Broadband Feasibility Report

Jackson County, Florida

March 19, 2024

DRAFT

Finley Engineering
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EXECUTIVE SUMMARY

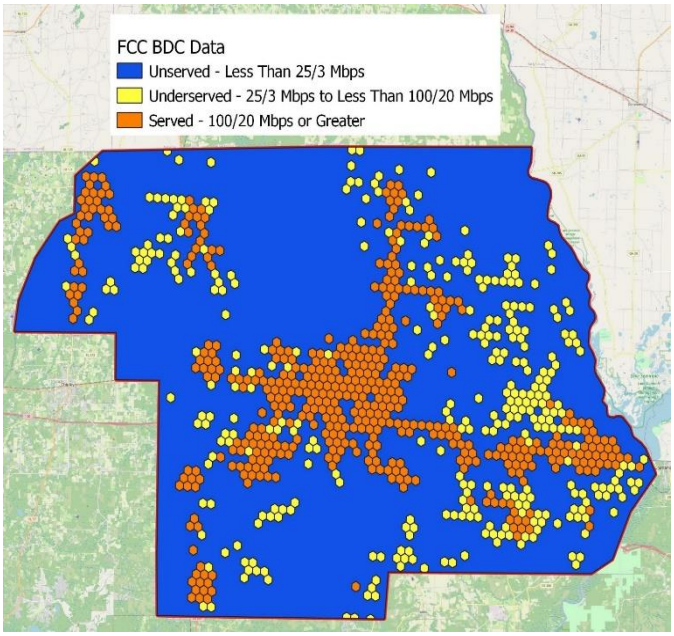
Finley Engineering and CCG Consulting submit this Broadband Feasibility for Jackson County, Florida. We've written this report to be an actionable plan for seeking better broadband for the unserved rural residents who don't have good broadband today. We believe we have described a compelling story for ISPs to use to pursue grant funding for all unserved areas of the county. We think the County can play an important role in finding a broadband solution for everybody.

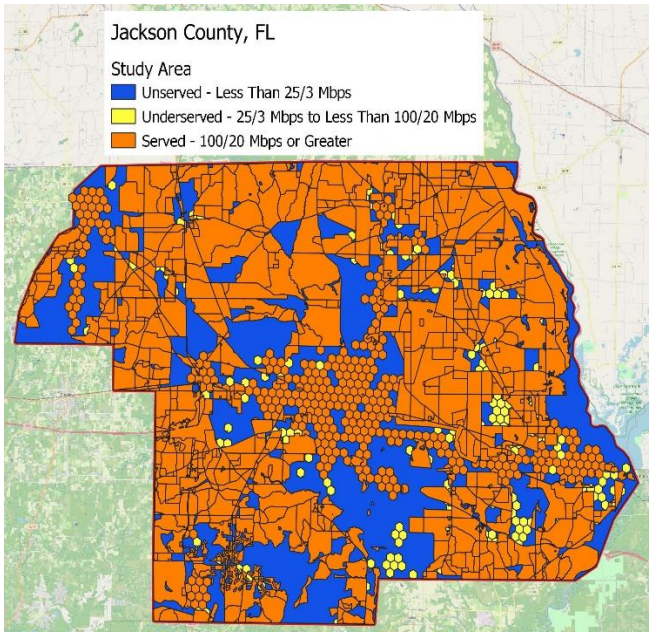
The federal BEAD grant program announced that Florida will be receiving a little over $1.17 billion in grant funding to build broadband infrastructure. There are other federal and state grants that can also benefit broadband infrastructure. There are other grants available to tackle the digital divide to get computers into homes and train folks how to use computers.

One of the most important parts of our analysis is that we were able to identify the homes and businesses in the county that don't have access today to speeds of at least 100/20 Mbps (100 Mbps download and 20 Mbps upload). This is an important speed, because the various grants are aimed at bringing better broadband to locations where this speed is not available today.

Following are two maps that summarize our analysis. These maps have three colors. Blue represents homes where there is no broadband option of at least 25/3 Mbps. Yellow means the best speeds available are between 25/3 Mbps and 100/20 Mbps. The orange areas have at least one broadband option today that is faster than 100/20 Mbps. In both maps, the blue and yellow areas combined would be considered to be grant-eligible.

The map on the left comes from the most current FCC broadband maps. This maps show that most of the county doesn't have adequate broadband – which is the situation today.





There are a lot of issues with the current FCC map. The map doesn't reflect that three companies have won a large amount of federal subsidy in the Rural Digital Opportunity Fund (RDOF) to bring fiber to parts of the county. Comcast also won a state grant in the county to build broadband. None of this fiber has been built yet, but these areas are not eligible for other federal grants.

The current FCC map also includes reporting by ISPs that we believe overstate broadband speeds and coverage. The second map reflects the grant area and the other adjustments, and we think this map most correctly identifies the homes and businesses that should be eligible for the upcoming federal grant programs like BEAD.

We overlaid detailed GIS information to count the homes and businesses inside the colored areas of each map – shown as follows:

Speed	Per FCC	Adjusted
Unserved (blue) - Less than 25/3 Mbps	7,831	1,697
Underserved (yellow) - From 25/3 Mbps to 100/20 Mbps	2,894	992
Served (orange) -100/20 Mbps or faster	15,557	23,593
Total	26,282	26,282

Our analysis shows that the cost to build the needed broadband network will range from $16.7 million at current market labor rates for construction ad $19.3 million of a grant winner is required to pay prevailing wages.

There is one broadband concern that must be discussed when talking about the County. The Rural Electric Cooperative Consortium (Conexon Connect) won $10,487,547 to serve 6,838 locations in the county. The County has talked to the company several times, and Conexon has always assured the County that they will fulfill that obligation.

The worry comes because Conexon hasn't started to build any fiber yet. Unfortunately, FCC rules allow the company to measure it's completion project on RDOF at the state level and not at the county level. At the state level, an RDOF winner must complete 40% of the construction by the end of 2024, 60% by the end of 2025, 80% by the end of 2026, and everything by the end of 2027.

Conexon is building fiber first in counties where it has partnerships with electric cooperatives, so counties without partnerships, like Jackson County will be at the end of the line. The County is rightfully concerned that Conexon could walk away from its RDOF obligations. There has been a lot of inflation since the end of the RDOF auction, and it's harder every year for an RDOF winner to justify building rural fiber.

The report discusses what we think are the next steps for the County after getting this report. The most important next steps include:

- Deciding if the County will financially support any BEAD applicants.
- Determining the process for supporting or not supporting ISPs that want letters of support from the County for BEAD grants.
- Deciding if the County should take an active role in pursuing digital equity grants.
- Deciding if the County should encourage citizens to provide multiple speed tests for cellphones to make sure the county is eligible for upcoming grants to expand rural cellular networks.

SUMMARY OF FINDINGS

Existing ISPs. There are a lot of ISPs operating in the county:

- AT&T, Consolidated Communications, and CenturyLink are the incumbent telephone companies. The companies primarily provide DSL broadband over copper wire.
- Comcast and Charter are the incumbent cable companies in the county.
- CenturyLink has built a small amount of fiber under the Quantum Fiber brand name.
- Point Broadband is the only fixed wireless provider.
- Some rural customers use broadband provided by cellular companies with cellular hotspots or the newer fixed cellular products.
- Most rural homes and businesses can buy Viasat, HughesNet, or Starlink satellite broadband.

Existing Broadband Prices. Broadband prices vary widely. The following summary shows the prices charged for residential broadband by ISPs in the county. These are the prices for the product from each ISP that is closest to the 100/20 Mbps definition of broadband.

Provider	Technology	Download	Upload	Price
AT&T	DSL	100 Mbps	100 Mbps	$65 + $10 router
AT&T	FWA Cellular	40-140 Mbps	Best Effort	$60
CenturyLink	DSL	Best Effort	Best Effort	$50 + $15 router
CenturyLink	Fiber	500 Mbps	500 Mbps	$50
Consolidated	DSL	100 Mbps	Best Effort	$90 + $10 router
Comcast	Cable	100 Mbps	5 Mbps	$83 + $15 router
Charter	Cable	300 Mbps	10 Mbps	$84.99
Point Broadband	Fixed Wireless	30 Mbps	3 Mbps	$126 + $13.99 router
Verizon	FWA Cellular	300 Mbps	20 Mbps	$45 - $60 with Data Caps
T-Mobile	FWA Cellular	100 Mbps	20 Mbps	$65
Starlink	Satellite	Up to 100 Mbps	15 Mbps	$110 - $120 + $499 receiver

Broadband Gaps. In addition to the widespread broadband availability gap, which is the emphasis of this study, Jackson County also suffers from what we call the competitive gap. There are almost no places in the county where residents or businesses have a choice between two fast ISPs. This means that in any town or neighborhood, the fastest ISP largely enjoys a broadband monopoly.

Like most places, there are also other broadband gaps in the county, such as an affordability gap, a computer gap, and a computer training gap. The report discusses ways that the County might address this issue while also tackling the more important availability gap.

The report also highlights that the demand for broadband continues to grow at a rapid pace. The national average monthly household broadband usage at the start of 2018 was 215 gigabytes per month. According to OpenVault, that has grown to 641 gigabytes per month at the end of 2023.

Speed Tests. As part of the study, we purchased speed test data from Ookla (speedtest.net) for the most recent twelve months for all ISPs. Following is a summary of the average speed tests by technology averaged over the previous year.

Technology	Download	Upload
DSL	13 Mbps	2 Mbps
Fiber	298 Mbps	290 Mbps
Cable	269 Mbps	21 Mbps
Cellular	37 Mbps	8 Mbps
Satellite	49 Mbps	6 Mbps

Speed tests highlight the obvious differences between technologies. Fiber is the only technology with fast download and upload speeds. Cable company broadband had fast download speeds but slow upload speeds. DSL, fixed wireless, and satellite have the slowest speeds.

Residential Survey. We conducted a statistically valid telephone survey that has an accuracy of 95% ± 5%. The full survey results are included in Exhibit I. The following are the key results of the survey:

- 84% of survey respondents buy broadband at home, and 16% have no home broadband.
- Residents use a wide variety of broadband technologies today. 15% of survey respondents buy broadband from a cable company. 41% of respondents use DSL technology from a telephone company. 20% use satellite broadband, and 8% use fixed cellular broadband and hotspots.
- We asked the respondents without broadband why they did not have broadband. 14% said it was too expensive, 4% said they were uncomfortable using the Internet, 21% said they get broadband outside of their home, 44% said they are not interested in using the Internet, and 17% said that broadband is not available at their home.
- There is a lot of dissatisfaction with ISPs. 35% of respondents are unhappy with download speeds. 27% are unhappy with ISP customer service. 43% of respondents are unhappy with the value received for the price paid for broadband. 30% are unhappy with the reliability of the broadband connection.
- 43% of respondents use broadband for work or school from home. 8% work or school from home full time, 18% several days per week, and 17% said occasionally. 46% of these respondents said their broadband is not good enough to support online work or school.
- 66% of respondents spend over $60 per month for broadband. 42% of respondents think prices should be less than $60. 52% of respondents spend over $80 per month.
- 51% of respondents said they would definitely buy broadband from a new network if it was faster and at the same price. Another 19% said they would probably buy from a new network.
- 31% of respondents said that cellular coverage is not good enough at their home.

Business Survey and Interviews. CCG Consulting reached out to businesses through an online survey and by interviewing businesses and stakeholders in depth. A few of the key things we learned include:

- We heard about broadband problems at schools and libraries.
- Rural businesses have the same slow broadband choices as rural residents. Rural businesses say they don’t have a reliable broadband choice, and what they can buy is expensive.
- The only rural broadband technology that got any praise was Starlink. Businesses that subscribed to other broadband had problems with reliability and speeds.

- We heard about a wide variety of problems from businesses such as the inability to use need software, the inability to upload files, the inability to reliability participate in activities like Zoom calls.
- We also heard that poor cellular coverage causes as many problems as the lack of broadband. Farmers, in particular, do not have good enough cellular coverage to take advantage of smart farming technology.

Engineering Analysis. Section II.A of the report discusses the technologies we found during the engineering field review. Section II.B. discusses issues that affect broadband speeds. Section II.C. Discusses the various broadband technologies in use in the county today. Section II.D. discusses the network design used to estimate the cost of building fiber to reach the unserved and underserved parts of the county.

Finley Engineering investigated the technology options for bringing broadband and selected XGS-PON technology, which delivers symmetrical 10-gigabit broadband to small neighborhood clusters of residents and businesses. The network was designed using the following primary assumptions:

- The network was designed to pass every unserved and underserved home and business.
- The network is designed to accommodate future growth.
- Fibers were sized to fit the needs of each route using industry-standard fiber sizes of 12, 24, 48, 72, 144, and 288 fibers.

Cost of the Needed Network**.** Below is a summary of the cost to bring fiber to the remaining unserved and underserved locations in the county. The first column shows the cost of building the network at current market labor rates in Florida. The second column shows the cost for the same network using Davis-Bacon prevailing wages. These higher wages are required by most federal broadband grant programs. Projects funded privately or using most other grant programs can be built using the lower market labor rates.

	Market Labor	Prevailing Wage
Fiber	$12,992,234	$15,252,949
Drops	$ 1,984,945	$ 2,212,644
Electronics	$ 1,322,494	$ 1,400,646
Operational Assets	$ 425,613	$ 425,613
Total	$16,725,286	$19,291,852
Passings	2,689	2,689
Cost per Passing	$6,220	$7,174

The cost of building fiber in the county is not extraordinarily high – construction costs are actually lower than in some other parts of the country. But these costs are high enough that no ISP would be bringing new broadband networks without funding assistance from grants

Amount of Grants Needed. As part of the study, CCG Consulting looked at numerous financial scenarios to try to quantify the amount of grant funding that is needed for an ISP to get a BEAD grant to serve all of the unserved locations in the county. A summary of the financial findings is included in Exhibit II. Our first look used conservative assumptions – a 60% customer penetration rate, a starting broadband price of $60, debt financed at a 7% interest rate.

Even with these conservative assumptions, an ISP can successfully pursue the upcoming BEAD grants and could succeed by requesting a grant less than the 75% maximum grant award. The BEAD grant process favors ISPs willing to take less than a 75% grant. The following table shows the minimum amount of BEAD grants needed at various penetration rates, and assuming prevailing wages. The table shows that, using conservative assumptions, the BEAD grants can work even if the expected customer penetration is as low as 50%.

Penetration Rate	Assets Needed	Breakeven Grant Needed	Percent of Assets
50%	$18.7 M	$13.2 M	74%
55%	$19.0 M	$12.8 M	67%
60%	$19.3 M	$11.8 M	61%
65%	$19.6 M	$10.8 M	55%
70%	$19.8 M	$ 9.8 M	52%

We additionally conducted a sensitivity analysis to understand the impact of changing other key variables. The good news is that changing some of the other underlying key assumptions would improve the financial outlook shown in the above table. Some of the key findings include:

- Raising broadband prices by $5 increases cash over 20 years by $2.2 million.
- Lowering the interest rate on debt by 1% improves cash over 20 years by $1.1 million.
- If loans can be refinanced in five years at a 4.5% interest rate, cash improved by $2.1 million.
- Financing the grant with an additional $1 million in equity instead of debt improves cash by $2.2 million. Even a little extra equity makes a difference.
- Financing the project over 25 years instead of 20 years increases cash by $1.5 million.

In our analysis, we looked at one example of changing several key variables. We increased the starting broadband price from $60 to $65. We assumed the ISP would be able to obtain a 25-year loan term. We assumed the ability to refinance the loans in five years. These three changes together lowered the breakeven amount of BEAD grant funding needed to 33%. The point of this analysis is that there are ways for ISPs to succeed with a BEAD grant significantly below the 75% cap if that's needed to win the grants.

Upcoming Grant Funding Opportunities. The most likely grant funding opportunities will be from various federal broadband grants. The three most likely sources of upcoming grant funding are:

- On June 30, 2023, Florida was awarded $1.17 billion in grant funding for the Broadband Equity, Access, and Deployment (BEAD program. These grants can make awards up to 75% of the cost of the network, with provisions in some cases to go as high as 100%. These grants will be awarded and administered by the Florida Office of Broadband. Grant award cycles are expected to start sometime in the summer of 2024 (every state will have a unique grant schedule).
- There are $13 billion in grants available from the U.S. Department of Energy to expand the electric smart grid that could be used to build some fiber.
- There is a new round of the ReConnect grants administered by the Rural Utility Service (RUS) that is part of the U.S. Department of Agriculture that was announced in February 2024.
- There are State and Federal grants that can be used to tackle digital equity issues like lack of computers and computer training.

The County has a Role in the BEAD Grants. A County government can help a prospective BEAD applicant win 25 points in the BEAD scoring, which is 6.3% of the total grant points possible. The 25 points comes from:

- 10 points for a letter of support.
- 5 points if the County provides meaningful financial support to an ISP
- 10 points for any ISP that participated in the Local Broadband Committee process.

This scoring gives the County a say in choosing BEAD grant winners and losers. If there are multiple ISPs asking to serve the same parts of the County, you could choose the one you want to get the grant funding, and not support others.

Benefits of Broadband. Section III.C. discusses the many benefits of getting broadband to everybody.

STRATEGIC CONSIDERATIONS

According to the most current FCC broadband maps, there are 10,725 homes and businesses in the county today that can't buy broadband with a speed of at least 100/20 Mbps. Many of these locations are supposed to be getting fiber broadband. The FCC awarded funding from the Digital Rural Opportunity Fund (RDOF) to bring fiber broadband to 7,754 of these locations. The State of Florida gave a grant to Comcast to bring fiber to 1,082 rural locations, many of which overlap the RDOF award area made to Conexon. The Finley Engineering and CCG Consulting determined that there are still 2,689 rural locations that don't have good broadband today and that are not slated to get better broadband through the Federal or State grant and subsidy program.

Through past work with the County, we understand you have two primary goals – to make sure that ISPs bring better broadband to the areas that still don't have an identified broadband solution, and to make sure that the companies that won broadband grants and subsidies fulfill their commitments.

The County's Role in the BEAD Grants

The upcoming federal BEAD grant program awarded almost $1.17 billion to Florida to bring better rural broadband.

One of the primary purposes of this study was to gather the facts needed by ISPs that want to pursue grants to build rural broadband. This report does several things for any potential ISP partner:

- We've created maps showing the areas that we think are eligible for the BEAD or other federal grant programs.
- The engineering was done in such a way that Finley Engineering can supply an ISP with a subset of the costs if an ISP wants to tackle bringing broadband to a portion of the county.
- We've quantified the amount of grant funding needed – something an ISP needs to understand to make realistic plans to tackle the unserved areas.

The County can play a significant role in determining the ISP(s)s that will be awarded BEAD grant funding. In the past, the County's role for grants was likely to give a letter of support to every ISP that asked for one. However, the BEAD grant rules give the County a more significant role. ISPs can get significant grant scoring points for three different interactions with the County:

- The State's grant scoring matrix awards up to 200 points. ISPs with the most grant points in any local area should be the grant winner.
- There are 10 grant points awarded for getting a letter of support from the County. This means that an ISP the County doesn't support gets zero points.
- There are 5 grant points if the County makes a meaningful financial contribution to an ISP.
- There are 10 grant points for ISPs that participated in the Local Broadband Committee Process.

These points represent 6.3% of the total grant points needed to win a BEAD grant. However, the Florida grant rules make it virtually impossible for a grant applicant to get 100% of the available grant points, so the points listed above will have an even larger impact.

The County's strategic decision is to determine the extent to which you are willing to exercise the power the BEAD rules have given you in the grant scoring rules. If you support only one ISP for a BEAD grant

in each rural part of the County, that ISP will have a significant advantage for winning the grant compared to other ISPs. It's not guaranteed that County support will pick the grant winner, but it could. The same is true if the County provides funding to an ISP that you support – that ISP will have a grant scoring benefit over its competitors.

ISPs will probably soon come to the County asking for letters of support and funding. You could elect to give a letter of support to every ISP, and many counties will take this approach.

The grant scoring system gives the County the option to support only certain ISPs in a meaningful way. The County might prefer certain ISPs. You might want to support grants asking to build fiber and not wireless technology. You might want to only support ISPs that already work in the County today. You might prefer small ISPs over big ones or vice versa.

In order to exercise the power given in this grant scoring, the County needs to talk to ISPs to understand where they propose to serve. Once you understand the plans of each ISP, you can exercise the most influence by supporting only one ISP in each area of the county.

Timing of Existing Infrastructure Upgrades

There are ISPs in the county that have already won State or Federal funding to bring fiber to rural areas. This includes:

- 445 locations in the southeast corner of the county by Charter Communications funded by the FCC's RDOF subsidy.
- 471 locations in south-central county for Windstream funded by the FCC's RDOF subsidy,
- 6,838 locations all around the county for Conexon from the FCC's RDOF subsidy.
- 1,082 for Comcast in the central part of the county from a State grant. Many of these locations overlap with the Conexon RDOF award area.

We recommend that the County regularly meet with these ISPs to understand the proposed timelines for broadband construction.

It's Not Just About Infrastructure

The study demonstrates that the county doesn't just have a broadband infrastructure gap. There are residents who can't afford a home broadband connection. There are homes that can't afford to buy or maintain a home computer. There are also many folks who don't have the knowledge or training to take full advantage of broadband.

There are several billion dollars in grant funding coming over the next three years that can be used to solve these digital divide gaps. The biggest challenge in going after this kind of grant funding is to determine who in the community is willing to pursue the solutions and ask for the grant funding. We're seeing a wide range of solutions to these issues. In some cases, communities are relying on existing non-profit organizations to tackle the problems. Other communities are pursuing the grant through libraries or government social agencies. What's clear is that if nobody steps up to pursue these grants, the funding won't come to Jackson County.

The challenge is to identify the interested stakeholders and get them to work together to pursue these grants. The grant rules strongly reward community collaboration, so the ideal grant applications will involve all stakeholders willing to tackle different parts of the solution or perhaps tackle specific geographic areas. If multiple local grants are instead filed by local stakeholders, there is a good chance that the County won't receive your fair share of funding.

RECOMMENDED NEXT STEPS

The section above discussed the biggest strategic decisions that must be made if you want to pursue getting better broadband. Once you've made that decision, this section discusses specific steps that we think you'll want to consider. Note that you might want to undertake some of these steps concurrently while wrestling with the strategic issues.

Who Will Tackle the Next Steps?

One of the first things to consider after getting this public is to determine who specifically needs to get involved in the next steps. A few of the steps are now time-critical since the BEAD grants are likely to be due in the next few months. Staff might be able to tackle some of these tasks, but that will require giving the tasks high priority. You may need to hire outside help to get some of these tasks done in time to get ready for upcoming grants.

Once you've decided which recommendations to consider and pursue, the next question should be to ask who will make sure that the work gets done in a timely manner.

A Final FCC Mapping Challenge

The Florida Office of Broadband will soon hold a final mapping challenge before finalizing the locations where BEAD grants can provide funds. Map challenges can only be made by ISPs or by local governments.

This challenge is a final chance for local governments to make sure that all locations that need better broadband are eligible for the BEAD grants. Any location that is not on the final State BEAD map cannot be included in a grant application.

We've identified only a small number of locations that might be worth conducting a challenge. There are 28 locations that are claimed to be served by T-Mobile and Verizon cellular service at a speed faster than 100/20 Mbps.

We know that some other states are counting FWA cellular wireless locations as underserved for the BEAD grants, meaning these locations would all be eligible for BEAD grants even though they are claimed by carriers to be delivering speeds of 100/20 Mbps or faster.

We also know by looking at detailed speed tests that the cellular technology can only deliver fast speeds for about two miles from a cell tower, and some of the locations claimed by the carriers are outside the two-mile limit.

This is a relatively small map challenge, but it would make 28 more locations eligible for grant funding.

Before filing this challenge, we'll reach out to the State of Florida to see how they plan to treat FWA cellular wireless for the BEAD grants. It's possible they have already made this adjustment.

Identifying ISP Partners

Since there are grant points in the BEAD grants for ISPs to get support from the County, we are sure that ISPs will be contacting you to get letters of support and to ask for funding.

There is no decision to make if you want to issue a letter of support to any ISP that asks. Many local governments are taking this approach since they don't care who wins the BEAD grants as long as somebody does.

But the Florida BEAD grant rules give some power to the County to influence who wins BEAD grants if you want to exercise it. If you only support one ISP in each portion of the county, that ISP will have an advantage in the grant process. This might or might not make enough of a difference to determine the grant winner.

ISPs are also going to hope that you will provide monetary support as matching funds for the BEAD grants. There is a definite grant scoring advantage to any ISP you support with funding.

If you want to consider only supporting some ISPs with letters of support or funding, you'll need to quickly initiate the process of determining who to support. We've seen other communities decide this in the following ways:

- Some Counties decide to give the funding to a strong local ISP like a cooperative or small telephone company. There is no strong local ISP candidate in the County.
- The County can talk to ISPs informally. In fact, anybody interested in BEAD grants will soon be knocking on your door to ask for support. You could use these conversations to pick the ISPs you want to support. It's likely that you are going to hear from ISPs you don't know that don't operate in the county today.
- A more formal process, but still somewhat informal, is to invite ISPs to tell you their plans. This could be done by sending a letter to ISPs with a list of question they should answer. This could also be done using a Request for Information (RFI), which is a more formal way to ask questions. These two processes don't normally trigger any formal purchasing rules.
- The most formal approach would be to issue a Request for Proposal (RFP), which would be part of a formal purchasing process. We've seen Counties where legal or purchasing folks have given the opinion that a more formal process is needed if the County is going to award some of your ARPA funding to ISPs.

