Internet Service Providers (ISPs) within the online marketplace. ***The goal of this plan is to make world class fiber optic connectivity available to every address in Duluth for $45-$55 a month for 1,000 x 1,000 Mbps.*** Additionally, the city will develop and implement Customer Affordability Programs for those most impacted by affordability constraints.

How will Duluth determine rates and charge fees?

Utilities are fundamentally different from other businesses because they are NOT allowed to charge whatever they want, or whatever the market will bear. Because a public utility model will be applied to the fiber optic system, rates will be determined based on the actual costs to maintain and operate the system, not on market rates. This public process requires utility rate changes to undergo a regular 'rate case' or evaluation of actual expenses compared to the rates being charged, resulting in adjustments as necessary with an emphasis on providing an essential service at the least possible cost. True public utilities also benefit from specific legal and liability protections, as well as access to low interest, long term funding for capital projects that result in lower operating costs when compared to private businesses.

What will this do to my property's value?

High-speed fiber Internet can add an average of 3.1% to your home value, according to a study conducted by researchers at the University of Colorado at Boulder and Carnegie Mellon University in 2015. The study used data from nearly half a million home sales between 2011 and 2013, U.S. Census data and data from the National Broadband Map to determine the effect of high-speed fiber-optic Internet on home prices. The median home value in the study was $175,000. When high-speed fiber is added, this home sees an increase in value of $5,437. The increase is approximately equivalent to the value of a fireplace or a little under half the value of a bathroom. Since the pandemic has only increased the need for reliable, robust, digital access, subscribers can be confident that any investment in fiber to a property will increase its value.

What is a 'Pilot Project'?

The Pilot Project is a mini version of this plan that will serve to confirm the viability and outcomes of extending fiber to every address. The project will include the installation and operation of an automated open access fiber optic line to every address desiring an installation in the pilot area.

Where is the 'Pilot Project'?

An area of approximately 3,000 homes has been identified in the Lincoln Park area of Duluth for the Pilot Project.

What is the purpose of the 'Pilot Project'?

The Pilot Project will mitigate risk and further inform the plan by validating cost models and demonstrating the ability of automated open access systems to fulfill key functional requirements to help Duluth access the substantial resources necessary to extend the fiber utility to every address.

How was the 'Pilot Project' selected?

The Lincoln Park area was selected because the area is plagued by sub-standard infrastructure, affordability challenges, lack of competition, and network reliability issues. In summary, the area was selected because it represents one of the most challenging areas for access, making it the ideal location to demonstrate the benefits that will arise from making digital access affordable and available to every Duluth resident.

Are Pilot Project properties receiving a benefit that will not be available to other Duluth properties?

The City has a goal to provide world class connectivity for all Duluth residents. The City also seeks to eliminate gaps in affordability and availability across the entire City – and not just in the Lincoln Park neighborhood.

When will the 'Pilot Project' start?

Requests For Proposals (RFPs) for Pilot Project procurement are being released in conjunction with the release and adoption of this Plan, with construction of the Pilot Project scheduled as soon as the design and construction partners are identified and under contract with the City.

When can my property get a fiber optic connection?

This will vary by neighborhood. Duluth will prioritize the citywide buildout based on need and demand. There will be regular updates made available through the outlets maintained by Duluth. The goal is for all Duluth properties to have access by 2028.

What can I expect during the installation process?

A walkthrough of each property will be conducted as part of passing by or through each property only if the property owner requested the installation of a fiber line to the home or business. Mainline fiber is always installed in a city owned Right of Way (ROW) or public utility easement. The extension that crosses private property requires property owner permission, and the placement of all fiber and electronics inside the home or business will require property owner approval. The initial meeting will be scheduled in advance of the mainline cables being placed. The purpose of this meeting is to agree on the placement of fiber through the property and the placement of the electronics inside the building. If there is work desired within the home that cannot be performed by construction personnel due to cost constraints or complexity, a property owner may arrange the installation inside the building. Sometime after the mainline and extension or 'drop' to the property is installed, an installation will be scheduled where a technician will complete the fiber installation inside the building, set the equipment, and make sure that connectivity is complete. Duluth will provide multiple mechanisms and management systems to help property owners coordinate their installation, and any necessary property restorations that result from the construction process. These will include online, phone, and walk-in solutions.