Whatever process you choose needs to start soon since the deadline for filing BEAD grants will probably come by summer.

The County would then need to sift through these responses to pick a winner. It would be normal to ask follow-up questions or interview some or all respondents. Ultimately, the County would decide who gets letters of support and who gets funding.

Educate the Public

A lot of this report was written to inform staff and the general public about broadband issues. You should determine the best way to inform the public of the results of this report. We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson.
- Hold Public Meetings. Meetings can be held to explain the results of this report, or meetings could be more generic and be aimed at explaining the broadband issues.
- Gather a List of Broadband Proponents. One valuable tool is to create a database of local broadband proponents – citizens who say they support fiber. Having a list of emails, home addresses, and phone numbers can be useful when you want to ask for public support for specific tasks or want to notify people of upcoming meetings.
- Outreach Meetings. One of the most successful ways to reach the public is what CCG calls outreach. This means sending a spokesperson to meetings of local organizations to talk about better broadband. This can be any sort of group – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time for a short presentation. It's vital to have a prepared presentation to get across whatever message you want the public to know. These outreach meetings are best done by those who are strong broadband proponents – this could be one of the tasks assigned to a Broadband Task Force or given to willing volunteers.

Review Local Policies Related to Fiber Construction

Local rules and ordinances can have a big impact on fiber construction. If you decide that you are going to build a fiber network, one of the first steps is to become aware of all of the local rules that might impact fiber construction. Some of the areas that should be investigated include:

- Granting rights-of-ways to construct a network. This includes coordinating with local, County, State, and federal regulations – including BIA rules.
- Obtaining permits to construct a network.
- Locating existing underground utilities where fiber is to be buried.
- Inspection of the network during construction.
- Following local rules for traffic control, notifying homeowners, etc.
- Providing records of what's been constructed.

Tackle the Digital Equity Gaps

The report discusses ways to tackle the other broadband gaps, such as the homework gap, the computer ownership gap, and the digital literacy gap. There is currently a huge amount of federal grant funding available to tackle these issues. The County can play a key role in making sure that you get your fair share of this funding. The grant funding is not going to come automatically but will require one or more stakeholders in the County to step up and propose to tackle one of more of the broadband gap issues. For example, one entity might be willing to work to get computers into homes while somebody else is willing to tackle training folks how to use broadband.

The County needs to decide if you should play a role in this issue. If you want to get involved, the steps to do so would be:

- First, find out what various stakeholders are doing or planning for pursuing the grant funding or tackling the digital equity issues.
- If there is not a collaboration of stakeholders working to find funding together, the County could pull the stakeholders together and try to create the needed collaboration.
- The County can also provide funding or assistance to write the needed grants.

Consider Addressing the Competition Gap

We also describe what we call the competition gap. There are almost no places in the county where there are two fast ISPs competing against each other. The lack of competition means that each of the fast ISPs has a monopoly in most neighborhoods they serve. Over time, that kind of monopoly power means higher prices, less responsive customer service, and less incentive for ISPs to modernize and upgrade.

We know the County is laser-focused right now to make sure that all rural residents get at least one fast broadband option. But you are going to want to eventually consider if there are ways to promote competition in the towns and cities. The survey we did for this study showed a high level of interest from residents who want broadband competition – meaning they want at least two realistic choices of broadband provider.

There are concrete steps that other communities have taken to attract more broadband competition. This might include:

- Consider broadband studies for the cities. This study was focused on the rural areas that need broadband.
- Reach out to ISPs to see if there is any interest in building in the cities.
- Consider middle-mile fiber or other infrastructure that would make the county more attractive to ISPs.

Getting Better Cellular Coverage

We heard throughout the study process that rural cellular coverage in the county is poor in places. CCG has been working around the country, and the lack of cellular coverage is often on par as a local issue with the lack of broadband. Huge numbers of people don't have cell coverage at their homes and don't have the outdoor cell coverage that everybody else takes for granted.

The FCC released a Notice of Proposed Rulemaking (NPRM)[1] last year that restarts an initiative to improve rural cellular coverage. The proposed FCC funding is for $9 billion to create a 5G Fund to subsidize the construction of rural 5G cell sites. These funds will be paid out over multiple years from the Universal Service Fund.

The FCC first proposed the 5G Fund in 2020, but the initiative came to a sudden halt when it became obvious that the large cellular carriers had provided maps that substantially overstated where they have coverage. It might seem counterintuitive for the big cellular carriers to overstate coverage for a program that wants to pay to build cell towers, but smaller cellular carriers said the purpose of the overstatements was to lock them out of the FCC funding. The FCC agreed and killed plans for the program until it got better maps. Cellular carriers must now participate in the twice-annual broadband mapping that is required for ISPs. The FCC must believe that the maps are now better.

The NPRM asks questions about how the reverse auction should operate. Once the FCC resolves these questions, this funding should come available. It will be interesting to see if the FCC opens the 5G Fund

[1] https://docs.fcc.gov/public/attachments/DOC-396574A1.pdf

to local governments and not just to companies in the cellular or tower industries. There are counties that have built towers hoping to expand broadband and cellular coverage, and there are many other county governments that see the lack of towers as a detriment to their economic success.

The County faces a dilemma. There is no guarantee that the FCC maps used for the cellular auction will show that you need new cell towers. A lot of communities are asking if there is something that can be done locally to improve the chances of getting new cell towers.

There is a way for the community to help fix the FCC cellular maps. The FCC has a challenge process where people can take a speed test on their cellphone that is used by the FCC to document where coverage is poor.[2] Only speed tests that use the FCC app are considered by the FCC – not speed tests taken on other speed test websites.

Unfortunately, the FCC app requires a lot of speed tests in a given neighborhood before the FCC will consider the results. That means there must be a concentrated effort made to get folks to take the FCC speed test in areas where the cellular coverage is poor. This also means getting folks who subscribe to different carriers to take the test. You could encourage a lot of folks to use the speed test app and could even pay a few folks to move around the study area and take a lot of speed tests.

[2] FCC Speed Test App. https://www.fcc.gov/consumers/guides/fcc-speed-test-app-tip-sheet

I. MARKET ANALYSIS

This section of the report looks at current broadband rates within the Jackson County area.

A. Broadband Rate Study

There are a lot of ISPs operating in the county:

- AT&T, CenturyLink, and Consolidated Communications are the incumbent telephone companies. The companies primarily provide DSL broadband over copper wire.
- Comcast and Charter are the incumbent cable companies in the county.
- Quantum Fiber has built some fiber in the county.
- The county has one fixed wireless provider: Point Broadband.
- Some rural customers use broadband provided by cellular companies with cellular hotspots or the newer fixed cellular products.
- Most rural homes and businesses can buy Viasat, HughesNet, or Starlink satellite broadband.

Following is an analysis of the prices being charged in Jackson County today. We know from experience that prices vary widely by customer for many ISPs. Some ISPs include products in bundles. Many ISPs have special rates for new customers or customer rates for customers willing to negotiate rates. Some customers are grandfathered into old rates and products that don't change if they keep the original product. The wide variance in rates charged in the community means there is no longer anything that can be considered a standard price in the market.

Incumbent Telephone Companies

AT&T[3] is the incumbent landline telephone provider in the northwest corner of Jackson County. AT&T still sells traditional telephone service and legacy DSL broadband under the AT&T brand name. For many years, the company sold broadband under the AT&T U-verse brand name, but in March 2020, the company rebranded everything to the original AT&T brand name. In October 2020, the company announced that it would no longer sell new DSL. For now, existing customers can keep DSL, but nobody can add the product.

At the end of the fourth quarter of 2023, the company had a little less than 15.3 million broadband customers. AT&T added over 1.1 million customers on fiber in 2022. AT&T has built fiber to pass 20.7 million passings (potential customers).

AT&T is offering a revamped cellular broadband product in rural areas that is supposed to be a replacement for rural DSL. The company advertises speeds of up to 140 Mbps.

AT&T is clearly in the process of shedding the legacy business of selling DSL over copper and cable TV. It would be surprising to see the company begin dismantling the copper networks at some point, as Verizon has done elsewhere.

[3] https://www.att.com/

DSL. There are still DSL customers with grandfathered rates and speeds from old plans. Again, the company won't sell this product to new customers. AT&T has two classes of DSL service. The older products under 25 Mbps are still classified as DSL. AT&T Internet DSL uses two copper pairs that result in twice the speed.

DSL	Download Speed	Price
Basic 5	5 Mbps	$ 60
Internet 10	10 Mbps	$ 65
Internet 25	25 Mbps	$ 65
DSL Modem		$ 10

AT&T Internet		
Internet 50	50 Mbps	$ 65
Internet 75	75 Mbps	$ 65
Internet 100	100 Mbps	$ 65
DSL Modem		$ 10

There is a monthly data cap for basic DSL customers when total monthly usage exceeds 150 gigabytes and customers are charged for exceeding the cap. The data cap for AT&T Internet customers is 350 gigabytes per month. Overage charges are $10 for an additional 50 gigabytes of data. For $30 per month, a customer can get unlimited data.

Fiber Broadband. While AT&T has built fiber widely in some communities, its normal method of deploying fiber is to build in small neighborhoods. The company builds small pockets of fiber scattered throughout a community. The following are the residential prices for AT&T broadband on fiber. Speeds on fiber are symmetrical for upload and download. There is evidence of this product in pockets in Oakland County.

Fiber		Price
Internet 100	100 Mbps	$ 60
Internet 300	300 Mbps	$ 65
Internet 1000	1 Gbps	$ 80
Internet 2000	2 Gbps	$110
Internet 5000	5 Gbps	$180
Modem rental included		

Lumen (CenturyLink)[4] is the incumbent telephone company in throughout the County. The original telephone properties are still branded under the CenturyLink name. CenturyLink is the third-largest telephone company in the country, with headquarters in Monroe, Louisiana. The core company was originally known as Mountain Bell and US West and was part of the Bell Telephone system. At the end of the fourth quarter of 2023, the company had a little over 2.7 million broadband customers. The company bundles with DirecTV for cable service.

[4] https://www.centurylink.com/

CenturyLink got smaller in the fourth quarter of 2022 when the company sold its twenty easternmost states (other than Florida) to Apollo Global Management. The new company is now branded as Brightspeed. While the sale didn't include Florida, it's likely going to bring about significant changes to the company.

As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to offer service to all residential and business customers.

Lumen has an interesting path forward. A few years ago, the company stressed beefing up its long-haul fiber network that crosses the country. That network came about through the merger of the old Qwest network owned by CenturyLink and the network from Level 3, which merged with CenturyLink a few years ago. More recently, CenturyLink announced it will be investing in building fiber, with probably more emphasis on reaching businesses than homes. The company is struggling and recently restructured its debt to satisfy Wall Street. The company has a few years of breathing space before large amounts of its older debt comes due.

CenturyLink Residential DSL

CenturyLink sells broadband using DSL technology. It sells both a bundled DSL product, meaning that you purchase it along with a telephone line, and also a "Pure" product, meaning a customer can buy just DSL (most of the industry refers to this as naked DSL).

CenturyLink recently simplified its pricing for DSL to be $50 per month for any speed plus a modem rental fee of $15, or purchase of the modem for $200. The company still advertises temporary discounts for new customers, but prices revert to the list price at the end of the special period.

CenturyLink Business DSL

CenturyLink no longer publishes business DSL prices. There are no prices on the website and no prices listed in any of their sales literature or tariffs. CenturyLink will negotiate a price with a business customer based on both how many other products they purchase as well as how long they are willing to sign a contract.

When CenturyLink last published rates, their slowest business DSL ranged from $40.00 per month for a 3-year contract up to $62.50 for a month-to-month product and no contract commitment. But today, the company negotiates with each business customer, and rates are all over the board for the same product.

Fiber. Quantum Fiber is the brand name for CenturyLink's fiber broadband. Quantum Fiber provides broadband to a few areas in central Jackson County. Quantum Fiber offers both broadband and voice services.

Residential Broadband	
500/500 Mbps	$ 50
1/1 Gbps	$ 75

Business Broadband	
500/500 Mbps	$ 50
1/1 Gbps	$ 75

Telephone Rates

CenturyLink's telephone rates are as follows.

	Monthly
Flat Rate Residential Phone Line	$18 - $22
Flat Rate Business Telephone Line	$42 - $45
Business PBX Trunk Lines	$45 - $51

These rates do not include the Subscriber Line Charge, which is currently $6.50 for both a business and a residential line and would be added to the above rates. The rates also do not include the Access Recovery Fee (ARC), which is an FCC fee that is currently capped at $1 per month, and CenturyLink could be charging any amount up to and including the $1 rate.

CenturyLink telephone line prices don't include any features. These features are either sold individually or are sold in bundles and packages. Some of the most commonly purchased features are call waiting, 3-way calling, voice mail, and caller ID. CenturyLink offers dozens of residential features, which range in price from $2.95 to $8.50 per feature. These products are also now de-tariffed, and CenturyLink can charge whatever it likes for these products.

Consolidated Communications was founded in 1894 and is headquartered in Mattoon, IL. Consolidated Communications provides business and consumer services in more than 20 states. The company also owns an extensive 50,000 miles of fiber used for middle-mile. The company operates in the southern part of the county.

Residential DSL Broadband	
Up to 20 Mbps	$30
Up to 50 Mbps	$60
Up to 100 Mbps	$90
Modem	$10

Cable Companies

Comcast Xfinity[5] is the incumbent cable TV provider to Marianna, Greenwood, Bascom, Two Egg, Cypress, Grand Ridge, Sneads, Cottondale, Malone, Chattahoochee, Alford, and Round Lake. Comcast markets and bills using the "Xfinity" brand name. The company offers the traditional triple play of cable TV, broadband, and voice services. Comcast is the largest cable TV company in the U.S., with 2023 revenues of $121 billion, and is the second largest cable company in the world. It is headquartered in Philadelphia. At the end of the fourth quarter of 2023, the company had 32.2 million broadband customers and 14.1 million cable customers.

[5] https://www.xfinity.com

In addition to providing triple-play services, the company owns a number of media assets like NBC, Telemundo, MSNBC, CNBC, USA Network, The Golf Channel, Syfy, numerous regional sports networks, Universal Pictures (and theme parks), Dream Works, and the Philadelphia Flyers hockey team and arena.

Stand-Alone Broadband

Following are the most recent list prices for stand-alone broadband. These rates include a $3 rate increase announced in January 2024. New customers are generally not offered products below the 200 Mbps tier.

Connect	75/5 Mbps	$ 66.00
Connect More	200/5 Mbps	$ 86.00
Fast	400/5 Mbps	$ 96.00
Superfast	800/15 Mbps	$106.00
Gigabit	1000/35 Mbps	$116.00
Gigabit Extra	1200/35 Mbps	$126.00
WiFi Modem		$ 15.00
WiFi Modem (Gigabit Pro)		$ 19.95

Comcast has data caps in much of the country – but not every market. The monthly data cap varies between 1 and 1.2 terabytes of total data per month. A terabyte is 1,000 gigabytes. When customers exceed the cap for a given month (the usage adds together both download and upload data usage), Comcast bills $10 for each additional fifty gigabytes of data used, with a maximum of $50 extra.

Comcast offers discounts to new customers, meaning customers that move from another ISP. As this paper was being finalized, the price for Comcast special pricing for standalone broadband was:

75 Mbps	$30.00
200 Mbps	$35.00
400 Mbps	$55.00
800 Mbps	$70.00
1000 Mbps	$60.00
1200 Mbps	$85.00
WiFi modem	$15.00

Telephone

Comcast sells standalone residential telephone service. The prices are as follows.

Basic	$30.00
Additional Line	$ 9.95

The basic line is a telephone line with standard features but no long-distance option. Comcast used to offer a telephone line with unlimited long-distance, but that's no longer available. We think it now directs customers to the Comcast cellular service for those wanting unlimited calling.

Cable TV

The following prices are for stand-alone cable TV. The Limited Basic tier includes network broadcast channels like ABC, CBS, FOX, NBC, and PBS. The Popular tier includes most of the popular channels that people expect from a cable subscription. The Ultimate tier includes every non-premium channel offered by Comcast.

Choice TV	$30.00
Popular TV	$70.00
Ultimate TV	$90.00
Set-Top Box	$10.00
DVR Service	$10.00

Hidden Fees

Comcast charges significant hidden fees to new customers. These are fees that are usually not mentioned when Comcast advertises to get new customers, but which are included on the customer bill.

- The broadcast fee is $26.80 per month. This is a fee where Comcast has accumulated increases in programming costs into this side fee rather than raising the basic price of cable.
- The regional sports fee is $10.00 per month – the fee varies by market depending upon the local sports networks that Comcast carries. Again, the company has accumulated rate increases for sports programming to hold down the advertised price of cable TV.
- Comcast also charges $10.00 for each settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $30 basic cable product from Comcast could get the first bill over $75 – a startling difference.

Comcast also has what most in the industry consider as hidden fees for broadband. The company charges $15 per month for a WiFi modem. The biggest surprise for a new customer is the Comcast data cap on broadband. The company charges $10 for each 50 GB of data over the data cap limit, with a maximum monthly fee of $50.

The hidden fees are controversial. In 2018, Lori Swanson, the Attorney General of Minnesota, sued Comcast, seeking refunds for all cable customers who were harmed by the company's alleged violation of the state's Prevention of Consumer Fraud Act and Uniform Deceptive Trade Practices Act. The suit concentrated on the Broadcast TV fee and the regional sports fee, which are charged to every cable customer. Comcast started charging separately for these two fees in 2014, but the size of the fees has skyrocketed. In recent years, the company has put a lot of the annual rate increases into these fees, allowing the company to continue to advertise low prices.

In January 2020, Comcast settled with the Minnesota Attorney General's Office. Comcast agreed to pay $1.4 million in refunds to 15,600 Minnesota customers. Comcast also agreed to pay $160,000 to the Attorney General's Office to use for settlement administration costs.

The Comcast Bundle

An ISP that wants to compete against Comcast to understand the power of its bundles. Comcast uses bundles to entice customers to buy more than one service from the company and increases discounts for buying multiple products. Because the company has so many products, it offers a dizzying array of bundles, with prices that change often as inducements to get customers to buy additional products.

Comcast has learned that customers who buy multiple products – particularly products in addition to the triple play – rarely churn and become loyal customers.

One of the most important aspects of bundles is that the company punishes customers for dropping a bundled service. Consider the following simplified example of how this works. Suppose that a customer purchased the $66 broadband product and the $70 cable product and is given a $20 bundling discount and charged $116 for the bundle. If a customer drops either product, the customer loses the entire $20 discount, and the remaining product reverts to the list price.

Customers never know what they pay for any given product within the bundle. For example, there are bundles that make it look like a customer is getting telephone service for free. But if the customer breaks the bundle and wants to keep only telephone with Comcast, prices revert to list price.

The Comcast bundle creates challenges for competing ISPs. If a customer tries to break a bundle to move broadband to a competitor but wants to leave cable TV with Comcast, the cable prices revert to list prices. This is a big disincentive for customers to break the bundle.

Comcast has expanded the bundle in the last few years. Their newest offering is cellular service, which is only available for customers buying Comcast broadband. The pricing is simple and inexpensive. Cellular customers pay $15 for each gigabyte of data used. For $45 per month, customers get unlimited data. Comcast uses the Verizon network to carry the traffic, but the company recently purchased wireless spectrum and uses its own towers to serve some customers. Comcast is benefitting from the fact that customers mostly use cellphones when near to WiFi.

Comcast also provides smart home products under the brand name Xfinity Home. The company is now supporting the home automation devices of nine major manufacturers: August (smart locks), Automatic (automobile), Cuff (fitness tracking), Lutron (smart lighting) Leeo (alarms), Nest (thermostat), Rachio (sprinkler system), Skybell (doorbell), and Whistle (pet tracking). It's an impressive suite of products and is all integrated through the Comcast portal. Comcast also offers traditional home security with hardware developed at Comcast Labs. This includes the traditional suite of burglar, fire, and other alarms that are monitored and reported to authorities when there is a problem.

Charter Communications (Spectrum)[6] is the second-largest cable TV company in the country, with over 30.5 million broadband customers and 14.1 million cable TV customers at the end of the fourth quarter of 2023. Charter had revenues of $54 billion in 2022. The company reached its current size after its 2016 acquisitions of Time Warner Cable and Bright House Networks. The company has rebranded its triple-play products as "Spectrum." Charter is the incumbent cable company in around Graceville.

Charter/Spectrum says it has upgraded all systems nationwide to a new technical standard DOCSIS 3.1. This technology from CableLabs allows the bonding of an unlimited number of spare channel slots for broadband. This allows the company to increase data speeds to over one gigabit.

[6] https://www.spectrum.com/

Along with the introduction of gigabit broadband, the company announced across-the-board speed increases for upgraded markets. Charter/Spectrum announced in 2022 that the base broadband product will now be up to 300 Mbps – an upgrade from 100 Mbps.

Broadband Pricing

The company currently has three broadband products.

	Speed	Price
Spectrum Internet	300/10 Mbps	$ 84.99
Spectrum Internet Ultra	500/20 Mbps	$104.99
Spectrum Internet Gig	1 Gbps/35 Mbps	$124.99
Activation Fee		$ 59.99

The company has raised rates by $5 per year for the last five years, with the latest increase announced in the summer of 2023.

The company generally gives a $10 discount for bundling broadband with other products, although this can be negotiated.

There are no data caps on the monthly broadband download. However, in June 2020, Charter asked the FCC to allow data caps but was denied. The company has been prohibited from using data caps as a condition for being allowed to purchase Time Warner Cable. The FCC agreement expires in 2024, and it seems likely that the company will implement data caps.

Telephone Pricing

Residential telephone service is only available as part of a bundle and not as a standalone product. Depending upon the bundle, the voice product that comes with the most popular features adds $10 to $15 per month to the cost of a bundle. Charter/Spectrum does not advertise business telephone rates.

Video Pricing

Spectrum TV Basic	$ 9.99
Spectrum TV Choice	$49.99
Spectrum TV Select	$89.99
Settop Box	$12.50
Installation	$59.99

Hidden Fees

Charter uses hidden fees as part of its strategy when advertising to get new customers. The motivation for having hidden fees is clear – it lets a cable company advertise a low base price for service by not mentioning the hidden fees. It's an odd tactic since customers find out about the hidden fees when they get the first bill. The current Charter hidden fees include:

- The broadcast fee is $25.75 per month. This is a fee where Charter has accumulated increases in programming costs into this side fee rather than raising the basic price of cable.
- Charter also charges $12.50 for each settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $49 basic cable product from Charter will get a first bill for over $88 – a startling difference.

Charter has no hidden fees for broadband.

Fixed Wireless

Point Broadband[7] is a fixed wireless and fiber provider founded in 2017 and is headquartered in West Point, Georgia. In Jackson County, Point Broadband provides licensed fixed wireless service along the eastern border.

Residential Fixed Wireless Broadband

Air Connect Lite	5/1 Mbps	$ 66
Air Connect Basic	10/1 Mbps	$ 76
Air Connect Performance	20/3 Mbps	$106
Air Connect Ultra	30/3 Mbps	$126
Whole Home WiFI		$13.99

Cellular Data

Cell Phone Broadband

The three largest cellular companies now advertise unlimited data plans for cell phones. The plans for AT&T and Verizon are not actually unlimited and have monthly data caps in the range of 20 - 25 gigabytes. These plans might provide some relief to homes that rely on cell phones for home broadband, although there have been reports of Verizon disconnecting rural customers who use too much data on these plans. These cellphone plans have limits on how much data can be used when tethering from a cell phone to connect to other devices. T-Mobile claims to offer unlimited data but begins throttling customers after 50 gigabytes of data usage in a month.

Most of the study area should be seeing cellular coverage over the next few years from Dish Networks. The company's first markets were launched in June 2022.

Hotspots and FWA Broadband.

In recent years, the cellular plans available for home broadband have been marketed as hotspots. These plans have small data caps similar to traditional cellular plans.

Cellular companies have recently introduced fixed cellular plans that use the new spectrum that each company labels as 5G. These plans are still only available in places where a carrier has upgraded cellular cell sites, and where the new product has been opened for marketing. It's likely that these products are starting to be available in parts of the study area but not everywhere.

T-Mobile and Verizon have done extraordinarily well with these products. In a little over a year, T-Mobile has added almost 3.2 million customers nationwide, and Verizon has added 1.9 million.

[7] https://www.point-broadband.com/

AT&T has historically offered hotspot plans. More recently, it is offering fixed wireless plans that use the new bands of spectrum labeled as 5G.

4G Hotspots	
15 Gigabyte of data	$ 35
100 Gigabyte of data	$ 55
Additional 1 Gigabyte	$ 10

AT&T Internet Air -5G Fixed Wireless	
40 - 140 Mbps	$ 60
Discount for autopay	$ 5

Verizon historically offered cellular hotspot broadband. More recently, it offers fixed wireless plans using the new bands of spectrum labeled as 5G.

4G Hotspots	
15 Gigabyte data cap	$ 20
50 Gigabyte data cap	$ 40
100 Gigabyte data cap	$ 90
150 Gigabytes data cap	$110

Customers also have the option to purchase an additional 1 gigabyte of data for $15 or 5 gigabytes for $35. If a customer doesn't buy extra data, the speeds are significantly choked to be very slow.

5G Home	
With cellphone plan	$ 45
Standalone	$ 60
Discount for autopay	$ 10
Speeds up to 300 Mbps	
Unlimited usage	

T-Mobile historically offered hotspot plans. More recently, it offers fixed wireless plans that use the new bands of spectrum labeled as 5G. T-Mobile advertises speeds as fast as 100 Mbps for this product.

4G Hotspots	
5 Gigabyte data cap	$ 20
10 Gigabyte data cap	$ 30
30 Gigabyte data cap	$ 40
50 Gigabyte data cap	$ 50
Discount for autopay	$ 5

Speeds revert to 3G speeds when the cap has been met. The plans include unlimited texting.

5G FWA Fixed Wireless	
Up to 100 Mbps	$ 65

Discount for autopay	$ 5
Unlimited usage	

Satellite Broadband

There are two geostationary satellite broadband providers that cover most places in the country. Both Viasat and HughesNet use satellites parked at a stationary orbit over 22,000 miles above the Earth. There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much (Viasat reported in the second quarter of 2023 that the average residential broadband bill was $89.71). Customers also hate the high latency, which can be 10 to 15 times higher than terrestrial broadband. The latency is due to the time required for the signals to go to and from the high-orbit satellites, which adds time to every round-trip connection to the Internet. Most real-time web applications, such as using voice-over-IP or connecting to a school or corporate server, only function reliably with a latency of less than 100 milliseconds. Satellite broadband has a reported latency between 400-900 milliseconds.

The other customer complaint is about the tiny data caps. As shown in the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault announced recently that the average U.S. home uses over 620 gigabytes of data per month. The small data caps on satellite broadband make it impractical to use for a household with school students or for a household that wants to use broadband to work from home.

Viasat (formerly marketed as Exede or Wildblue). Viasat satellite broadband has gotten better over time. The broadband on the ViaSat-1 satellite launched in 2011 was relatively slow, with speeds as fast as 25 Mbps. The company advertises speeds as fast as 100 Mbps download on the ViaSat-2 satellite launched in 2017. The company plans three new ViaSat-3 satellites with even higher capacity, with the first launched in May 2023.

Prices are high compared to other broadband products. The latest pricing from the company is as follows:

	Price	Data Cap
Up to 25 Mbps	$ 84.99	60 Gigabytes
Up to 50 Mbps	$119.99	100 Gigabytes
Up to 75 Mbps	$169.99	150 Gigabytes
Up to 100 Mbps	$249.99	300 Gigabytes
Up to 100 Mbps	$349.99	500 Gigabytes
Equipment Fee	$ 14.99	

A customer must sign a 2-year contract to get these prices and pay a fee of $15 for each remaining month if a customer breaks the contract. The packages are advertised as offering unlimited data, but online reviews say that speeds can be throttled to be as slow as 1 Mbps once a customer reaches the monthly data cap.

HughesNet is the oldest satellite provider. They have recently upgraded the satellites and now offer speeds advertised as 25 Mbps download and 3 Mbps upload for all customers. Prices vary according to the size of the monthly data cap. These packages are advertised as offering unlimited

broadband but are severely throttled after meeting the data caps. These packages require a 2-year contract. The packages are as follows:

Up to 50/5 Mbps	100 Gigabytes	$ 74.99
Up to 100/5 Mbps	200 Gigabytes	$ 89.99
Up to 100/5 Mbps	200 Gigabytes	$109.99
Router Node		$ 5.00
Installation		$ 99.00

Low-Orbit Satellite. There has been a lot of news concerning the three new low-orbit satellite companies that will be offering broadband. These companies are putting satellites between 300 and 600 miles above the Earth.

Starlink is owned by Elon Musk. The company recently reached 2 million worldwide customers. The company had over 5,500 satellites in orbit at the end of November 2023 and needs 11,000 to complete its first constellation.

Residential Broadband	
Standard	$ 120
Receiver	$ 599

Business Broadband	
Priority 40 Gigabytes	$ 140
Priority 1 Terabyte	$ 250
Priority 2 Terabyte	$ 500
Hardware	$2,500

Mobile	
Regional	$ 150
Global	$ 200
Hardware	$ 599

Mobile Priority	
Priority 50 Gigabytes	$ 250
Priority 1 Terabyte	$1,000
Priority 5 Terabyes	$5,000
Hardware	$2,500

A few months ago, the company claimed the following speed capabilities on its website; however, it no longer posts any claims about residential speeds. Interestingly, the speed claims below are much slower than promised as recently as September 2022. For example, residential customers were told in 2022 that download speeds would be between 50 – 200 Mbps with upload speeds of 10 - 20 Mbps. Customers have been saying online that speeds are getting slower – something that Ookla speed tests have validated. Ookla recently released a report stating the nationwide median download speed for Starlink was 64.5 Mbps.

	Download	Upload
Residential	20 – 100 Mbps	5 – 15 Mbps
Business	40 – 220 Mbps	8 – 25 Mbps
RV	5 – 50 Mbps	2 – 10 Mbps

Project Kuiper is owned by Jeff Bezos. The company recently launched its first two test satellites. The company has reserved many slots on upcoming space launches from several rocket companies. The company is being fully funded by Bezos and Amazon. The completed constellation is slated to have 3,236 satellites.

Low-Income Broadband Programs

There are several programs available to subsidize broadband rates for qualified low-income households.

Access from AT&T

AT&T has a low-income program called Access from AT&T that provides broadband to qualifying households. The program offers a free modem, no annual contract, no deposit, and up to $10 off per month with a maximum speed of 25 Mbps. The amount of savings per month is dependent on the fastest speed available at the address.

Households must have one or more members that receive one of the following assistance programs: Supplemental Nutritional Access Program (SNAP), income of 135% or less than the Federal Poverty Guidelines, or National School Lunch and Head Start Programs.

Comcast Internet Essentials

Comcast has a low-income program called Internet Essentials that provides broadband to qualifying households. Comcast delivers 50/5 Mbps speeds for $9.95 per month. The program was created as a condition by the FCC for the purchase of NBC Universal in 2011. For a long time, the program was lowkey, and the company barely advertised it to customers. But over the years, the company has embraced the program, and in August 2019, it announced it had connected over eight million people to the Internet with the program.

In addition to the low monthly broadband rate, those in the plan are eligible to buy a low-cost computer for $149.99. Comcast also offers broadband training in Internet basics, online safety and security, using basic computer tools and programs, etc. These training courses are available online or can be taken in person.

Comcast has widened the eligibility for the program over the years, and current eligibility covers families that participate in Medicaid; live in public housing; participate in SNAP, TANF, SSI, National School Program, Headstart, LIHEASP, or WIC; attend college using a Pell grant; receive a VA pension; or receive various kinds of tribal assistance are eligible for the program.

Charter Internet Assist

Charter has a low-income program called Internet Assist that provides broadband to qualifying households. The program offers speeds of 30 Mbps, a free modem, no data caps, and an optional in-home WiFi service at $5 a month. Charter/Spectrum provides Internet Assist for $14.99 per month.

Households must have one or more members that receive one of the following assistance programs: National School Lunch Program (NSLP), Community Eligibility Provision (CEP) of the NSLP, or Supplemental Security Income (for applicants age 65+ only).

Federal Lifeline Program

CenturyLink, Consolidated Communications, and Point Broadband participate in the FCC Lifeline program, which is a part of the Universal Service Fund. With the program, a customer can receive a discount in Florida of $9.25 per month off a telephone bill or a broadband bill for qualifying customers. The program works with ISPs providing a discount to customers, and the FCC reimbursing the companies for the discount. This means it costs the telephone companies nothing to offer the discount – the discount is funded by the FCC.

To qualify, a customer must participate in one of the following programs: Medicare, SNAP (formerly Food Stamps), SSI, Federal Section 8 housing, VA Veterans pension, or VA survivor's pension. The FCC has recently established a web portal where participating carriers can check customer eligibility each month.

The telephone companies don't tend to aggressively pursue this program, but they will enroll anybody who qualifies and asks for the discount.

Affordable Connectivity Program

This federal program was created with $14.5 billion in funding from the Infrastructure Investment and Jobs Bill. The program starts in early 2022 and provides a $30 monthly discount on broadband bills for homes that make up to 200% of the federal definition of poverty. To put that into perspective, in 2021, that would equate to a household of three making less than $44,000 per year.

Qualifying Tribal Lands can receive additional benefits of up to $75 a month and a one-time discount of up to $100 for a laptop, tablet, or desktop computer with a co-payment of more than $10 but less than $50. Qualifying Tribal Lands include any federally recognized Indian Tribe's reservation, pueblo, or colony, former reservations of Oklahoma, Alaska Native regions, Indian allotments, Hawaiian Home Lands, and any land approved as Tribal for the purposes of the Lifeline program or the ACP by the FCC's Office of Native Affairs and Policy and Wireline Competition Bureau.

The big news is that this program is running out of money and will end in May 2024 unless Congress votes for the funding to keep the program going. The program has over 23 million subscribers, and it's anybody's bet if the program continues.

The FCC stopped new customers from enrolling in early February 2024.

Customers have been able to qualify by participating in a wide variety of federal subsidy programs.

ISP Pricing Philosophies and Practices

Factors that Impact Broadband Rates.

One fact that becomes clear by examining broadband rates from various ISPs is that there is a wide range of different philosophies on how to price broadband. CCG Consulting has hundreds of clients that provide broadband over fiber networks. In talking to these clients, we see the following factors affecting the decision of how ISPs set rates.

Competition. Most ISPs start by considering the existing broadband rates of existing ISPs. Even when a new ISP will be offering faster speeds, they want to know how much households in the area are spending on broadband each month. ISPs have learned that it's a lot easier to sell broadband if you don't have to ask customers to spend more than they spend today.

Market Perception of Rates. Market perception of existing rates is different than an analysis of the actual existing rates. Many ISPs undertake market surveys before launching into a new market and often find out surprising things about the market perception of rates. For example, we've seen communities where a large percentage of potential customers think existing rates are too high – even if that is not true. Other nearby communities might not share the same perception of the identical rates. This doesn't seem to be strictly related to demographics – we've seen relatively wealthy communities complain about high rates and communities with lower incomes that are willing to pay for good broadband.

Over the years of helping ISPs understand market rates, CCG Consulting boiled this issue down to the concept of perceived value. Some communities grow to have a widespread perception that the existing ISP is not providing value – this perception might not be due only to rates but can be due to outages, slowness in fixing problems, or poor customer service experience. What we've seen is that when an ISP is disliked, the public often comes to think they are paying too much. This is an interesting bias that a new ISP entering the market must deal with if they intend to charge the same or higher prices than the unpopular incumbent.

Marketing versus Actual Speeds. One of the dilemmas faced by fiber-based ISPs is how to compete against competitor products that don't deliver the advertised speeds. It's not unusual for the big ISPs to advertise 'up-to' speeds but deliver slower speeds than advertised. The public has no easy way to distinguish between an ISP selling an honest broadband product and another that advertises the same speed but delivers less. This can be a challenge for a fiber ISP that can largely deliver the speeds it promises – how does it convince the public of the difference?

Goals for the ISP Business. One of the biggest factors in setting rates is the overall goal of the ISP business. For example, a commercial ISP probably has a goal of making some targeted amount of profit, while the cooperative might be happy breaking even. This difference in goals can have a drastic impact on rates.

As an example, big cable companies now have base prices over $90 per month when considering the mandatory add-ons like a required modem. While the big cable companies might have low introductory rates for new customers, the companies expect that customers will eventually pay the higher list price.

These higher prices are set to satisfy Wall Street earnings expectations - in fact, industry analysts have been pushing the big cable companies to migrate base prices to be over $100.

Bias of Decision-Makers. This is an issue that can apply to any ISP but is prevalent in municipally-owned ISPs and cooperatives. The initial pricing philosophy is often driven by the perception and biases of the elected officials or Board of Directors who approve rates. We've seen the philosophies of decision-makers direct the rates to be either too high or too low – instead of being based on market factors.

Simplicity versus Complexity. It's not hard to find ISPs at both ends of a simplicity scale. There are a few ISPs like Google Fiber and Ting that offer only a single broadband product for a set price that doesn't vary. Both of those ISPs sell a gigabit of speed for a set price – Google Fiber at $70 and Ting at $80. Google Fiber had changed to a 2-product offering but eventually returned to the flat-rate $70 gigabit product. An ISP with this philosophy is not trying to capture everybody in the market – they are instead only willing to sell a product with a decent margin to customers willing to pay the set price. There are examples at the opposite extreme. We know some mid-sized cable companies with hundreds of different bundles and combinations of broadband, cable TV, and telephone service. The majority of ISPs are somewhere in the middle between these two extremes and offer a limited number of broadband products.

Residential Pricing Philosophies

Most ISPs have a pricing philosophy that brings the above factors together into a set of rates and policies. It's not unusual to have different philosophies for business and residential customers. It's also somewhat normal to adopt a policy that is a blend of two of the following philosophies:

Low Price / Internet for Everybody. ISPs in this category are almost often municipalities or cooperatives. This ISP will have a low-price product that will make broadband affordable for most homes in the market. Note that this is different than having a low-income product that only qualifying households can buy. This ISP is looking to serve the greatest number of customers, with the philosophy that this is best for the community. This ISP focuses on the customer penetration rate.

Good Everyday Prices. This is probably the most common ISP pricing philosophy for smaller ISPs. This ISP will price most products slightly below market prices so that it is always less costly than the competition. This ISP rarely uses any gimmicks like bundling discounts, new customer incentives, or hidden fees. This ISP generally advertises with, "What you see is what you get."

Maximize Profits. This doesn't necessarily mean high prices, but it could. Instead, this ISP charges for everything. There's a connection fee. There is a fee to get a paper bill. There is a separate bill for the modem and advanced WiFi. There's a fee for paying late. There's a fee for a technician visit to the home. There may be a fee for data caps. This ISP will probably have pricing plans that make it easy for customers to upgrade and spend more.

Charge Premium Prices for Superior Technology. Maybe the best historical example of this was Google Fiber. When the company launched, it had one broadband product priced at $70 for a symmetrical gigabit. At the time, nobody else sold gigabit speeds, and this price was more than charged by other ISPs. It's clear the company wanted every customer to generate a good margin.

Simple to Use. This ISP offers only a few products and makes it easy to become a customer. Perhaps the most recognizable example of this is also Google Fiber. They started with only one broadband product priced at $70. They offered Google Voice (which is also available to anybody with broadband, not only to their broadband customers). They offer YouTube TV as an online video product. This was a simple triple play based on only three simple products.

Attract Customers with Special Incentives. This ISP practically gives away broadband to get a new customer. The marketing campaign is all about super-low introductory prices and almost nothing else. After a 1 – 3 year contract, prices revert to the higher market prices, and a lot of customers will bail. This is still how most of the big cable companies and most of the big telcos advertise.

Business Pricing Philosophies

It's not unusual for an ISP to have a different philosophy for business and residential customers. The following are the most typical business broadband pricing philosophies:

Good Everyday Prices. An ISP with this philosophy probably publishes business rates. They think the rates are fair. There is no negotiation with customers and no bundling. They sell a menu of products, each with a price tag that they think is fair. Many government-owned ISPs price in this manner since they feel they cannot discriminate among customers and must charge and treat all businesses the same.

Maximize Profits. This ISP publishes no rates, and they negotiate a unique price with every business. This is the predominant business sales model for most ISPs that sell to businesses. ISPs will typically offer a price to a new customer that is lower than what the customer is already paying – even if the current rate is higher than market rates. This ISP will require a contract and will ruthlessly enforce it.

Charge Premium Prices for Superior Technology. This philosophy is used by some fiber ISPs. Their sales pitch is that fiber is a premium technology, and they market on reliability and low downtime rather than price. This is also the philosophy for ISPs that sell specialized broadband products, such an ISP that sells to a specialized customer like a hospital complex.

Attract Customers with Special Incentives. This is rare for selling to businesses, and if introductory incentives are used, it's typically only done to attract small businesses.

Specific Issues Involved in Setting Rates

Setting the Base Broadband Price. ISPs struggle with this decision since it often defines the biggest difference between competitors in a market. CCG Consulting has access to the prices and the resulting customer penetration rates from several hundred ISPs, and historically we saw that a large percentage of customers will buy the base broadband product if the speed for the introductory product is acceptable. A base product with a perceived slow speed won't get a lot of customers in today's market, but a base product at even modest speeds of 100 Mbps or faster will be perceived as acceptable to a significant percentage of households if the price is low enough.

However, that phenomenon is no longer true everywhere. ISPs have been telling us that a much higher percentage of customers are opting for more expensive broadband that offers faster speeds. It seems that a lot of the public has accepted that faster speeds mean better broadband.

Another interesting thing we've seen is that having a low base rate doesn't seem to result in drastically higher market penetration. Having a low introductory rate just means having lower earnings for the ISP.

Price Steps or Tiers**.** Another factor in setting the rates is the price differential between products. This is where a pricing philosophy is most obviously manifested. To give a simple example of what this means, consider the difference for ISPs that have a $60 base rate but a different philosophy of the price steps. The difference in the rates below is that the Rate 1 table is $30 between rates, Rate 2 is $15, and Rate 3 is $10.

	Rate 1	Penetration	Rate 2	Penetration	Rate 3	Penetration
100 Mbps	$ 60	80%	$60	55%	$60	35%
250 Mbps	$ 90	15%	$75	30%	$70	40%
Gigabit	$120	5%	$90	15%	$80	25%
Monthly Revenue for 1,000 Customers:						
Revenue	$63,000		$69,000		$69,000	

As ISP using Rate 3 prices should have an easier time convincing customers to upgrade to a faster product, at least compared to using Rate 1. CCG has found that when customers confront a big difference in the rate tiers, like with Rate 1, a lot of customers will choose the base rate because they perceive it costs too much to upgrade to the next higher rate.

The pricing between tiers reflects how an ISP thinks about the market. An ISP that believes that price is the biggest determinant for customers will set the difference between tiers narrowly. This invites customers to upgrade to faster speeds since the price penalty for an upgrade is likely to be perceived as small by customers.

An ISP that thinks that speed is the most important factor, meaning that customers will buy faster speeds regardless of price, is likely to set a larger gap between tiers. This ISP assumes customers are going to upgrade speeds out of need, and that price won't stop a household from buying the bandwidth it needs.

Rate Bundles. Large cable companies are well-known for having bundles of products that provide a discount to customers buying more than one product. CCG does market surveys, and it's still common to find half of the cable company customers are buying a bundled package.

Generally, customers buying a bundle don't know the price for any individual product inside the bundle. Customers know they get a discount for buying extra products and don't really worry about where the discount is applied. Many consumers are shocked when they try to cut the cord or drop one of the products in the bundle and find that the cable company will assign the entire discount to whatever product they are trying to drop. At CCG, we refer to this as the bundling penalty because big cable companies make it costly for a household to drop only one or two products from a bundle. The bundle makes it harder to sell to cable company customers since they might decide to stick with the cable company once they realize

the cost of breaking the bundle. In fact, the industry uses the term stickiness to describe pricing strategies that can persuade customers to stick with current prices.

Interestingly, the industry is changing in the use of bundles. Most smaller ISPs don't use bundled prices. Verizon announced in 2020 that it was doing away with bundled rates for new customers. This was the first big ISP to eliminate bundles. Verizon described the new rate structure as more open and honest and what customers want. Verizon's new rates are similar to car dealerships that post the real prices on new cars and no longer haggle over price.

Introductory Rates. The big telcos and cable companies are well-known for advertising low introductory rates that increase dramatically after a term contract of one or two years. The real rates for these ISPs are generally buried in the small print of marketing materials, if shown anywhere. Customers have come to dislike the introductory rate process because they invariably get a big, unexpected rate increase when rates jump back to list prices.

Most small ISPs don't offer introductory rates. The biggest problem with a low introductory rate is that it tells customers that an ISP's rates are negotiable. Customers will expect the ISP to continue to negotiate rates at the end of the introductory period. Having low rates also requires having term contracts and keeping track of the timing of contract rate changes. Most small ISPs don't want the extra paperwork and set rates they think are fair and refuse to negotiate.

Grandfathered Rates. One interesting subset of special rates is what we call grandfathered rates. Cable companies and large telcos sometimes allow customers to stick with low-price broadband products if the customer is willing to keep the original broadband speed. For example, we sometimes still find a customer from a big cable company that might be paying a low rate for a broadband product that only delivers 20 Mbps. That customer might have purchased that product a decade ago and is being allowed to keep the original rate as long as they agree to keep the original product. Generally, a grandfathered customer is forced to upgrade if they want to make any changes to the existing product.

Hidden Fees is an industry term referring to rates that are routinely charged to customers but that are not mentioned or quoted in advertising (or perhaps only in the small print). For the larger ISPs, the following types of charges are routinely considered to be hidden fees – broadcast TV fees, regional sports fees, settop box or modem rental, WiFi routers, and various administrative fees. The hidden fees for Charter were detailed above in the list of prices.

As this report is being written, there is a national move to eliminate hidden fees. The Federal Trade Commission has proposed regulation that would not allow hidden fees. The FTC would make companies refund all overbilling and also assess fines. The FCC has also opened an investigation to specifically disallow hidden fees for cable TV service.

Installation Costs. ISPs vary widely in the philosophy of charging for installation. There are two types of installation fees that most ISPs consider:

- Routine Installation Fee. This covers part of the cost of building the fiber drop and connecting a customer to the network. It's common in a competitive environment for ISPs to routinely waive this fee. An examination of the financial benefit of the installation fee will show that the long-term benefits of having a customer far outweigh any advantage of an installation fee. If the impact of a

routine installation fee is to dissuade some customers from joining the network, then the ISP is turning away good customers by charging the fees.

There is a middle position, which is to have customers sign a contract and agree to only pay the installation fee if the customer leaves the network earlier than the term of the contract. Waived installation fees are generally prorated in the industry, meaning that the penalty for leaving early reduces over time. In a simple example, if the normal installation fee was $120 with a one-year contract, then the amount that a customer would owe for leaving early would be reduced by $10 per month.

- Aid-to-construction or Network Extensions. ISPs often charge a share of construction costs to add a customer that is not within easy reach of the existing network. The big challenge of charging aid-to-construction is determining the amount to charge to a given customer since the cost of extending the network is always going to be unique. It's not unusual to spread aid-to-constriction over time, but doing so should always include a contract that specifies that the customer owes the whole fee if they drop service before the full aid-to-construction has been recovered.

Customer Contracts. ISPs vary widely on the philosophy of requiring customer contracts. We've always boiled down the question of having contracts to the willingness of an ISP to pursue a broken contract. For example, many municipal ISPs don't require contracts for residential customers because they know the City would be unlikely to pursue a citizen for leaving the network early. Commercial ISPs often reach the same conclusion for residential customers since they think it would hurt their reputation in a market to sue non-paying residential customers who left because they didn't like the products or services.

There are circumstances discussed above that should always require a contract:

- Business premium service. Contracts are generally provided for anything considered as a premium service to document the rights and benefits of the business customer. This might mean a simple contract or something more extensive to document a Service Level Agreement.
- Deferred installation or aid-to-construction. A contract should be created to document and get a customer to pay deferred installation fees or aid-to-construction fees, assuming that the ISP will pursue these fees if a customer is unhappy with the service.
- Term discounts. It's routine to have a contract to recognize term contracts, meaning that a customer is given a discount for agreeing to buy service for multiple years. ISPs that have term discounts need to keep up with pending expired contracts because the rates ought to be increased to normal rates at the end of the contract (or another term contract put in place).

Broadband contracts don't need to be complex, and contracts for things like term agreements might fit on a single page. Service Level Agreements for big companies like AT&T are over 100 pages long.

Business Broadband Products

There is a huge range of industry philosophies for how to set business broadband prices. Business broadband rates vary more widely than residential rates. The following is a discussion of the ways that ISPs think about business broadband.

Published Rates. Most ISPs don't publish broadband prices for businesses – ISPs instead negotiate with each business that is interested in buying the service.

How Much Premium Should Businesses Pay? Most ISPs charge higher rates for businesses than for residential customers. This is a carryover from the days of regulated telephone companies when regulators forced telephone companies to charge more for businesses to keep residential rates low. There was a time in the past when it was assumed that businesses used more broadband and should pay more – but with the explosive growth of home broadband usage, this is no longer true. The average home today uses more broadband than the average small business.

Many ISPs negotiate rates with businesses based on what they are already paying today. This means that a business that paid a lot for broadband in the past will likely continue to do so. This sales philosophy has kept many business rates high, even after decades of competition.

Bundling with Telephone Service. Many of CCG's ISP clients tell us that businesses prefer to buy both broadband and telephone service from one ISP. Businesses often prefer one service provider for all telecom services because they fear the runaround that can happen when different service providers point the finger at each other when there is a problem. Many of CCG's clients sell bundled voice to more than 50% of their business customers.

Premium Broadband. It is difficult to justify charging a premium price for businesses if broadband speed is the only factor determining broadband prices. It's hard to justify a price difference based on cost difference because the cost of providing broadband service to a home, a small retail business, or even a large factory might be similar. Speed alone is a poor way to define the difference between residential and business products if the speeds are the same for both products.

ISPs that sell to businesses have found ways to distinguish business broadband from residential broadband. Following are some of the most common ways to define business broadband as separate from residential broadband:

> Service Level Agreement (SLA). This is a contract between an ISP and a customer that generally provides penalties for the ISP for not maintaining service to a customer. For example, an SLA contract might make specific guarantees of bandwidth or specific guarantees against network outages and then provide monetary penalties to the ISP for not delivering what was promised. Customers who get an SLA should pay a premium price because they are being guaranteed a premium level of service compared to other customers.
>
> Guaranteed Repairs and Maintenance. One of the most common benefits offered to premium customers is guaranteed priority repairs and maintenance. For example, a premium customer might be guaranteed same-day repair on outages, meaning the ISP will dispatch a maintenance or repair crew in the evening or on weekends. A premium customer might be assigned to a specific customer service representative. Non-premium customers will instead be offered normal maintenance and repair schedules.
>
> Term and Volume Discounts. Premium customers are often offered additional discounts for a term and/or volumes. A term discount will provide a lower price for an ISP that contracts for a service for a given term – generally two to five years. Volume discounts are applied to customers who buy multiple connections.