How can I make sure I get a fiber installation?

Regular communications related to plan progress will be distributed through the city's regular communications channels. Duluth will also maintain a robust and exhaustive online site dedicated to this effort. This site will include plan information, regular updates, maps, and forms to assure that all Duluth residents and businesses benefit from this important process. Property owners will also be notified when construction is starting near their property via mail and door hangers that will include information on how to make sure a property is signed up to receive an installation.

What does this mean for Duluth's incumbent providers?

Duluth recognizes and appreciates the historical investment already made by incumbent providers. Nothing in Duluth's plan will force these operators to abandon their current infrastructure and will not impose barriers to upgrading or extending their infrastructure if they desire to do so. This plan is neutral to those options while presenting opportunities for incumbent operators to upgrade their infrastructure at no capital cost by utilizing the new city fiber optic infrastructure. This opportunity is important to the incumbent phone operators as the twisted pair infrastructure they operate is decades old and often incapable of meeting the minimum requirement for broadband. It is equally important for the incumbent cable operators as they are private commercial operators that rely on franchise agreements to obtain access to Duluth's Rights of Ways (ROW) in which they install coaxial cable to deliver their service. These cable franchise agreements require that the operator is offering cable service, defined as channelized video content, for which access the city is adequately compensated. As system bandwidth is shifted from delivering channelized video to internet and data services, these operators will have no legal claim to continue accessing Duluth's ROW. This plan effectively solves this problem by providing cable operators with the ability to move their internet or data only customers over to the municipal fiber optic utility infrastructure with no capital costs incurred.

What relationships are important to plan success?

There are numerous internal relationships that will be cultivated between this new fiber optic utility and other city departments and operations. This infrastructure will be installed to meet the digital communication needs of all other city departments, operations, and functions over time. This will be a requirement in both ordinance and policy.

There will also be numerous external relationships established and cultivated for the combined success of Duluth and any other public or tax supported entity. State law allows for and encourages tax supported entities to enter interlocal or joint powers agreements, and to utilize cost sharing to reduce costs and improve services for the taxpayers they serve. These relationships will be encouraged and cultivated in both ordinance and policy.

Has this been done anywhere before?

Ammon, Idaho was the first municipality in the country to install a municipally owned automated open access fiber optic utility approach in 2017. Ammon has received numerous awards and accolades for their transformational approach. Residential properties with an Ammon fiber installation have the option of receiving 1 Gbps fiber optic internet service for less than $50 per month with no data caps or contract. Once the infrastructure is paid off, that cost drops below $30 per month. Today there are more than 30 other cities across the country actively planning for or in the process of implementing the 'Ammon Model'.

Is 4-5 years the right timeline for construction?

Duluth's plan identifies approximately 36,182 locations where fiber could potentially be installed. At a 60% take rate (21,709) this equates to an average of 5,000 installations per year or 20 installs a day. This should inform plan urgency. Duluth has set 5 years as an acceptable maximum to connect residential, commercial, and other anchor institution properties but intends to define the areas of critical need and drive a sense of urgency that will deliver the most important results in these areas first.

How will upgrades be handled in the future?

This is not a new challenge for municipal utilities. Operational maintenance and improvement costs will be averaged across all the system's customers and paid for over a period of time. It is these unique utility funding and rate mechanisms that help to maintain affordability even in the face of large capital improvements. These same frameworks will be used to maintain affordability if a costly system upgrade becomes necessary in the future. Additionally, fiber optic infrastructure is expected to have a 50-100 year lifespan.