Large Business / Carrier Broadband. There are specialized broadband products that are sold to larger businesses and carriers like cellular companies. These specialized broadband products generally fall into three categories, described as follows:

- Dedicated Broadband. Some businesses are willing to pay more for dedicated broadband. To a business, dedicated broadband means two things – the broadband stream is not 'shared' with another business, and the amount of bandwidth is guaranteed.

  The idea of sharing bandwidth on a fiber network is quaint because data streams of different customers are not mixed in any of the current fiber technologies. Both Active Ethernet and PON technologies on fiber encrypt the bandwidth between the ISP and a given customer in a way that is impossible to crack.

  The customer perception of 'sharing' broadband comes from the experience of having broadband provided with DSL or from a cable company network. Data speeds can slow down for both technologies when too many customers are using the network. Businesses that don't want shared bandwidth are asking for broadband that is not affected by what their neighbors are doing. If fiber networks are configured properly, there will be no noticeable slowdown of broadband speeds unless there is an extraordinary amount of traffic on a network, such as after some sort of major emergency. Businesses are not really concerned about having other businesses listen in on their broadband traffic, and this is not possible on any of the common broadband technologies, which all use encryption.

  It's common for ISPs to label dedicated access as a VPN (virtual private network). There are some specialized features that can be added to a VPN, but most such products on a fiber network are just a dedicated fiber connection.
- Dark Fiber. This involves selling the use of fiber that is not connected to electronics. The customer buying the dark fiber is responsible for providing and operating the electronics necessary to use the fiber. ISPs have strong opinions about offering or not offering dark fiber. The following issues are involved in deciding to sell dark fiber:
  - Most ISPs that sell dark fiber are only willing to do so for long contract terms ranging from three years to twenty years. The dark fiber customer must make a financial commitment to install electronics and usually wants the connection to last for the length of the expected life of the electronics.
  - One of the biggest concerns for selling dark fiber is that it uses fiber that can't be used for anything else. We know of examples where an ISP sold too many dark fibers and ten years later didn't have enough fiber left for other connections. It's essential to coordinate the sale of dark fiber with a long-range plan for the network.
  - One common way to sell dark fiber is through an IRU (Irrevocable Right of Use). This is a long-term fiber lease that lays out the operational and financial terms for the long-term sharing of fiber. It's not mandatory, but most IRUs require a sizeable payment upfront as part of the arrangement. It's normal for an IRU customer to pay a proportionate share of ongoing network maintenance to keep the fiber operating for the long term. This could be a monthly fee for maintenance or perhaps an occasional assignment of larger fees to cover the cost of repairing fiber cuts or other network events. IRUs generally define the specific

processes for the customer to use the fiber and interface with the network. It would not be unusual for an IRU to include collocation for customer electronics.
    - There is no 'standard' or market pricing for dark fiber or IRUs. The price is strictly negotiated between the two parties. Pricing can be structured in any mutually agreeable way, from flat pricing to paying for dark fiber by the mile.
- Transport. Transport means fiber that connects more than one location in the same local market. As an example, a bank might want a network in a community that connects to several banks along with standalone ATM locations. A transport network most typically aggregates traffic from multiple routes and locations back to one point of handoff to the customer. The customer uses the transport network to communicate between locations. There is generally no standard pricing for transport.

B. Surveys, Interviews, and Speed Tests

Residential Survey

A statistically significant survey was conducted by telephone in January 2024. Jackson County wanted this survey to represent households across the socioeconomic and age range, and the easiest way to get that broader mix is to include cell phones in the survey.

A statistically valid survey must be conducted randomly, meaning that the calling can't be clustered around any one particular portion of the study universe. For example, the survey would not be considered to be valid if all of the calls were placed in only one portion of the County.

Most business and political statistically valid surveys strive to achieve an accuracy of 95% with results that are plus or minus 5%. In layman's terms, this means that the results of such a survey are reliably accurate (the 95% number), and you would expect to get the same results (within 5%) if you could ask the same questions to everybody in the study area. In this survey we got 377 completed surveys and achieved the targeted accuracy.

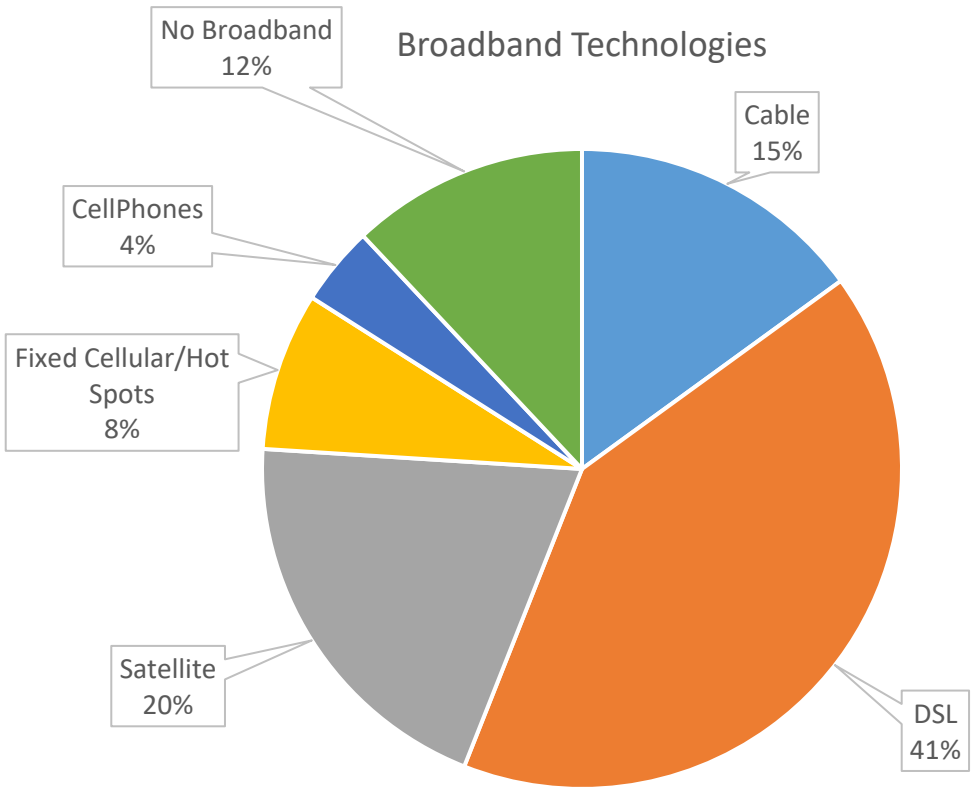
In the U.S. we know that many people distrust the results of surveys, mostly due to results obtained for political surveys. This speaks to the issue of bias. When callers are asked about sensitive topics like politics, religion, or anything personal or controversial, it's well-known that many respondents don't answer questions honestly to a stranger like a survey taker. The best example of this is when surveyors ask people for their household income. Survey companies have often noted that as many as half of residential homeowners will not give an accurate response to the salary question.

However, CCG Consulting has been conducting telephone surveys for over twenty years, and we've learned that people tend to give honest answers when asked about a non-emotional topic like broadband usage. We have evidence that the broadband surveys are good market predictors because we've had many opportunities to see the eventual broadband penetration rates on new networks to compare to the predictions made by our surveys. Surveys do not provide an ironclad prediction of market penetration because sometimes an ISP does something to change the public perception. For example, an ISP that has problems during a network launch might underperform the predicted results from a survey. In general, we've learned to have faith in the predictions made by these broadband surveys.

A full copy of the survey questions and the responses are included in Exhibit I of this report. Following are highlights of the survey results:

Broadband Customers. 84% of the respondents have a home broadband connection today – with 12% saying they don't have home broadband, and another 4% who only get broadband from their cell phone.

The survey responses showed a wide variety of broadband technologies in place in the County today. The following chart shows the percentage of respondents that use each technology.



Following is more detail about the ISPs serving the survey respondents:

- 15% of the respondents buy cable broadband from Comcast and Charter.
- 41% of respondents buy DSL broadband from a telephone company – 7% from AT&T, 33% from CenturyLink, and 1% from Consolidated Communications.
- 20% of respondents use satellite broadband. This is the highest market penetration for satellite broadband that CCG has ever seen.
- 8% use cellular hotspots or other fixed cellular technology for home broadband - 2% from T-Mobile and 6% from Verizon.
- 4% only use their cell phones for broadband.
- 12% claim to have no broadband.

We asked the respondents without broadband why they did not have broadband. 14% said it was too expensive, 4% said they were uncomfortable using the internet, 21% said they get internet outside of their

home, 44% said they are not interested in using the internet, and 17% said the internet is not available at their home.

Customer Bills. The survey asked customers what they pay each month for the broadband. We've found that this question must be taken with a grain of salt because what people say they pay is often different than what they actually pay. For example, a household might cite a $100 special price they were quoted without realizing that they actually pay more due to hidden fees. It's especially easy these days for customers that pay automatically with credit cards or bank debits to not know how much they pay. With that said, here is what respondents said they are spending:

Bundled Services. A bundle means that customers are buying more than one product from an ISP and being charged one fee for the services combined. For example, customers might be buying a package of broadband and cable TV from a cable company. Historically, as many as 70% of customers were buying a bundle. Cable companies had bundled that included some combination of cable TV, telephone, and broadband. Telephone companies offered bundles of DSL and telephone.

Over time, bundles have become less popular with customers. A lot of customers broke the bundle when they dropped cable TV service. The survey shows that 36% of residents in the county are still buying a bundle.

Bundles are expensive. Only 15% of respondents are spending less than $80 for the bundle. 32% of respondents are paying more than $200 per month for a bundle.

Standalone Cable Service. Customers can buy standalone cable service from the cable companies or from the satellite providers DirectTV or Dish Networks. Respondents also told us that standalone cable TV is expensive. Only 9% are paying less than $80 per month. 18% are spending more than $200 per month.

Standalone Telephone Service. This is a combination of a landline, features, and long-distance. 59% of respondents are paying less than $80 per month. 11% are paying more than $200 per month.

Standalone Broadband. We also asked what respondents are paying for standalone broadband. We got the following responses:

$20- $40	8%
$41 - $60	20%
$61 - $80	14%
$81 - $100	25%
$101 - $120	15%
$121 - $150	8%
$151 - $200	4%
Not Sure	6%

People might be surprised to see that 27% of respondents are spending more than $100 per month. However, the reason for the high spending is a lot more apparent after seeing the ISP for the customers claiming high monthly bills. Over half of this group is subscribing to satellite broadband. Starlink prices start at $110 per month. The other satellite ISPs have tiny data caps, and many subscribers go over those caps. There are also tiny data caps on cellular hotspots that drive up the monthly bill for many customers. Some of the Comcast broadband products cost more than $100 per month.

One of the benefits of bringing fiber broadband that doesn't get talked about enough is that the monthly bill for broadband will go down in rural areas if somebody builds a fiber network. It's highly likely that a fiber provider will have several broadband products priced under $100 per month, and without data caps.

Affordable Rates. We asked survey respondents to define what they think is an affordable rate for broadband. They responded as follows:

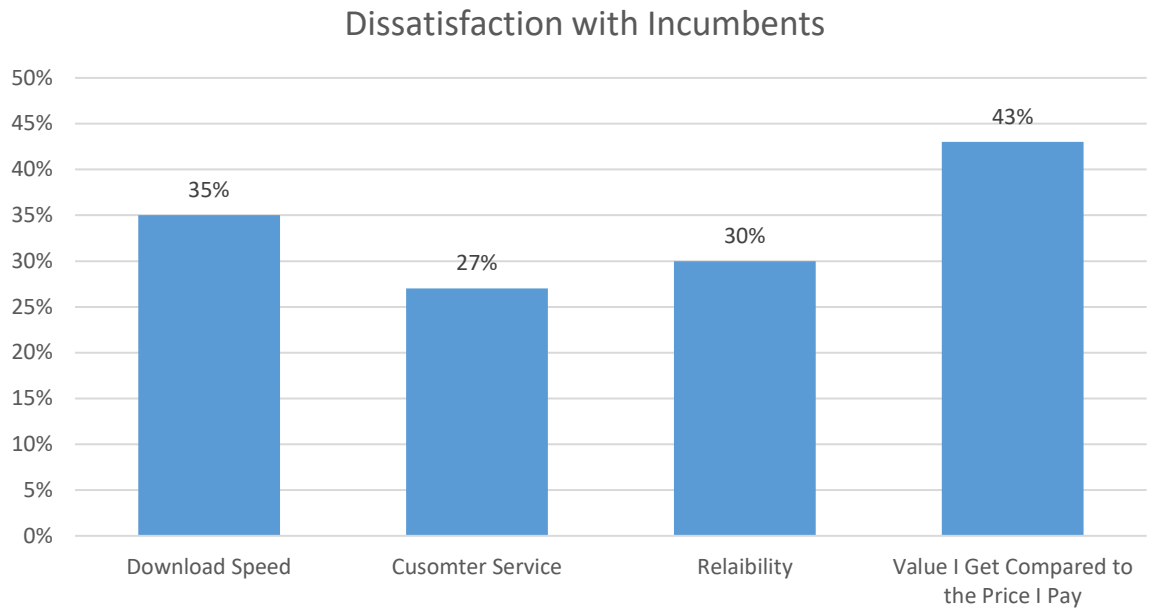
Monthly Rate	
$0 - $20	2%
$21 - $40	8%
$41 - $60	32%
$61 - $80	17%
$81 - $100	17%
$101 - $125	3%
$126 - $150	4%
More than $150	1%

What is striking about this response is that 42% of respondents would like a broadband price under $60 per month – a rate that is exceedingly hard to find in the county today.

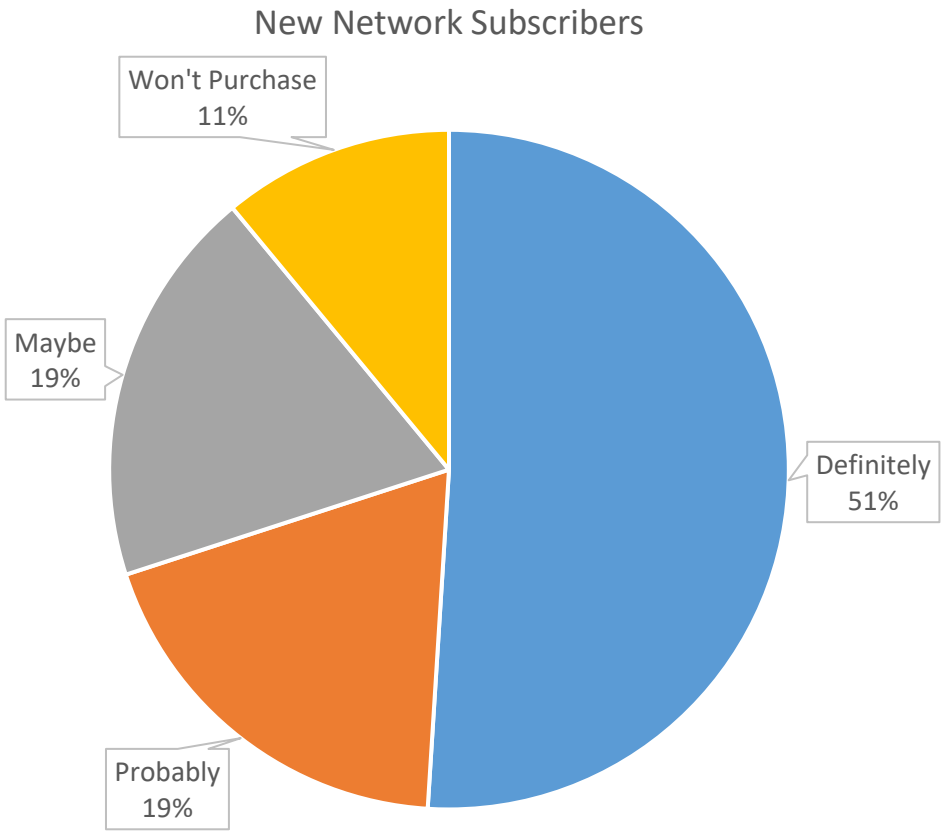
Importance of Broadband. We asked respondents if anyone in the household uses broadband for work or school. 8% said every day, 18% said several days per week, 17% said occasionally, and 57% said never.

46% of these households that use broadband for work or school said that their broadband is inadequate for supporting online work or school. We've learned during the pandemic that most of the problems encountered when working and doing schoolwork from home come from inadequate upload speeds. This is something that many people don't yet understand, and they often assume that the entire broadband connection is inadequate.

Satisfaction with Existing Broadband. Below is a graph of the survey responses highlighting the dissatisfaction with the current ISPs in the study area. The highest level of dissatisfaction (43%) comes from the value compared to the price residents pay.



Switching Service to a New Network. In probably the most important question of the survey, we asked respondents if they would buy broadband from a new fiber network. As seen in the chart below, 70% of survey respondents were strongly interested in subscribing to the new network (will definitely buy or probably buy service). Only 11% of respondents wouldn't consider buying from a new network.



Interpreting the Results of the Survey

It's always a challenge to interpret survey results. The survey showed strong support for the County luring an ISP to bring faster broadband with 70% likely to buy broadband from a new network. Following are CCG's observation of the survey responses:

Dissatisfaction with the Incumbents. The survey shows a lot of dissatisfaction with the current providers. 35% of respondents were unhappy with download speeds, 27% are unhappy with customer service, and 30% are unhappy with reliability. The highest level of dissatisfaction of 43% was related to getting overall value for the price paid for broadband.

Over one-third of respondents are unhappy with their download speeds. This is not surprising; the two most subscribed technologies by the respondents were DSL and satellite. DSL can provide fast speeds only to customers close to the DSLAM (the DSL cabinet), with speeds dropping with distance. Satellite requires a clear line of sight, and any physical impediment, like tree leaves, will drastically reduce speeds. The respondents using cable were much happier with the speeds they were receiving.

The dissatisfaction with the overall value for the price paid for broadband is another way of saying that respondents are unhappy with broadband prices. Interestingly, the two ISPs that received the most dissatisfaction with pricing were CenturyLink and Comcast. We believe that most of Comcast's dissatisfaction is related to the higher pricing rather than the speed provided. CenturyLink customers are likely unhappy with the price paid for the speed received.

42% of respondents want to pay $60 or less for broadband. But the corollary is that 58% of respondents find it reasonable to spend more than $60 per month. 14% of respondents without broadband said high prices is the reason they don't have broadband.

Potential Customers on a New Network. The primary purpose for the statistically valid survey was to estimate the customer penetration rate if Jackson County were to attract ISPs to bring fiber to the rural areas. Following is how we interpret the responses about buying service from a new network:

- Our experience is that statistically valid surveys provide a reasonable prediction of how a new ISP will do within the first five years after market launch. We've been able to track client performance compared to pre-launch surveys like this one.
- Customers who say they will definitely buy service probably will. Every study area has some core of customers that don't like the incumbent providers. The customers who say they will definitely buy are dissatisfied with the current providers and really like the idea of having fiber. We typically see between 20% and 30% of customers saying they will definitely change to a new network. This survey was far higher than the typical response, with 51% of the respondents ready to immediately change to a new fiber network.
- We've always found that around two-thirds of those that say they will 'probably' change will do so. Some won't take the initiative to make the change, and some will be lured with low-priced packages aimed at keeping them on the current provider. But overall, these respondents have indicated a decent interest in changing providers. In your case, 19% of respondents said they would probably change to a new fiber network.

- The 'maybe' respondents are just that. We've always seen that about one-third of these customers can be gained as customers – but at a cost. This is the part of the market that requires the marketing budget. These customers can be won if you explain the benefits of your network and have products and prices the public finds attractive. In this survey, 19% said they might buy broadband.
- The survey indicates a 5-year target penetration of broadband of 64%. That prediction assumes that the new network provider(s) do a good job of meeting expectations. New ISPs can make mistakes and underperform.

Business Interviews and Surveys

We reached out to businesses in two ways. We interviewed a sample of businesses and other key stakeholders to dig deeper into specific issues. We also posted a business survey online. This survey basically asked businesses to tell us their broadband story – is current broadband meeting their needs, and what could they do better if they got better broadband? The following write-up includes what we learned from businesses and stakeholders.

We heard a wide range of broadband stories. We also were able to gather in-depth information about home broadband from the various stakeholders as well, and many lived in rural parts of the county. Following are some of the stories we heard.

- We talked to a school where broadband is generally okay. However, the broadband can't support all students taking standardized tests at the same time and they must space the tests out over multiple days due to broadband issues. Broadband has frozen in the middle of testing and students had to retest the following day. The school has a laptop for every student but doesn't send laptops home for anybody under high school since most students don't have home broadband or cellular connections that are good enough to do homework. The estimate is that 70% of students don't have adequate home broadband.
- We talked to several farmers. A few farmers have converted to Starlink for home broadband, and it is serving their needs. Of more concern for several farmers is the lack of cellular coverage that makes them unable to use any outdoor smart farming technology. Several farmers subscribe to more than one cellular service in the hopes (often futilely) that one of them will work. We heard from a farmer who doesn't have enough bandwidth to try farming apps that would help him.
- One farmer still uses DSL and says that there are still issues brought about by the hurricane that have never been addressed, and quality is usually poor.
- We heard from a real estate appraiser who has heard of sales that fell through when the prospective buyers found out that the bandwidth was inadequate. We heard that lack of cellular coverage makes it hard for anybody who works outdoors and drives through the county.
- We heard from a retired medical professional who would like to work part time from home, but the broadband is inadequate. We heard from a student unable to pursue a graduate degree online due to lack of broadband.
- We heard several concerns about high prices both for business broadband and home broadband.
- We heard a success story from a businessman who works from home and was able to return to the county to work once Starlink was available.
- We got feedback overall about the inadequacy of high-orbit satellite like Viasat and HughesNet and about cellular hotspots.

- We talked to a library that struggles to keep broadband working. They have tried both AT&T and Charter, but both are unreliable and too slow at times. Most people who come to the library are looking for WiFi.
- We heard from several folks that they've been told that better broadband is coming but are frustrated because they haven't seen any progress.

We asked businesses in the county how they use the Internet (or would like to use it) and got the following responses:

- Communicating with Customers. Businesses routinely have portals that make it easy for customers to place and track orders and communicate with the business. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly passing away, and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. Businesses that operate busy e-commerce ordering sites need enormous amounts of bandwidth to make sure that all customers have a successful purchasing experience. In the rural parts of the county broadband is not good enough to consistently process credit card transactions. That requires almost the bare minimum amount of bandwidth, which speaks volumes about the quality of rural broadband in the county.
- Communicating with Vendors. Businesses also routinely use online portals to buy from suppliers.
- Communicating with Other Branches of the Company. A number of businesses are part of larger corporations and maintain open data connections to communicate with other parts of the company and with headquarters.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, Microsoft, or a private cloud available only to employees of the business. This is the change in the ways that companies operate that has probably created the most recent growth in bandwidth. Much of the routine software that companies use now works in the cloud, meaning that productivity comes to a halt when the Internet connection isn't working. We heard from businesses in the county that report that a broadband outage cripples them since they work in the cloud.
- Security Systems. Businesses often have their security monitored by offsite firms. Security today also means the use of video cameras to monitor the inside and outside of a business. Rural broadband is not sufficient to provide around-the-clock video surveillance.
- Sending and Receiving Large Data Files. Most businesses report that the size of data files they routinely transmit and receive has grown significantly larger over the last few years.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video both inside and outside the business. We saw a huge surge in this during the pandemic as students and employees increasingly used video conferencing services, but these services had already started to become routine for businesses before the crisis.
- Collaborative Software. While many businesses still rely on email, many have gone to more advanced communications systems that let parties connect in a wide variety of ways. Businesses are using collaborative tools that let multiple employees from various locations work on documents or other materials in real time. This software requires a steady upload and download data path.
- Supporting Remote Employees. Supporting employees that work from home is a major new requirement for many businesses. Communicating with remote employees most generally is done by creating a virtual private network (VPN) connection with each employee. For a business, this

means establishing both a dedicated upload and download link for each remote employee. These connections can vary between 1 – 3 Mbps per second in both the upload and download directions.

- Data Backup. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that monitor data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function when connected to the Internet.
- Farmer Software Ecosystem. Farmers now have a complete ecosystem of smart machinery and devices that must be connected to work. Farmers want to send huge data files to convey the data about soil conditions in each part of their fields. Farmers want WiFi around the farm buildings, which requires a strong Internet signal to the primary broadband location. Farmers want to be able to control devices like grain bins and corn driers remotely.

Speed Tests

One of the most important aspects of obtaining broadband grants is that the grants are only available in areas where the existing broadband speeds are below par. Speed tests provide a way to judge the quality of broadband, which differs significantly from other ways to measure broadband performance. A given speed test is not 100% reliable and doesn't always deliver a true picture of the broadband being delivered to a given address. However, we've found that when speed tests are administered in mass for a whole community, we can gain a good understanding of the overall quality of broadband. Following are a few of the criticisms that ISPs rightfully make about any individual speed test:

- A speed test only measures the speed of a ping and a short-term connection of less than a minute between a user and the test site router used by the speed test. That doesn't necessarily indicate the speed of every activity on the web, such as downloading files, making a VoIP phone call, or streaming Netflix.
- Every speed test on the market uses a different algorithm to measure speed. The two most commonly used speed tests are offered by Ookla and M-Labs. The Ookla speed test generally connects to local or regional servers and also tests several connections at the same time. M-Labs attempts only one connection.
- A speed test can be slowed due to network issues within the home, such as problems with a home WiFi router or faulty wire inside a home. A slow speed test doesn't always mean that the ISP was providing a slow connection.
- Internet speeds vary throughout the day. Taking only a single speed test might not tell the real story about a given customer.
- Some ISPs use something called "burst" technology. This provides a faster Internet connection for one or two minutes. ISPs know that a large majority of Internet activities are of short duration – things like opening a web page, downloading a file, reading an email, or taking a speed test. The burst technology increases the priority of a customer during the burst window, and the Internet connection then slows down when the temporary burst is over. This raises an interesting question – what's the real Internet speed of a customer that gets 100 Mbps during a 2-minute burst and something slower after the burst – there is no consensus in the industry.

Ookla Speed Tests

One of the best sources of speed test data comes from Ookla[8], which operates the most-used speed test site on the web. The following map shows the net result of the Ookla speed tests taken in the county over the last year.

Ookla Speed Tests

The following table shows the average Ookla speed tests received between Dec 2022 to Jan 2023 by ISP. Each speed test is an average for the entire year.

Provider	Technology	Down (Mbps)	Up (Mbps)
AT&T	DSL	3	1
AT&T	Cellular	37	6
AT&T	Fiber	232	204
CenturyLink	DSL	14	2
CenturyLink	Fiber	301	294
Consolidated Communications	DSL	13	5
Charter	Cable	252	18
Comcast	Cable	278	22
T-Mobile	Cellular	40	11
Verizon	Cellular	34	7
HughesNet	Satellite	19	3
Viasat	Satellite	15	4
Starlink	Satellite	57	7

Following is the same data showing average broadband speeds by technology.

Technology	Download Mbps	Upload Mbps
DSL	13	2
Fiber	298	290
Cable	269	21
Cellular	37	8
Satellite	49	6

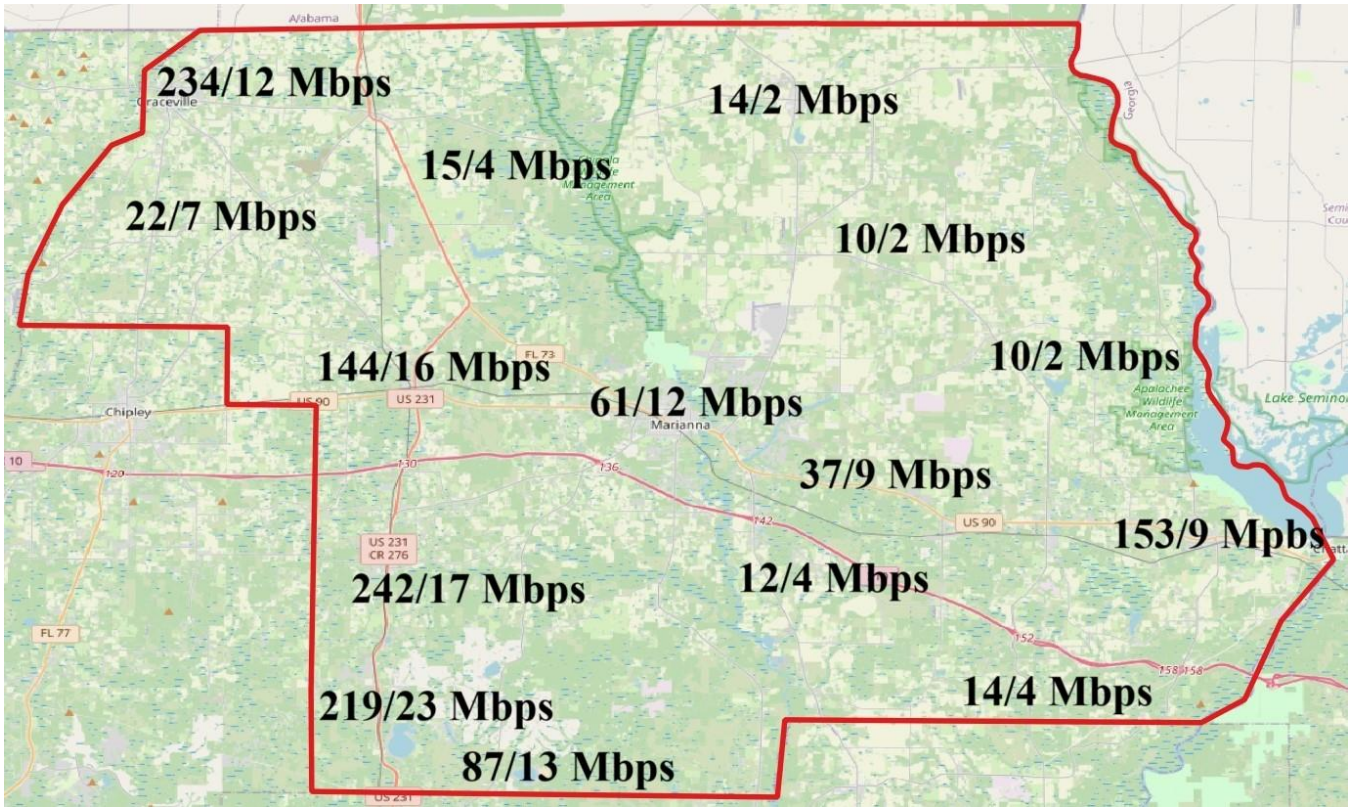
Fiber provides both fast download and upload speeds. Cable technology has a fast download speed and a slow upload speed. DSL speeds are the slowest of any technology. Note that there were no speed tests for fixed wireless in the previous year. The Ookla data shows that AT&T has fiber in the county that is not being reported to the FCC.

The numbers in the table can't be used to compare the quality of various ISPs. Consider a comparison between Comcast, which uses hybrid fiber-coaxial technology, and CenturyLink fiber.

[8] https://www.speedtest.net/

- Comcast shows an average download speed of 278 Mbps, while CenturyLink Fiber shows an average download speed of 301 Mbps. This doesn't mean that CenturyLink has faster download speeds than Comcast. The numbers in the table are overall averages of all speed tests and there is no way to know the mix of customers using different speed packages included in the average.
- We can use the table to say that fiber ISPs have superior upload speeds since Comcast has an average upload speed of 22 Mbps while CenturyLink fiber has an average of 294 Mbps – many times faster than Comcast.

The following map shows that the average speeds in Alford, Cottondale, Sneads, Graceville, around Compass Lake, and Marianna are much faster than the rest of the county. Marianna's average speed is slower than expected since the average speeds shown combine all technologies. Marianna is served both by fast cable and slow DSL. The result below shows there is likely a mix of residents subscribing to both technologies. The other cities listed are mostly only served by a cable company. Many rural residents will look at this map and say that they can't achieve the speeds shown on this map. The rural speeds on this map are an average for each area of all technologies including slow DSL speeds and faster satellite speeds.



C. The Mapping Story

The easiest way to visualize the current state of broadband in the County is by mapping available broadband data. Our analysis starts with publicly available broadband mapping data. As will be discussed below, we know that a lot of the FCC mapping data is inaccurate, so Finley Engineering and CCG Consulting have created maps that we think more accurately portray the real state of broadband coverage in the County.

The FCC Definition of Broadband

The FCC officially defines the speed of broadband to meet a legal requirement. Congress established a requirement for the FCC in Section 706 of the FCC governing rules that the agency must annually evaluate broadband availability in the country. Further, the FCC must act if broadband is not being deployed in a timely manner. The FCC is supposed to report the state of broadband to Congress every year - although the most recent FCC broadband report is for 2020.[9] In these reports, the FCC compiles data about broadband speeds and availability and offers an opinion on the state of broadband in the country. In every report to date, the FCC has acknowledged that there are broadband gaps of various kinds, but the FCC has never determined that the problems are so bad that they need to take extraordinary measures to close any broadband gaps. Most recent FCC reports claim that the broadband situation is improving due to actions taken by the FCC.

In 2015, the FCC set the definition of broadband at 25/3 Mbps (which is 25 Mbps download and 3 Mbps upload). Prior to 2015, the definition of broadband was 4/1 Mbps, set a decade earlier. The FCC didn't use empirical evidence like speed tests in setting the definition of broadband in 2015. It instead conducted what is best described as a thought experiment. The FCC listed the sorts of functions that a typical family of four was likely to engage in and determined that a 25/3 Mbps broadband connection was fast enough to satisfy the typical family.

The FCC asked again in 2018 and 2020 if 25/3 Mbps was still an adequate definition of broadband. They took no action and left the definition at 25/3 Mbps. FCC Chairman Jessica Rosenworcel recently opened a docket to ask if 25/3 Mbps is still a good definition and recommended that the definition be increased to 100/20 Mbps. There is a general industry consensus that this will be done in early 2024.

FCC Broadband Maps

The FCC decided a decade ago that the way for it to track broadband utilization is to require ISPs to periodically tell them where broadband is deployed. This resulted in an elaborate process of gathering broadband data that ultimately resulted in what is generally referred to in the industry as the FCC broadband maps.

For many years, the maps were not used for purposes other than the FCC's broadband report to Congress. The FCC took some heat because the broadband reports to Congress were badly flawed, but ultimately, the broadband industry didn't care a lot because there were not a lot of real-life consequences of the bad maps.

Over time, the FCC started to rely on the information in the mapping data for setting policies. For example, the FCC started to cite statistics from the broadband mapping system as justification for making decisions that impact rural broadband.

[9] The FCC report to Congress for 2020 can be found at https://docs.fcc.gov/public/attachments/FCC-20-50A1.pdf and https://docs.fcc.gov/public/attachments/FCC-20-50A2.pdf.

Even more importantly, the FCC began using the maps to determine the parts of the country that are eligible for federal broadband grants. This created an outcry in the industry that has led to a process to improve the mapping data. Following is the story of the original FCC maps and the progress that has been made to transition to better maps.

The Original FCC Maps

The FCC historically gathered data about the broadband being delivered to customers in each Census block in the country. A Census block is a finite geographic area defined by the U.S. Census Bureau that typically covers between 60 and 120 homes. In a city, a Census block might be just a city block, but in a rural area, it might cover a substantial portion of a county.

There were a lot of flaws in earlier FCC maps due to the reporting requirements for ISPs:

- ISPs have been free to report coverage anywhere, even in places that are not covered. As an example, there are many ISPs that claim coverage over an entire county when actual coverage is much smaller.
- If an ISP followed the rules, it showed a Census block as covered if there was only one customer in the Census block. This overstated broadband coverage, particularly in rural areas that have large Census blocks.
- The FCC allowed ISPs to report marketing speeds to describe the broadband being delivered. To give a simple example, a telephone company might advertise that its DSL can deliver speeds up to 25/3 Mbps. The telephone company might deliver that speed to a few customers who live close to the DSL transmitter, but DSL speeds decrease drastically with distance from that transmitter. In the areas surrounding a town, the actual DSL speeds might be only a few Mbps. If the telephone company reports the marketing speed of 25/3 Mbps everywhere, then the FCC accepts as fact that speed is available, when in fact, the majority of rural DSL customers have much slower actual speeds – if they can buy DSL at all.
- Perhaps the biggest problem with the FCC maps is that there have been almost no consequences for ISPs that exaggerate speeds or coverage. There are only a few examples of ISPs being ordered to fix clearly untrue mapping inputs.

These factors taken together mean that the traditional FCC broadband maps have been inaccurate, sometimes grossly so. Even in towns, the broadband speeds likely represent marketing "up to" speeds instead of actual speeds. Speeds for areas just outside of towns and cities are routinely overstated and often show broadband coverage where there is none. Many ISPs providing rural DSL or fixed wireless overstate the broadband speeds to the FCC.

The New FCC Maps

Congress passed legislation to require the FCC to fix the maps. In March 2020, Congress passed S.1822, the Broadband Deployment Accuracy and Technology Availability (DATA) Act. That bill requires the FCC to gather granular service data for wired, fixed wireless, cellular, and satellite broadband providers. The law requires a crowdsourcing process to allow the public to participate in data collection. The Act provides penalties for ISPs that knowingly or recklessly submit inaccurate mapping data. Finally, the Act requires that all federal agencies begin using the new mapping database before awarding any major broadband funding.

As often happens in the government, this bill didn't provide any funding to make the needed changes. The FCC started the process of formulating new rules around the Act but didn't take any action to fix the maps due to the lack of funding. Congress finally provided $98 million in funding from the American Rescue Plan Act (ARPA) in December 2020, which included $65 million to create better maps. The first round of the new updated FCC maps was released in November of 2022, with updates mandated every six months.

The new mapping system is now called the Broadband Data Collection (BDC) process and replaces the old mapping system. The FCC's goal is to make the new maps more accurate. The big change in the BDC data collection is that ISPs now have two choices for reporting broadband availability. First, an ISP can submit shapefiles for polygons that define the various service territories. Each polygon should include existing broadband customers along with homes or businesses that can be connected within ten business days of a request for service. If an ISP doesn't want to provide shapefiles, it can provide the detailed location of each customer. The 477 reporting now also requires traditional telephone and VoIP subscriber data.

The FCC maps have recently taken on extra importance since Congress dictated that the FCC maps would be the basis for deciding the eligible areas for the $42.5 billion BEAD grant program.

The first version of the new FCC maps was released in November 2022. As might be expected when changing to a drastically different system, there were a lot of mistakes in the new mapping data. A lot of the errors were in the mapping fabric. This is the underlying database that is intended to identify, on a map, every potential broadband customer. The FCC hired CostQuest to create the mapping fabric, and the company used a variety of data sources to pinpoint locations on the fabric. This included gathering national GIS mapping data, 911 data, and aerial photos from Google Earth.

A simplistic explanation of the CostQuest approach is that they placed a dot on the map for every known residential and business passing. Not surprisingly, identifying every residential living unit in the country is a massive challenge. Considering that the U.S. Census spends many billions every ten years to identify where people live – the FCC is trying to do this accurately twice a year on a much smaller budget. There are huge challenges in identifying potential customers. As a few examples, how can the FCC make the distinction between an abandoned home and one where the owners are looking for a tenant? What does the FCC do about the many properties that contain multiple buildings? What's the right way to account for vacation homes, cabins, hunting lodges, etc.? Apartment buildings are really tough to accurately count.

Following is a map from the CostQuest system showing a small part of the County. Each green dot represents a location that is a potential broadband customer. To the right is a table that shows the ISPs that claim to be able to provide service to the home, shown by the blue pointer.

This FCC map tells us a lot about the broadband coverage claimed by ISPs in this particular neighborhood.

- Comcast (Xfinity) claims to provide speeds of 1200/35 Mbps on its cable network.
- CenturyLink (Lumen) claims to provide speeds of 10/1 Mbps on its DSL network.
- Hughes Net and Viasat claim to provide speeds of 25/3 Mbps and 30/3 Mbps, respectively, from geostationary satellites.
- Space Exploration Technologies (Starlink) says it offers a download speed of 220/25 Mbps.
- T-Mobile claims to provide speeds of 25/3 Mbps on its cellular network.

There is a process for State and local governments to challenge the mapping fabric by disputing if the FCC correctly identified the location of residential living units and businesses. When the maps first came out, the State of Vermont sent a challenge letter to the FCC saying that 11% of the locations in the FCC mapping fabric don't exist. Even worse, Vermont said that 22% of locations are missing from the FCC map. Vermont made the point that it is impossible to count the number of homes with or without broadband without first accurately counting the total number of homes.

The second issue with the new maps is the claimed broadband coverage of broadband. The new maps were supposed to be more accurate by fixing the inherent problems of reporting broadband coverage by Census block. Unfortunately, just the opposite happened. The first draft of the new FCC map showed significantly fewer homes that don't have broadband. States know this to be false since many of them have created their own broadband maps where they looked closely at actual broadband speeds being delivered.

Consider the effort undertaken by the State of Georgia in 2021. The State worked closely with ISPs to define coverage areas. The State also undertook a big effort to gather speed test results to distinguish actual speeds from marketing speeds. The results from the Georgia mapping effort are stunning. The Georgia maps showed that over 507,000 homes and businesses and 1 million people don't have access to 25/3 Mbps broadband. That is double the 252,000 homes identified by the FCC maps.

Vermont also undertook a mapping exercise. The State was shocked to see that the new FCC maps showed that over 95% of Vermont homes have access to broadband of at least 100/20 Mbps. The State's broadband maps show that only 71% of homes in the state can receive broadband at 100 Mbps or faster at the end of 2021. In looking at the new FCC data, the difference seems to come from claims by satellite and fixed wireless ISPs that claim to be able to deliver fast speeds to huge numbers of homes – something that is

not realistic or possible in hilly and wooded Vermont. There also are ISPs that claim speeds that are faster than what the State believes is being delivered.

Will the FCC Maps Get Better?

It is unfortunate that the new FCC maps were issued in the middle of the process of trying to determine the BEAD grant funding. Congress said that the amount of funding for each state must be based upon the FCC maps – and the first few drafts of the FCC maps have been clearly flawed. The FCC whiffed in many cases in counting the location of homes and businesses, and ISPs clearly exaggerated the broadband speeds available to customers.

Is there any hope for these maps to ever get better? Getting better maps requires improving the three basic flaws of the new FCC maps – the accuracy of the mapping fabric that defines the location of possible customers, the claimed coverage that defines where broadband is available, and the broadband speeds available to customers.

The mapping fabric will get better over time if state and local governments decide this is something that is important to fix. But there are two reasons why the fabric might never be fixed. Many rural counties do not have the staff or resources to try to fix the mapping fabric. There are still a lot of counties that don't have a GIS mapping system that shows the details of every home, business, land plot, etc. But even counties with GIS systems often cannot count broadband passings – for example, the GIS data doesn't include details about whether a home is occupied. There is also a big chance that once the BEAD funding is allocated that state and local governments will quickly lose interest in the FCC mapping fabric.

The FCC says it hopes the maps will get better over time. One new feature of the new FCC maps is that any homeowner can dispute that a given ISP can deliver broadband to their home. If a cable company incorrectly claims a home can get broadband, the homeowner can challenge this in the FCC map – and if validated, the map must be corrected. It's not likely that most folks will go through the formal process of challenging the maps. If the challenges don't happen then the new FCC maps will only be as accurate as ISPs are honest.

The issue that most people care about is broadband speeds. Unfortunately, the new maps are as badly flawed on this issue as the old maps. ISPs are still allowed to claim marketing speeds instead of some approximation of actual speeds. The ISP gets to define what it means by marketing speeds.

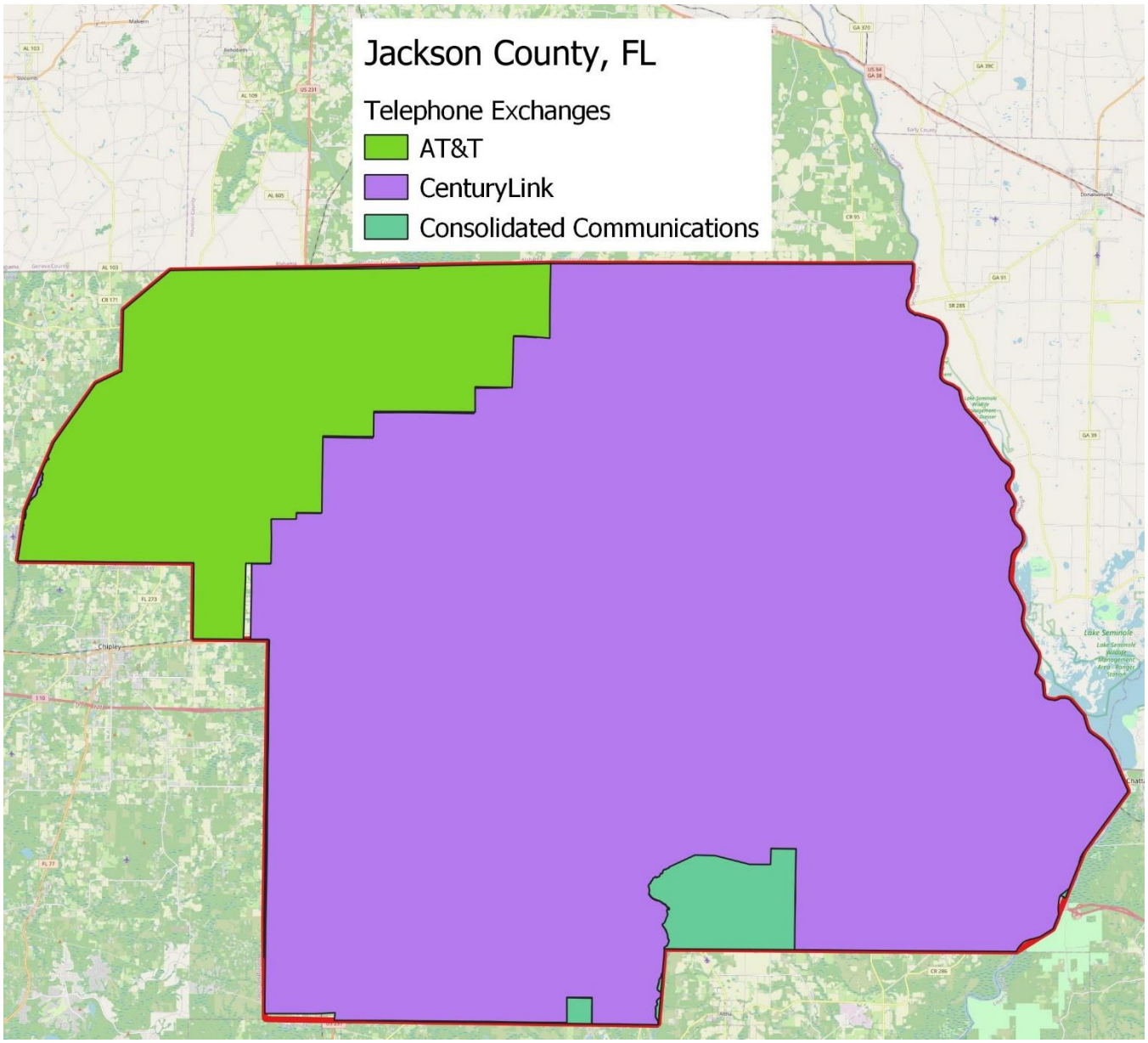
Other than the challenge process, there is one other possible remedy for fixing mapping problems. The Broadband Deployment, Accuracy, and Technology Availability (DATA) Act that created the new maps gives the FCC the ability to level fines against ISPs that knowingly or recklessly submit inaccurate mapping data.

FCC Mapping Data for the County

Even with the many faults, there is still some useful information in the FCC broadband data. If nothing else, the FCC BDC maps are a starting point for identifying the ISPs that claim to serve a given area and the speeds claimed.

Telephone Company Exchange Boundaries. The incumbent telephone companies in the County are AT&T, CenturyLink, and Consolidated Communications. The following map shows the historical monopoly boundaries for each telephone company. These boundaries were formally recognized by the Florida Public Service Commission, and each telephone company was given monopoly status within the borders shown on the map.

Map 1 Telephone Exchange Boundaries



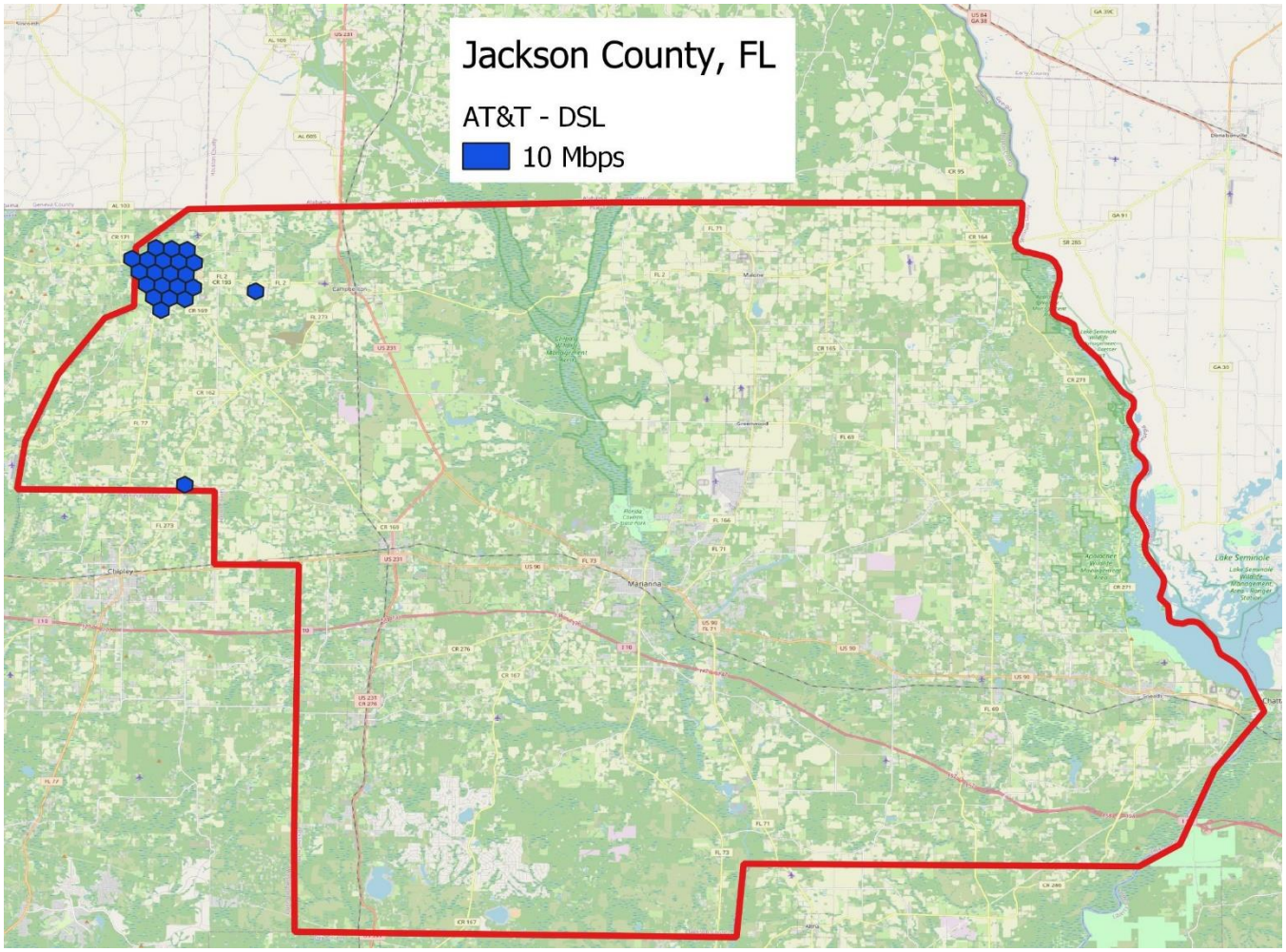
AT&T

AT&T is the incumbent telephone company in the northwestern part of the County. In the most recent FCC BDC reporting, AT&T claims to provide speeds of 10 Mbps using DSL technology on copper wires.