What can I do to support the plan?

Express your support on the fiber optic website. If you live in the Pilot Area, order a fiber installation at your property once the sign-up systems are in place.

How can I voice my concerns about the plan?

There will be regular public meetings associated with plan implementation, even at a neighborhood level. Public input from Duluth residents at these meetings is welcomed and encouraged. For commercial or industry interests with concerns, please direct all inquiries to the Planning and Economic Development Department.

How will the infrastructure support equity?

For the first time ever, Duluth will have the ability to focus a digital access investment to facilitate inclusive prosperity and advance local goals and priorities. Service subsidies do not effectively solve for these problems long term but are instead designed to only manage the problem. Duluth can include necessary structural reforms as part of plan execution, and will start by connecting those most disadvantaged first, something industry cannot do.

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Glossary

Industry Terms and Abbreviations

Term	Description	Definition / Narrative
Aerial	Fiber-optic network cables installed on existing utility poles	Aerial fiber deployments are one of the most cost-effective methods of installing fiber cables. Rather 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 nor 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 low-income and rural communities	The gulf between those who have ready access to computers and 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 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 given 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 given 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 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 Internet Exchange Point	The Middle Mile is usually 3rd-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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MEMORANDUM

To: Chris Fleege, Director of Planning and Economic Development
Rebecca St. George, City Attorney

From: Steve Hanke, Assistant City Attorney

Date: January 3, 2022

Re: Municipal Broadband Internet Regulations

Introduction

Director Fleege asked me to prepare a legal memorandum summarizing the municipal broadband internet legal framework applicable to the City of Duluth.

I. Bonding Authority.

The City of Duluth can fund municipal broadband internet via revenue bonds. *See, Bridgewater Tel. Co. v. City of Monticello*, 765 N.W.2d 905 (Minn. Ct. App. 2009) Installation of a broadband network to provide internet services is a "public convenience" for which cities can issue revenue bonds. *Id*. Also, the City of Duluth can issue revenue bonds even if it contracts with a private company that installs, manages, operates, and benefits from the broadband internet network. Id. Minn. Stat. § 475.52 allows for municipal revenue bonds to be used for an "operating reserve fund" to pay start-up costs for a city's broadband internet network; start-up costs, being non-recurring, are not "current expenses" within meaning of Minn. Stat. §475.52; *Bridgewater Tel. Co. v. City of Monticello*, 765 N.W.2d 905 (Minn. Ct. App. 2009).

II. Broadband Grant Programs.

Effective July 1, 2021, Minn. Stat. § 116J.395 establishes a border-to-border broadband development grant program. Grants may be awarded to fund the acquisition and installation of middle-mile and last-mile infrastructure that support broadband service scalable to speeds of at least 100 megabits per second download and 100 megabits per second upload. *Id*. Subd. 2. Municipalities are eligible to apply. *Id*. Subd 3. The application procedure is further described in Minn. Stat. § 116J.395 (copy attached) and through the Minnesota Department of Employment and Economic Development (DEED)'s website. The statute also provides the challenge procedure available to current broadband providers in Duluth (Charter Spectrum and CenturyLink). However, grants offered by DEED pursuant to Minn. Stat. § 116J.395 are limited to $5M and may not exceed 50 percent of the total cost of a project. *Id*. Subd. 7.

III. Broadband Internet Franchise Under Duluth City Charter.

The City of Duluth Charter franchise provisions apply to the City's operation of broadband internet service "if offered for profit." If the City charges any rate or tax assessment, it is "for profit." The franchise provisions are further described in Chapter XI (Franchises) Sections 79-89 (copy attached). 7/9ths vote of the City Council is required to authorize a franchise per Section 80. Duluth City Charter Chapter IX (Local Improvement and Special Assessments) provides City Council authority and procedure to make property tax assessments for public improvements such as broadband internet.

THANK YOU

For Your Consideration

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