AT&T has several options for providing DSL. Some of the slower speeds use ADSL technology, while faster speeds use the newer VDSL. It is likely that AT&T is providing DSL service on older ADSL technology.

The average Ookla speed test for AT&T DSL in the county was 3/1 Mbps.

Map 2 – AT&T FCC BDC Data



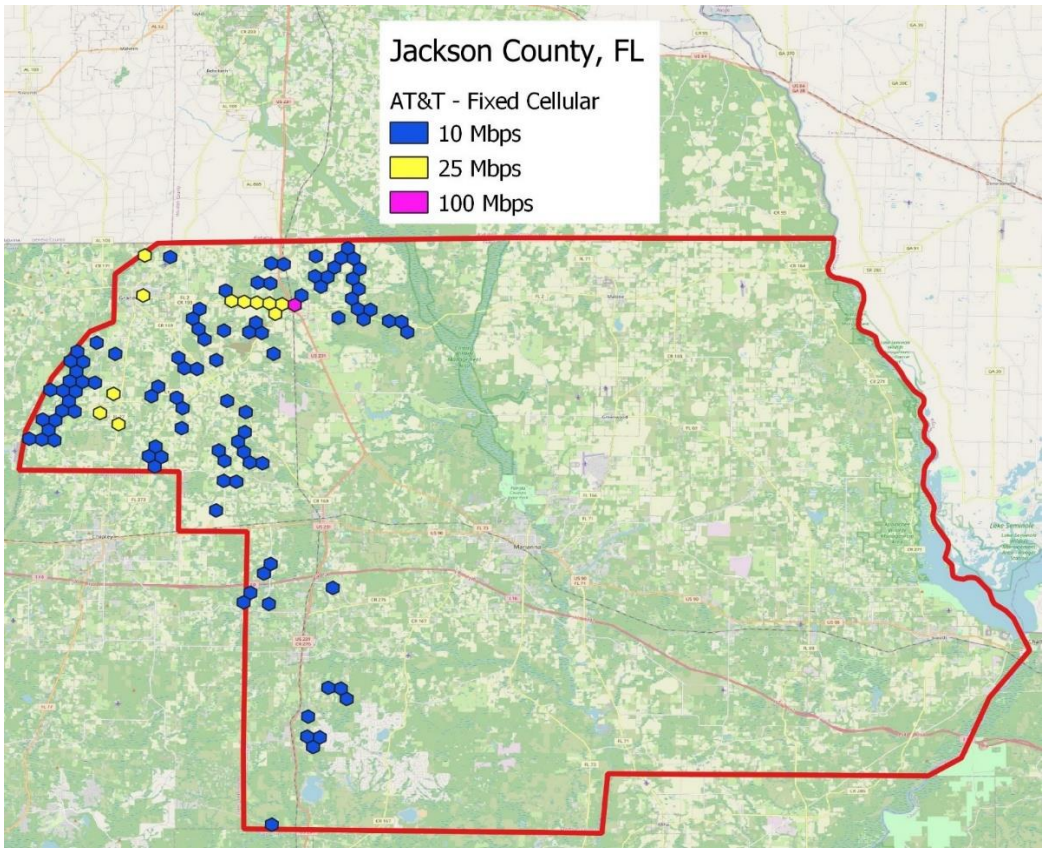
AT&T – Fixed Cellular

As of October 2020, AT&T will no longer sell a new DSL connection and began providing fixed cellular as an alternative. The speeds claimed in blue and yellow on the map below likely represent areas where AT&T sells its traditional hotspots using 4G LTE spectrum. The company is starting to sell faster

broadband using 5G spectrum, with reported speeds of up to 140 Mbps download, which is likely available in the area shown in pink. Like with all wireless technologies, only customers living close to a tower can receive the full claimed speeds. It's likely that some of the areas that are not close to a tower can't receive service. In addition, cellular carriers will throttle home service if cellular service experiences higher demand.

In the county, the average Ookla speed test for AT&T wireless broadband was 37/6 Mbps.

Map – 3 AT&T Fixed Cellular FCC BDC Map



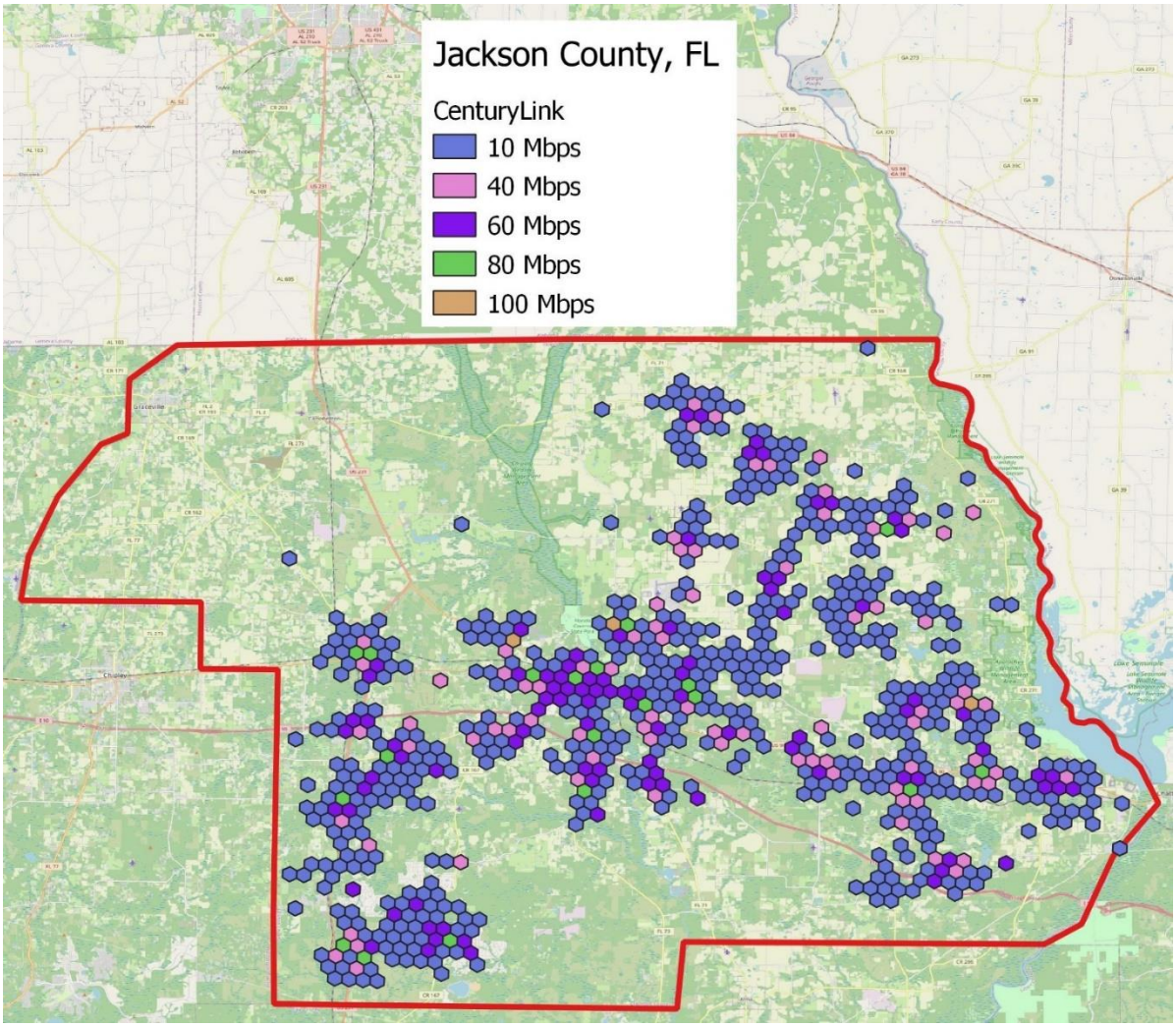
CenturyLink

CenturyLink is the incumbent DSL provider in much of the County. In the most recent FCC BDC reporting, CenturyLink claims to provide speeds between 10 and 100 Mbps using DSL technology on copper wires.

CenturyLink has several options for providing DSL. Some of the slower speeds use ADSL technology, while faster speeds use the newer VDSL. CenturyLink can also double speeds by providing two copper DSL links to a given customer. But regardless of the technology and the delivery option used, DSL can deliver speeds faster than 50 Mbps for only short distances from the DSLAM (the DSL hub electronics). We don't believe that many customers in the areas showing speeds of 60 Mbps or faster can get the shown speed.

The average Ookla speed test for CenturyLink DSL in the county was 14/2 Mbps.

Map 4 - CenturyLink FCC BDC Data

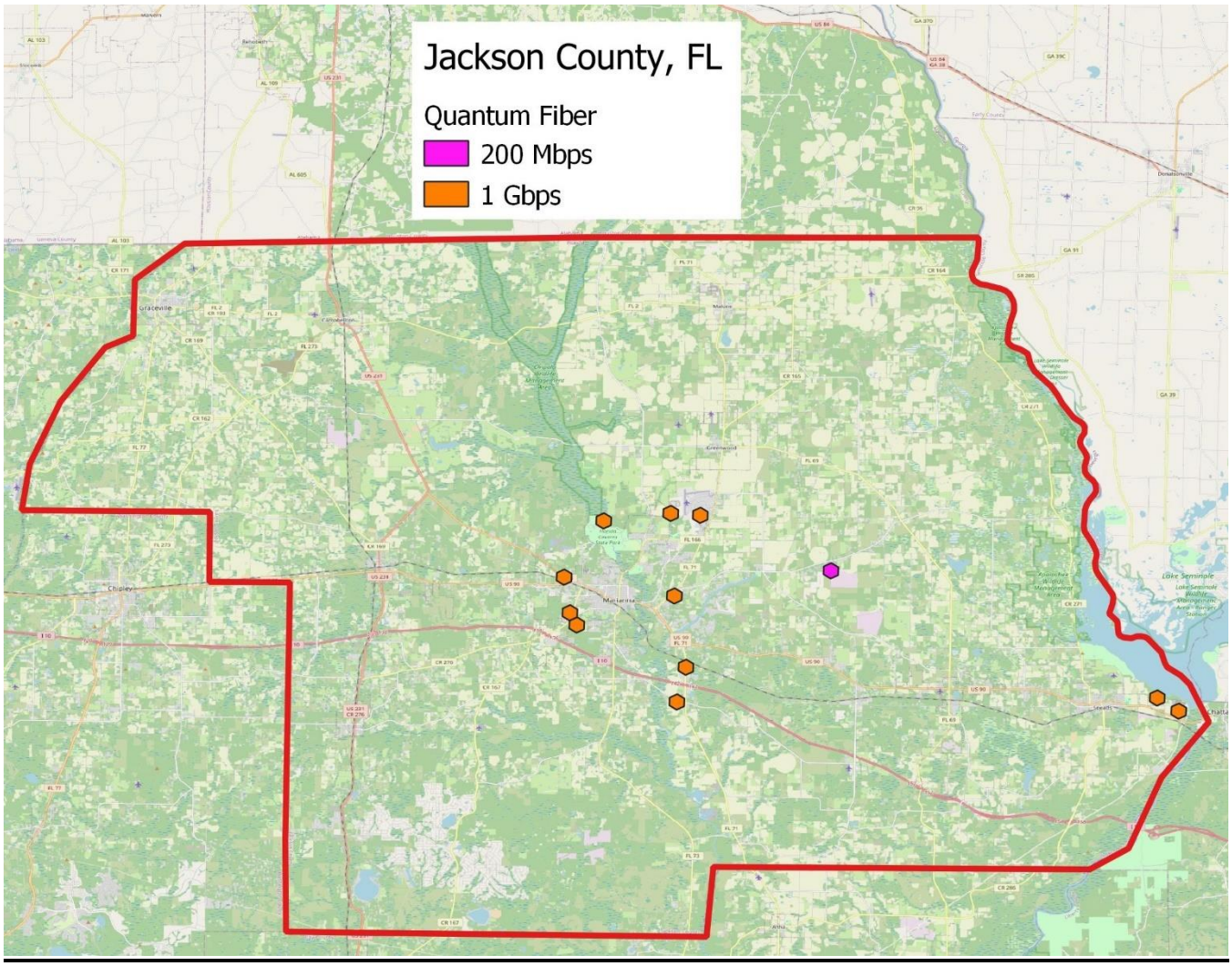


CenturyLink Fiber

Quantum Fiber is the brand name for CenturyLink's fiber network. In the most recent FCC BDC process, Quantum Fiber claims to provide 1 Gbps speeds (orange) or 200 Mbps (purple) to a few areas in the central and southeastern parts of the County.

The average Ookla speed test for Quantum Fiber in Jackson County was 301/294 Mbps.

Map 5 – Quantum Fiber FCC BDC Data



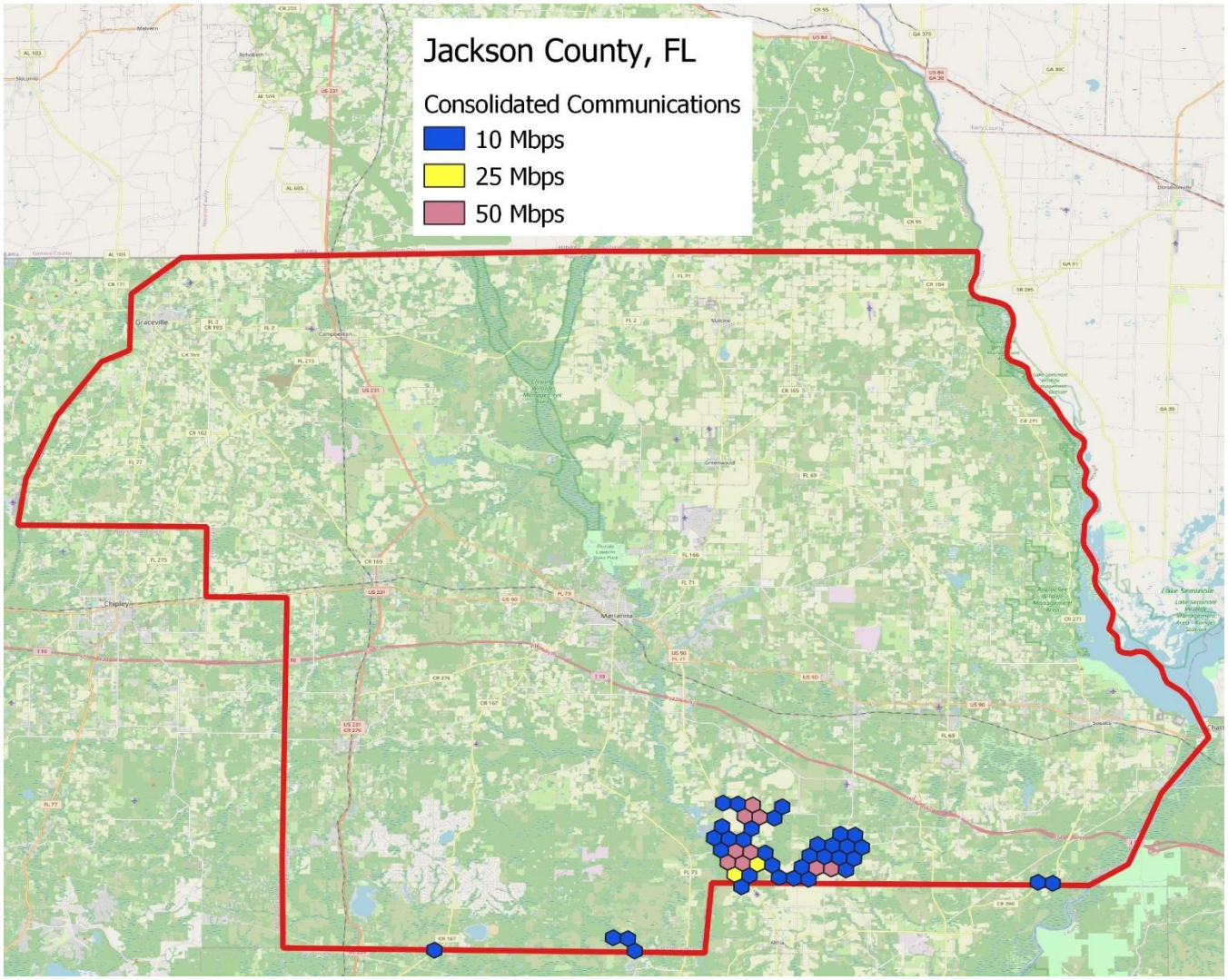
Consolidated Communications

Consolidated Communications is the incumbent DSL provider in the southern part of the County. Consolidated Communications claims to provide speeds between 10 and 50 Mbps using DSL technology on copper wires.

Consolidated Communications has the same options for providing DSL broadband as the other telephone companies. Newer DSL technologies can provide speeds over 50 Mbps for short distances. We don't believe that most of the customers in the areas showing speeds of 50 Mbps can get those speeds. It may be possible that a few customers can receive those speeds in the areas shown, but those speeds are not available to most customers.

The average speed for Consolidated Communication was 13/5 Mbps, according to the Ookla speed test data.

Map 6 – Consolidated Communications FCC BDC Data



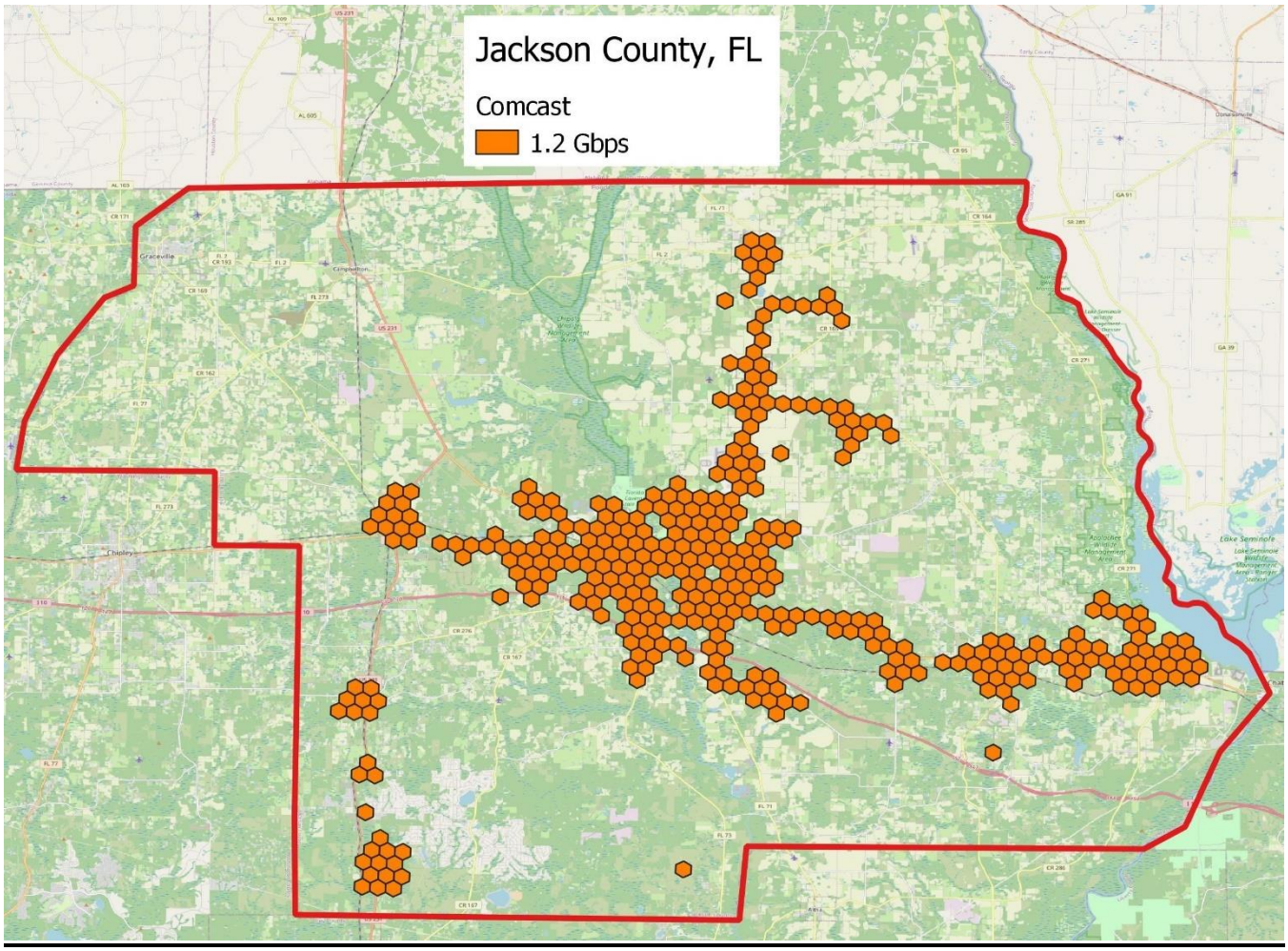
Comcast (Xfinity)

Comcast provides broadband under the brand name Xfinity, which provides broadband in Marianna, Greenwood, Bascom, Two Egg, Cypress, Grand Ridge, Sneads, Cottondale, Malone, Chattahoochee, Alford, and Round Lake. Comcast delivers broadband using hybrid fiber coaxial technology that uses fiber to get to neighborhoods and copper coaxial cable to reach homes and businesses.

Below is the coverage claimed by the company on the new FCC BDC mapping. Comcast claims to provide 1.2 Gbps download speeds and 35 Mbps upload speeds, shown in orange on the map below. This is the maximum speed offered, and most products are at slower speeds.

In Jackson County, the average Ookla speed test was 278/22 Mbps.

Map 7 - Comcast FCC BDC Data



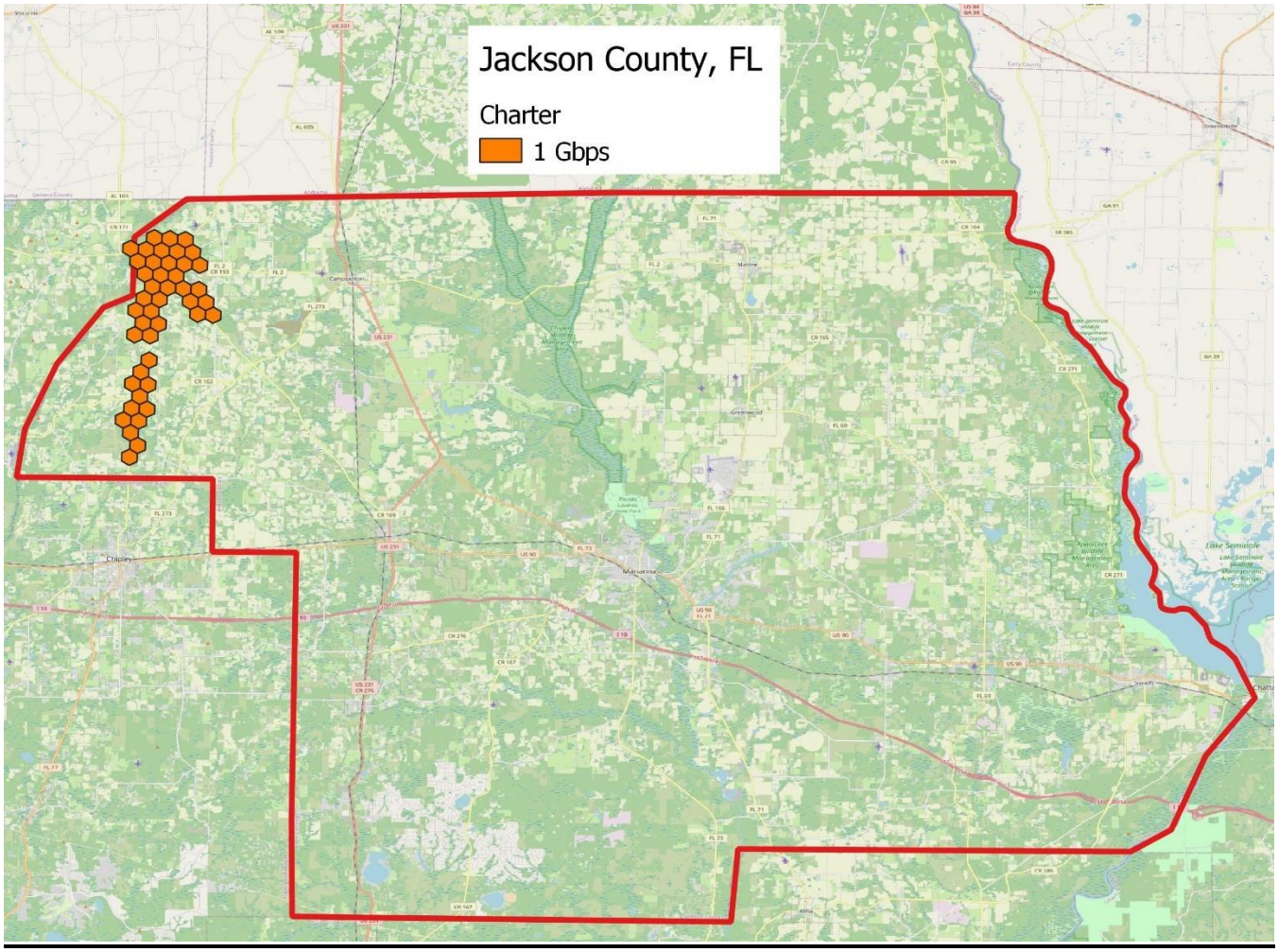
Charter (Spectrum)

Charter provides broadband under the brand name Spectrum and provides cable broadband in Graceville and the surrounding area. Below is the coverage claimed by the company on the new FCC BDC mapping. Charter claims to be able to offer 1 Gbps download speeds and 35 Mbps upload speeds, shown in orange on the map below. This is the maximum speed offered, and most products are at slower download speeds.

Charter delivers broadband using hybrid fiber coaxial technology that uses fiber to get to neighborhoods and copper coaxial cable to reach homes and businesses.

The average Ookla speed test in Jackson County for Charter was 252/18 Mbps.

Map 8 – Charter FCC BDC Data

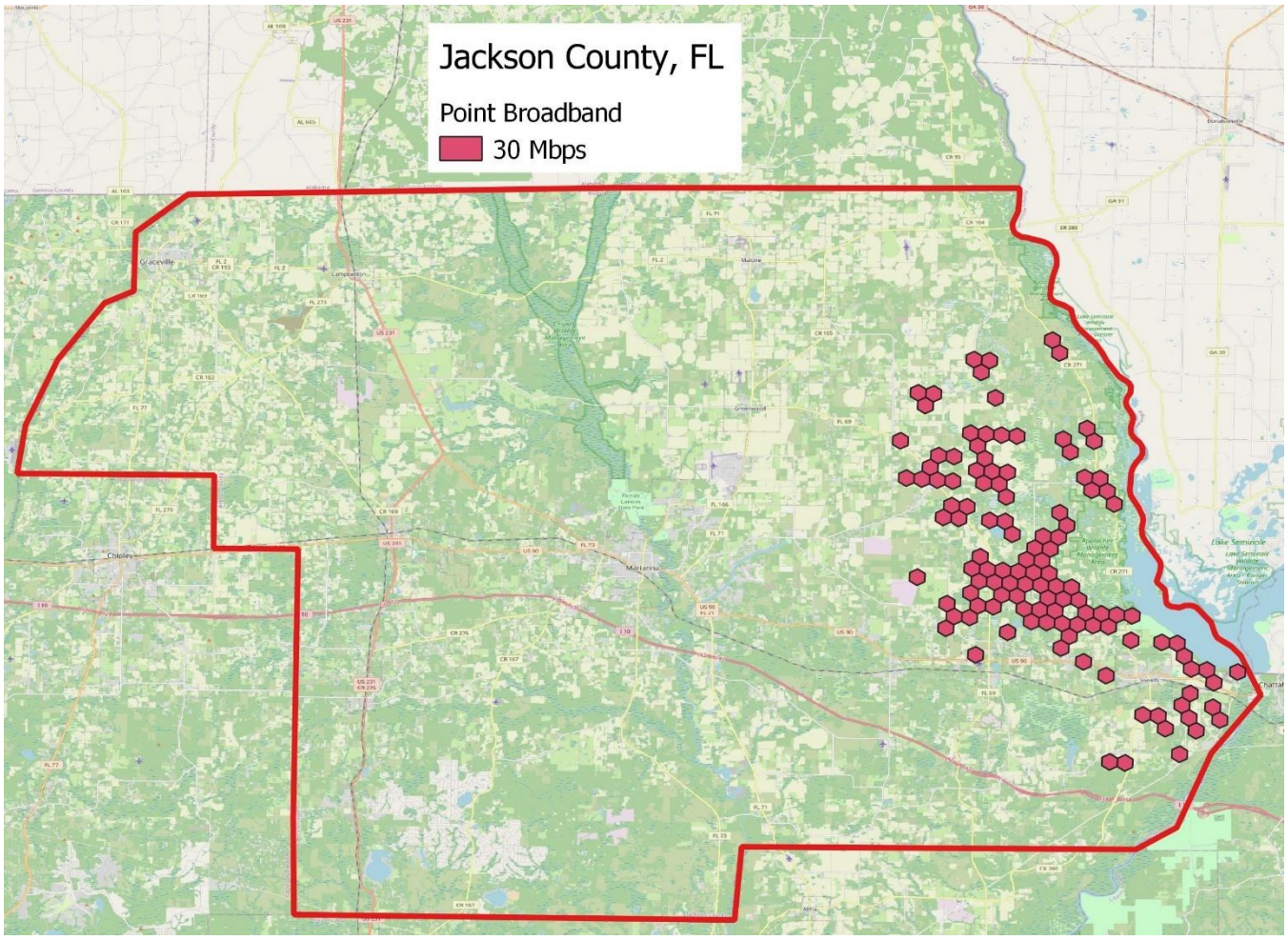


Point Broadband

Point Broadband provides service in the eastern part of the County using fixed wireless technology. Point Broadband claims to provide 30 Mbps download speeds in the most recent FCC BDC reporting. Fixed wireless technology can only deliver the fastest speeds to customers within the first several miles of a tower. It is unlikely that the entire area shown on the map can receive the claimed 30 Mbps speed.

There were no Ookla speed tests recorded for Point Broadband in the last year.

Map 9 – Point Broadband FCC BDC Data

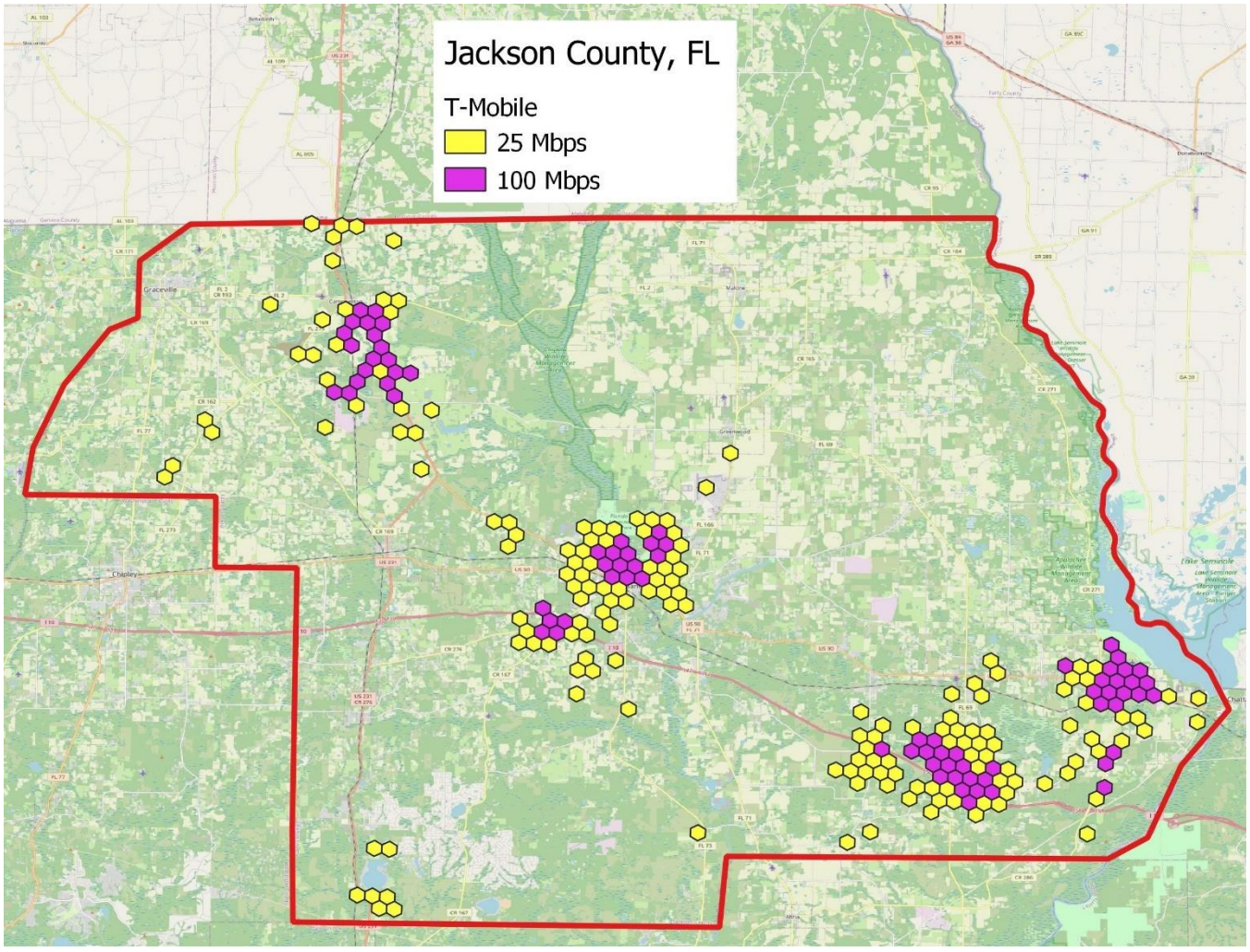


T-Mobile

T-Mobile reports broadband coverage in a few parts of the County using cellular spectrum. The speeds claimed in yellow on the map below likely represent areas where T-Mobile sells its traditional hotspots using 4G LTE spectrum. The company is starting to sell faster broadband using 5G spectrum, with reported speeds of 100 Mbps download, which is likely available in the areas shown in purple. Like with all wireless technologies, only customers living close to a tower can receive the full claimed speeds. It's likely that areas not close to a tower can't receive the fast speeds. In addition, cellular carriers throttle home service if cellular service experiences higher demand.

The average Ookla speed for T-Mobile was 40/11 Mbps in Jackson County.

Map 10 – T-Mobile Net FCC BDC Data



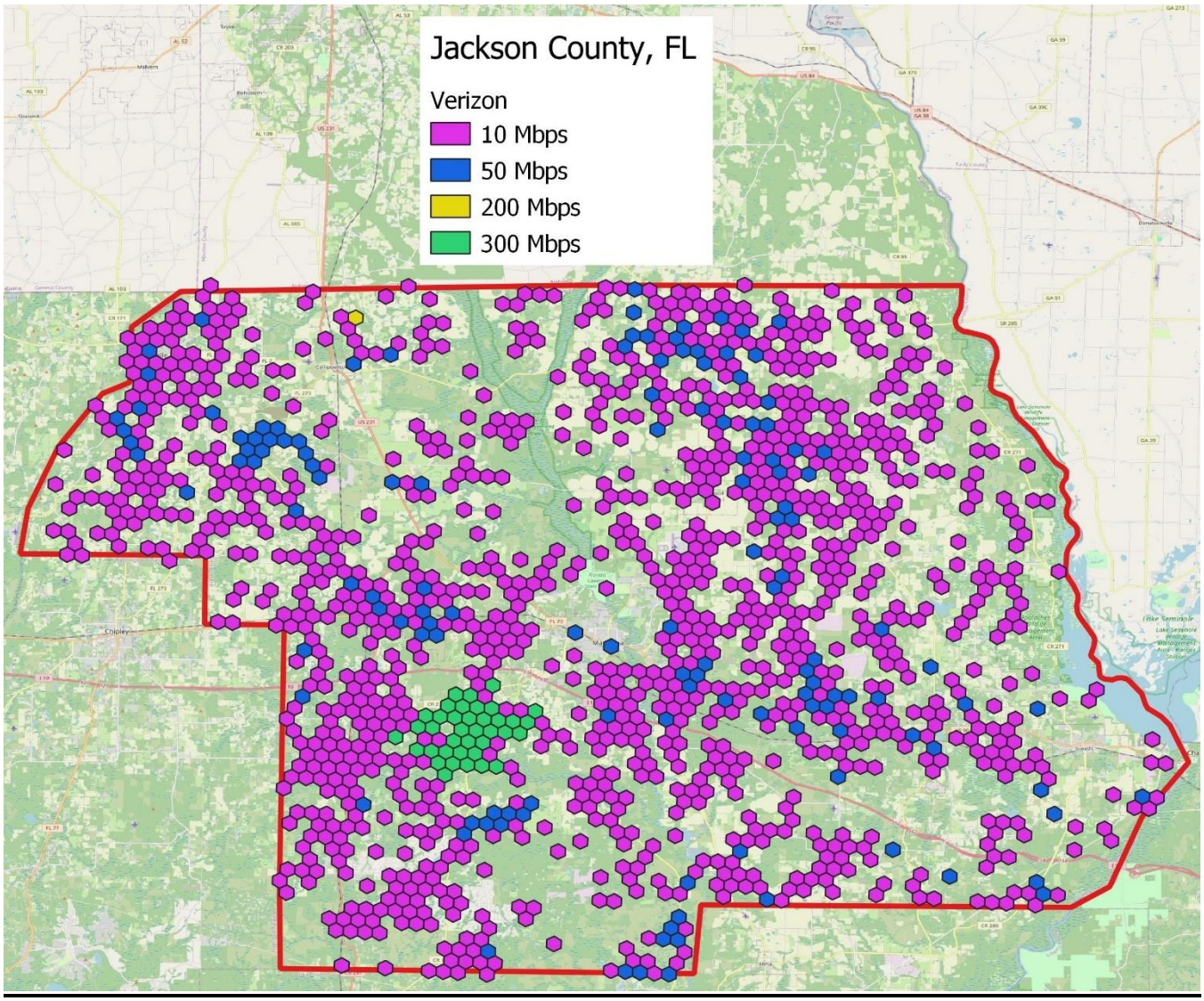
Verizon

Verizon reports coverage across the county using its cellular spectrum. The areas where Verizon claims 50 Mbps (blue) or 10 Mbps (pink) are areas where Verizon sells its traditional hotspots using 4G LTE spectrum. The areas shown to have 200 Mbps (yellow) and 300 Mbps speeds (green) are for the new 5G FWA technology.

Like with all wireless technologies, only customers living close to a tower can receive the full claimed speeds. It's likely that some of the areas claimed on the map can't receive fast speeds. In addition, cellular carriers throttle home service if cellular service experiences higher demand.

The average Ookla speed for Verizon in the county was 34/7 Mbps.

Map 11 – Verizon FCC BDC Data



Composite FCC Maps

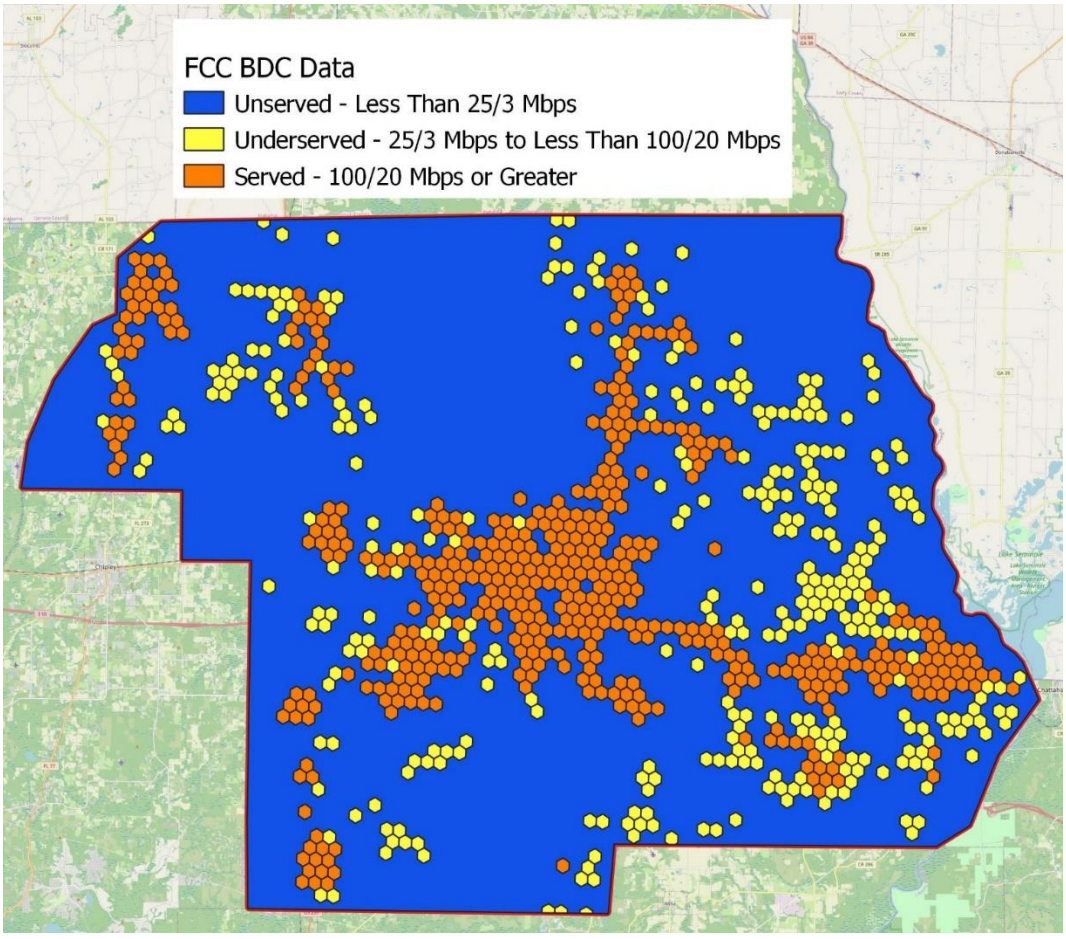
This discussion requires the introduction of a new term – passings. The industry uses passings to mean any home or business that can become a broadband customer. Finley Engineering gathered GIS data from the County that allowed us to identify and count the homes and businesses. We are able to count the potential customers covered by all of the maps shown above.

The main purpose for us doing the mapping analysis is to understand the number of homes and businesses in the County that don't have access to good broadband and that are not on anybody's radar to get faster broadband. For purposes of qualifying for current federal broadband grants, passings are categorized by speeds as follows:

- Unserved. Any place that has speeds of 25/3 Mbps or slower.
- Underserved – Any place that has speeds between 25/3 Mbps and 100/20 Mbps
- Served – Any place with broadband of 100/20 Mbps or faster.

Map 12 below shows the fastest broadband speed that is reported to the FCCs for every part of the County. In this map, the unserved areas are blue or empty, the underserved areas are yellow, and the served areas are orange.

Map 12 - Composite of all FCC BDC Mapping Data



FCC's Count of Homes Without Broadband. If the most current FCC map was accurate, the number of passing for each category is as follows:

	Speeds	Passings
Unserved (blue)	Less than 25/3 Mbps	7,831
Underserved Yellow)	From 25/3 Mbps to 100/20 Mbps	2,894
Served (orange)	100/20 Mbps or faster	15,557
Total		26,282

According to the FCC maps, 12,303 locations in the county are eligible today for broadband grants. That includes the 9,049 unserved passings and the 3,254 underserved passings. But we know that is not an accurate count.

Creating an Accurate Broadband Map

Our next step was to make corrections to the FCC maps to get a better picture of the need for broadband. To get a more accurate map, we made certain adjustments, as follows.

Known Grants and Subsidies. The FCC maps do not reflect grants and subsidies that have been awarded but that are not yet constructed. There was a huge subsidy award in the County that is not reflected on the maps – the monies awarded in the December 2020 RDOF reverse auction. There was also an award under the FL Broadband Opportunity Program. These awards will be discussed in more detail below.

Speed Exaggerations. Another common problem is that the FCC maps allow ISPs to report marketing speeds instead of actual speeds. In some cases, the marketing speeds are much higher than the actual speeds. We judged if the speeds are exaggerated in two ways. First, in the field review, we were able to review the technology in use, and in some cases, the reported speeds are faster than what the technology can support. We also had access to the trailing twelve months of Ookla speed data, where we can see the actual speeds being captured by Ookla speed tests.

Edge Distortions. ISPs sometimes claim serving areas in the FCC maps that are larger than where they can serve homes and businesses. The FCC rules allow ISPS to claim areas where they already have customers or where they can connect a customer within ten working days of a request for service.

Pending Upgrades. The FCC maps will also not reflect any planned expansions where ISPs are upgrading or planning to networks without the use of grant funding.

Change in Definitions. There was recently a change in the definition of locations that are grant-eligible for purposes of the $42.5 billion BEAD grant program. For the purpose of that grant program, fixed wireless WISPs are only considered as providing broadband if they use licensed spectrum. Areas covered by WISPs using unlicensed WiFi spectrum are assumed to be unserved – the NTIA has ruled that using unlicensed spectrum is unreliable.

The following entities own licensed spectrum in the County that can be used for wireless broadband. Any other wireless ISP is considered to not be providing broadband regardless of the speeds claimed.

- AirFi Inc. purchased 40 MHz of CBRS spectrum for $102,000 in Jackson County.
- Comcast (Xfinity) purchased 20 MHz of CBRS spectrum for $60,000 in Jackson County.
- Dish purchased 10 MHz of CBRS spectrum for $30,000 in Jackson County.
- Cellular service provided by AT&T, Verizon, T-Mobile, and others is usually licensed spectrum.

Our Adjustments to the Broadband Map

Speed Exaggerations. Both CenturyLink and Consolidated Communications claimed DSL capability of speeds between 50 Mbps and 100 Mbps. While there are probably a few customers that can get these speeds, only homes and businesses located close to DSL hubs can get such speeds. In the revised map below, we've shown these areas as unserved. Most State Broadband Offices consider DSL to be an obsolete technology for BEAD grant purposes regardless of the actual speed being delivered.

Wireless Broadband. Point Broadband claims speeds of 30 Mbps, which is considered to be underserved. The company uses licensed spectrum, and we have shown the area in the final map as underserved. The Point Broadband service area would still be eligible for BEAD grants.

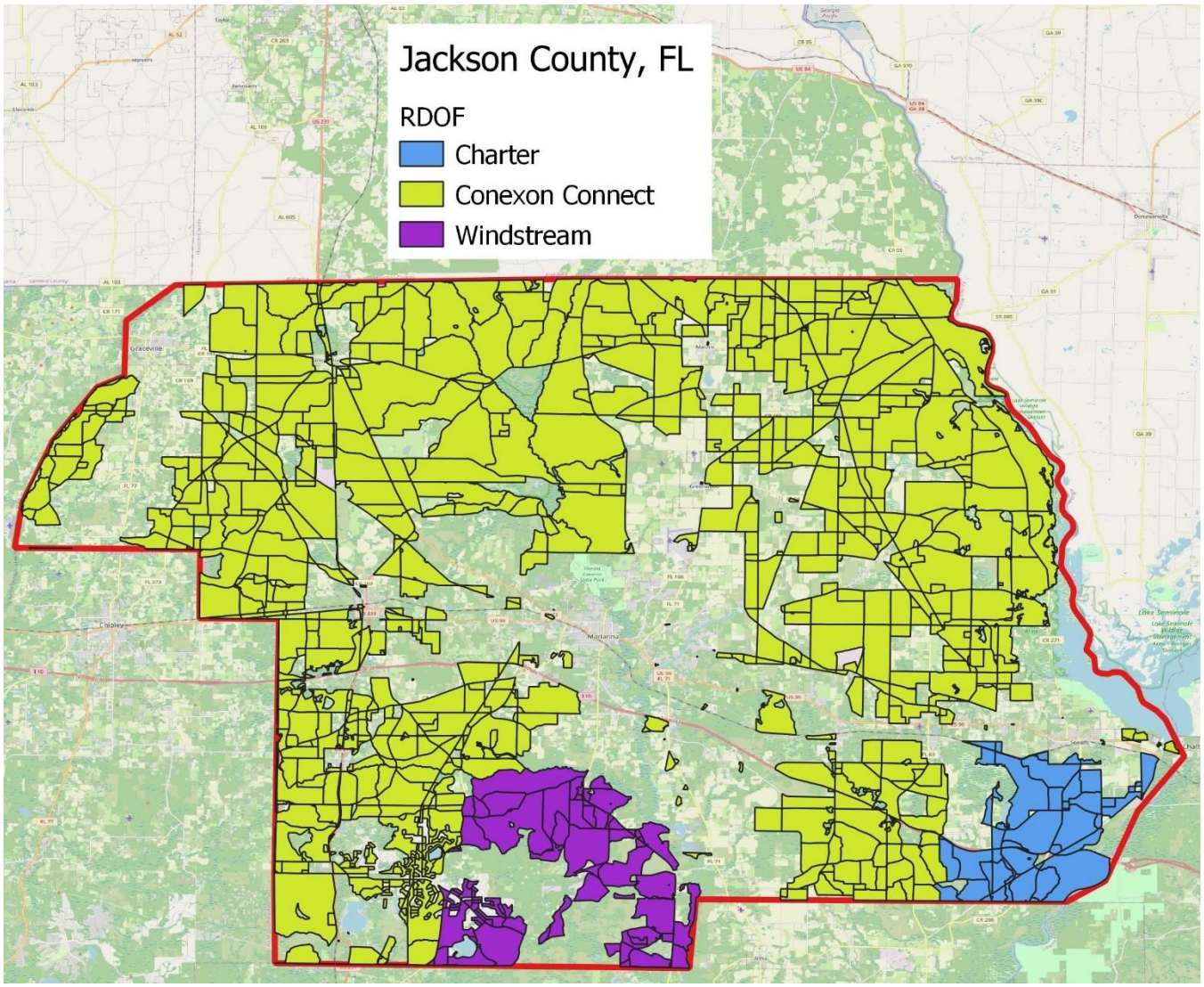
Known Grants and Subsidies. A huge award was made in the County in the FCC's Rural Digital Opportunity Fund (RDOF) subsidy awards. This program is being funded by the FCC from the Universal Service Fund. ISPs won the right to serve rural areas by competing for funding in a reverse auction that concluded in December 2020. In a reverse auction, the ISP willing to take the least amount of subsidy for a given geographic area was declared the winner of the auction. ISPs collectively and tentatively won over $6 billion in the reverse auction, but the money is not automatically awarded to each ISP, which must prove technical and financial capability before winning the funding. A winner of RDOF funding is expected to complete construction within six years, with completion milestones starting in the third year after the award.

The amount of RDOF awarded in the County is significant. There were three RDOF auction winners in Jackson County.

- Charter Communications (Spectrum) won $837,744 to serve 445 locations in Jackson County. The FCC has authorized the funding.
- Rural Electric Cooperative Consortium (Conexon Connect) won $10,487,547 to serve 6,838 locations in Jackson County. Conexon Connect was founded in 2021 to operate and manage fiber-to-the-home networks for electric cooperatives and investors. Conexon Connect typically partners with electric cooperatives to construct the RDOF award areas. But we know that in Jackson County, this partnership has not been formed. The FCC has authorized the award to Conexon.
- Windstream won $1,168,744 to serve 471 locations in Jackson County. Windstream is a large telephone company and plans to use the award to build fiber. Windstream currently serves customers in Alabama across the eastern border of the County. The FCC has authorized the Windstream award.

The following map shows the three RDOF awards. These awards cover a huge portion of the rural parts of the County.

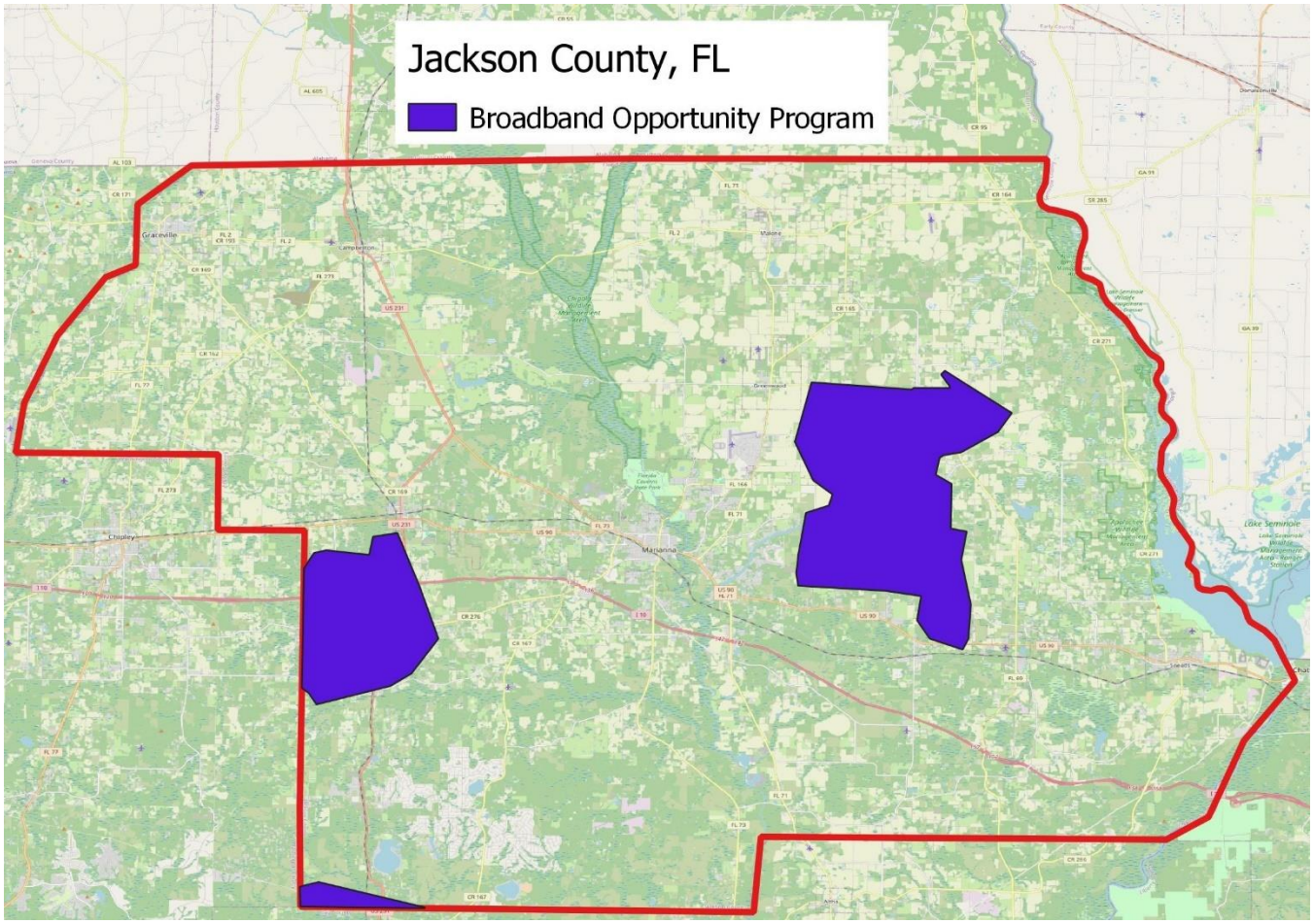
Map 13 - RDOF Auction Winners



Broadband Opportunity Program

This is a State of Florida grant program. In February 2023, Comcast was awarded $2,040,743 to provide fiber to the home to 1,082 unserved and underserved residential customers and 29 businesses and anchor institutions in the towns of Alford, Cottondale, Grand Ridge, Greenwood, and Two Egg from the Florida Broadband Opportunity Program. Oddly, some of this award overlaps areas where Conexon won RDOF – we're not sure what that is going to mean in terms of who builds in these areas – since both companies are now obligated to build fiber based on two different grant programs.

Map 14- Broadband Opportunity Program Map



Adjusted Broadband Map

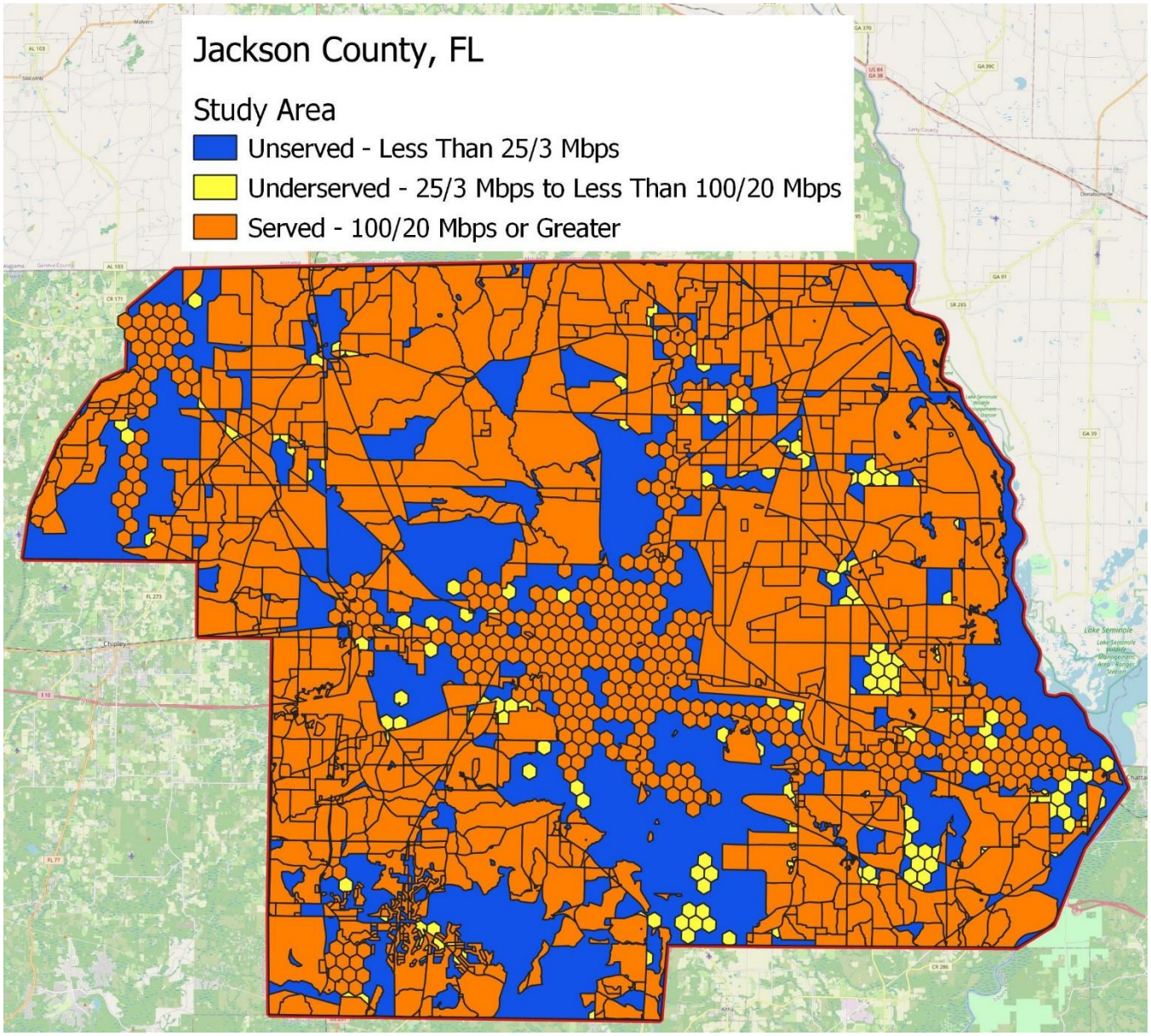
The following reflects the above changes to the FCC map. The adjusted map is below. The passings that match the adjusted map are as follows:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	1,697
Underserved	From 25/3 Mbps to 100/20 Mbps	992
Served	100/20 Mbps or faster	23,593
Total		26,282

The revised map shows a lot fewer locations that are grant-eligible. This is mostly due to the large areas awarded to the RDOF subsidy and state Broadband Opportunity grant.

What does the adjusted map tell us? It shows that there are 2,689 homes and businesses in the County (in areas shown in blue or yellow on the map) that don't have broadband today of speeds of at least 100/20 Mbps and which are not currently on any ISP's radar to upgrade.

Map 15 Adjusted Broadband Map



We know the County is concerned about the 7,754 locations covered by the RDOF subsidies. Over the past two years, a number of RDOF winners defaulted on the RDOF awards. In the most recent defaults, the FCC levied some hefty fines to dissuade ISPs from defaulting. There was also a recent petition to the FCC from electric cooperatives asking for relief from the RDOF awards. The subsidy winners are hoping the FCC will give them more funding by extending the payments for an additional year or two. The FCC rejected the request.

The County needs to stay in contact with the RDOF winners and pressure them to meet their commitments to build fiber.

D. Broadband GAP Analysis

A broadband gap is a situation where some residents of an area are disadvantaged in their ability to use the Internet. This report will look at the various kinds of broadband gaps as described below.

- The Gap in Broadband Speeds. Broadband speeds vary widely in the county, as documented in the preceding section of the report.
- The Gap in Broadband Availability. There are homes with no landline broadband available.
- The Competition Gap. This gap is created whenever there are areas that are served by only one high-quality ISP, leaving residents and businesses with no choice of provider.
- The Gap in Broadband Affordability. There are households in every community that don't subscribe to broadband because of the cost.
- The Gap in Computer Ownership. There are households that don't subscribe to broadband because they can't afford a computer.
- The Gap in Broadband Skills. There are citizens who don't buy broadband because they lack the skills needed to operate in the digital age.
- Future Broadband Gaps. Even where there is adequate broadband today, we can expect the natural growth of broadband usage to create new broadband gaps in the future.

After describing the different broadband gaps, this report will look at the consequences of the broadband gaps and will ask the question if there are any practical solutions to the broadband gaps that Jackson County could facilitate.

The Gap in Broadband Speeds

The mapping analysis above shows the coverage areas and the claimed broadband speeds of the various ISPs in the county. This section of the report will look at other data sources to tell us more about the state of broadband in the study area.

Microsoft Speed Data

Microsoft is in an interesting position when it comes to looking at broadband speeds. The vast majority of computers in the country download sizable upgrade files from Microsoft. Even Apple computers are loaded with Microsoft Office products like Word, Excel, and PowerPoint.

Microsoft decided a few years ago to record customer download speeds during software upgrades. There is probably no better way to measure a broadband connection than during a big file download. Most speed tests only measure broadband speeds for a minute or less. There are a lot of ISPs in the country that deploy a technology referred to as burst. This technology provides a faster download for a customer for the first couple of minutes of a web event. It's easy for a customer to know if their ISP utilizes burst technology because, during a long download, such as one updating Microsoft Office, the user can see the download speeds drop to a slower speed after a minute or two. This burst technology has great benefits for customers since most web activities don't take very long. When customers visit a website, open a picture, or even take a speed test, the customer only needs bandwidth for a brief time. The burst technology gives

customers the impression that they have a faster download speed than they actually have (or it could be conversely argued that they have a fast speed, but just for a minute or two).

Microsoft measured downloads starting in September 2018 and found:

- The 2019 FCC data claimed that 14.5 million people in the U.S. don't have access to download speeds of at least 25/3 Mbps. In October 2020, Microsoft claimed that 120.4 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2020 that 53.3% of households in Jackson County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 88.0% of all downloads in the county were made at speeds of less than 25 Mbps.

The Microsoft data is drastically different than what was reported in the FCC maps. It's important to note that the FCC and Microsoft are not measuring the same thing. The FCC measures the percentage of homes that can purchase 25/3 Mbps broadband. Microsoft is measuring the actual speeds of downloads. There are a few reasons why the speeds might be different:

- Some people opt to buy broadband products slower than 25/3 Mbps, even when faster broadband speeds are available – although there aren't many broadband products slower than 25/3 Mbps.
- Some households receive slow speeds due to issues in the home, like poor-quality WiFi routers.
- Many ISPs use burst technology, where the first minute or two of a download session is faster than the speeds after that. Microsoft is seeing post-burst speeds in a big software upgrade.
- The biggest difference is due to the ISPs overstating the speeds to the FCC made available to the public. As stated earlier in this report, the FCC doesn't challenge speeds reported to them by ISPs.

But the biggest difference is due to ISPs overstating the speeds to the FCC. The real speeds in the county are not nearly as good as what the FCC tells Congress. The differences between Microsoft and the FCC have probably narrowed since 2020. The cable companies have significantly increased speeds. A few other ISPs have built fiber in the county. But ultimately, the Microsoft analysis is more realistic because it's the speeds actually being used by residents for a software download. Microsoft provides a real-life way to judge the overall accuracy of the FCC maps.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that could buy broadband at various speeds.

Jackson County

The following is what the FCC reported to Congress in 2021 about Jackson County.

Urban population:	10,501
% that can buy at least 25/3 broadband	81.8%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	81.8%
Rural population:	35,913
% that can buy at least 25/3 broadband	53.5%

% with 4G LTE coverage at 5/1 Mbps	100%
% with both	53.5%

The FCC data coverage does not look accurate for the urban area. Most of the towns in the county have broadband from Comcast or Charter. The FCC data shows that only 53.5% of the rural parts of the county can buy 25/3 Mbps broadband. The FCC data was collected in 2019. The most recent FCC data reinforces that there are large rural parts of the county that do not have access to broadband according to the FCC. The FCC's numbers are reasonable when contemplating the situation in the county before the RDOF subsidy awards.

Comparing Jackson County with the Rest of Florida

According to FCC data, Dixie and Levy Counties have the greatest percentage of locations that can't get speeds of at least 25/3 Mbps coverage in the state at 0.8% and 14.0%, respectively. At the other end of the scale, the FCC says that 11 counties have 100% coverage of 25/3 Mbps broadband. According to the FCC data, Jackson County, at 59.9% 25/3 Mbps coverage, has some of the lowest broadband coverage in the state.

Ookla Speed Test by State

Ookla collects speed tests across the country. It is the most popular speed test website, making it an excellent resource for looking at current broadband speeds in any area of interest. In 2020, Ookla started to report median download and upload speeds and latency by state. The median means the speed at which half of all broadband speeds are slower and half are faster. Below are the average speeds for the whole state as reported by Ookla since the third quarter of 2022.

	Download	Upload
3rd Quarter 2022	193 Mbps	23 Mbps
4th Quarter 2022	204 Mbps	23 Mbps
1st Quarter 2023	212 Mbps	23 Mbps
2nd Quarter 2023	233 Mbps	23 Mbps
3rd Quarter 2023	240 Mbps	24 Mbps

As seen in the table above, download broadband speeds have been improving rapidly in Florida. From the third quarter of 2022 to the third quarter of 2023, the median download speed has increased from 193 Mbps to 240 Mbps. There are three likely reasons for this trend:

- Cable companies in cities have increased speeds across the board. Where the speed for the most common product might have been 100 Mbps a few years ago, cable companies have increased the speeds for the same product to 200 Mbps or 300 Mbps.
- Fiber networks are being built around the state. When fiber is built in rural areas, the speeds drastically improve overnight.
- As is shown later in this section, people across the country have been upgrading to faster speeds at existing ISPs in the last few years.

The increase in upload speeds might be driven by some of the same reasons, especially from fiber networks being built in the state. When cable companies improve the download speeds, they often don't change the

upload speeds. The same happens when customers upgrade with a cable company to a faster download product – in many cases, the upgrade doesn't mean a faster upload speed.

According to Ookla, AT&T Internet is the fastest ISP in Florida, with a median download speed of 288 Mbps.

The Gap in Broadband Availability

There are residents in every rural area who say they can't buy broadband. We've found that this usually means that there are no broadband alternatives they are willing to buy. Many folks won't buy a broadband product that doesn't meet their needs. Most people won't pay for broadband that only delivers 1 or 2 Mbps download speeds with barely any upload speeds.

As an example, many people won't consider satellite broadband as an option. We've talked to many rural residents who tried satellite broadband and rejected it. The speeds are often far below what is advertised since trees and hills can block a satellite signal. The latency is dreadful - in places where the speeds are impaired, high latency means a household can't hold a connection to a website, making basic things like shopping on the web impossible. Satellite plans also come with tiny data caps, and people find it impossible to make it through the month with a 40 - 60 gigabyte data cap. The killer issue with satellite broadband is the cost. Viasat told investors in 2021 that its average revenue per customer was over $93 per month. Many rural residents refuse to pay that much for a broadband product that doesn't work.

Rural residents might also have tried cellular hotspots. These are the plans that cellular companies have had for years that price home broadband at the same data rates as cellular broadband. During the pandemic, CCG heard from families who were spending $500 to $1,000 per month on a hotspot to enable home-schooling. Cellular coverage is often spotty and poor in most rural areas.

We believe it when a rural household tells us they have no broadband available. They will typically already have tried DSL, satellite, and a cellular hotpot and decided that none of the technologies work well enough to be worth paying for.

The Gap in Broadband Affordability

The FCC reports that the total broadband adoption in the country is around 89%. Even after accounting for the rural areas that have no broadband option, there are many millions of people who don't buy broadband when it is available. Numerous studies and surveys have investigated this issue, and the predominant reason that people elect to not buy broadband is the price – people say they can't afford broadband.

Statistics on Affordability

In larger cities, it's somewhat easy to equate broadband penetration rates to household incomes. This is because a Census block in a city might be as small as a block or two, and it's easy to match Census data to broadband data from the FCC.

An analysis of recent FCC 477 data shows that there is a direct correlation between household income and buying a home broadband connection. The FCC data from the Fourteenth Broadband Deployment Report released in January 2021 shows that only 38.4% of households in the lowest quartile of earnings are buying broadband of at least 10/1 Mbps. The percentage that buys faster broadband drops to only 4.7% of households buying broadband of at least 250/25 Mbps.

Average County Overall Adoption Rate for Fixed Terrestrial Services by County Level Demographic Variable (December 31, 2019)

	10/1 Mbps	25/3 Mbps	50/5 Mbps	100/10 Mbps	250/25 Mbps
Median Household Income					
First Quartile (Lowest Median Household Income)	38.4%	28.3%	23.4%	20.2%	4.7%
Second Quartile	51.6%	41.6%	36.4%	31.0%	6.0%
Third Quartile	58.8%	47.6%	42.2%	35.2%	6.2%
Fourth Quartile (Highest Median Household Income)	71.2%	61.3%	56.7%	43.8%	8.1%
Population Density					
First Quartile (Lowest Population Density)	48.8%	34.2%	26.8%	22.7%	8.0%
Second Quartile	43.9%	34.3%	30.1%	25.0%	4.8%
Third Quartile	55.1%	46.5%	42.6%	36.0%	5.0%
Fourth Quartile (Highest Population Density)	72.0%	63.6%	58.8%	46.1%	7.8%

There are studies available for those who want to dig deeper into quantitative and qualitative research into broadband affordability for low-income households. The first was published by the Benton Foundation and authored by Dr. Colin Rhinesmith.[10] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[11] This report looks at a study conducted in three low-income neighborhoods of Detroit.

Both reports say that low-income households with a limited budget appreciate the advantage of having broadband at home but often can't fit it into their budgets. They find it difficult or impossible to prioritize broadband compared to paying rent or buying food. These studies indicate that a big part of the solution for getting broadband into homes without it is going to have to involve finding a way to pay for monthly broadband access.

[10] Digital Inclusion and Meaningful Broadband Initiatives. https://www.benton.org/publications/digital-inclusion-and-meaningful-broadband-adoption-initiatives

[11] Broadband to the Neighborhood. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3103457

The Pew Research Center shows a direct correlation between income and broadband adoption. The non-profit has been conducting an ongoing investigation into broadband-related issues since 2000[12]. Pew shows that as of February 2021, only 57% of homes with household incomes less than $30,000 have broadband, compared to 92% of homes with household incomes over $75,000.

The survey shows that 4.4 million households currently don't have broadband because of affordability. That works out to be 3.5% of all households in the country. As can be seen by the statistics in the third column, the homes that can't afford broadband meet many of the same demographic characteristics cited in the Pew study above:

- 45% have a household income below $25,000 per year.
- There is a higher percentage of African Americans and Hispanics that can't afford broadband.
- There is a much higher percentage of households with nobody with post-secondary education.
- 29% of these homes previously had broadband but no longer do.

The National Telecommunications and Information Administration (NTIA) conducts surveys about broadband adoption. The table below shows survey results released in October 2022 that show some interesting statistics on broadband affordability.

Selected Characteristics by Home Internet Use or Non-Use
Percent or Mean Response of Households, 2021

	Internet at Home	No Need/Interest	Too Expensive
Total Households	108.5 million	13.8 million	4.4 million
Family Income < $25K/Year	15%	35%	45%
School-Age Child Present	24%	12%	19%
Located in Rural Area	12%	16%	14%
Internet Use at Other Locations	85%	13%	24%
Previous Home Internet Use	N/A	14%	29%
Household Reference Person* Characteristics			
Mean Age	50.6	60.5	51.3
No Post-Secondary Education	30%	59%	57%
White, non-Hispanic	66%	61%	49%
African American, non-Hispanic	12%	16%	25%
Hispanic	14%	17%	19%
Willingness to Pay for Home Internet Service (Per Month)			
Mean Price	N/A	$5.92	$15.69
Price is $0 or "None"	N/A	83%	54%

* The reference person is the first individual in each household who is identified as owning or renting the housing unit.

[12] Demographics of Internet and Home Broadband Usage in the United States | Pew Research Center. https://www.pewresearch.org/internet/fact-sheet/internet-broadband/?menuItem=2ab2b0be-6364-4d3a-8db7-ae134dbc05cd

Demographics in the County

Jackson County Demographics

There are many studies that suggest that demographic factors are a major factor in whether homes can afford broadband. This section of the report looks at some of the key demographics in Jackson County. These statistics are based on the recent 2020 Census data.

Population Demographics

Community	Population	Change Since 2010	Percentage Under 5	Percentage Under 18	Percentage Over 65
Jackson County	47,319	-4.8%	5.0%	18.6%	21.0%
Florida	21,538,187	14.6%	5.0%	19.3%	21.6%
United States	331,449,281	7.4%	5.6%	21.7%	17.3%

As seen in the above table, Jackson County has been losing population while Florida is growing. Jackson County has the same percentage of residents under the age of five as the state average and a lower average of residents under age 18 compared to the state average. Both Jackson County and Florida have lower percentages of residents under ages 5 and 18 compared to the nationwide average; both have a higher percentage of residents over 65 compared to the nationwide average.

Home Ownership and Educational Demographics

Community	Percent with High School Degree	Percent with Bachelor's or Higher	Percentage Home Ownership	Median Home Cost
Jackson County	84.2%	13.9%	74.0%	$113,300
Florida	89.3%	32.3%	66.9%	$292,200
United States	89.1%	34.3%	64.8%	$281,900

The above table highlights that Jackson County has a lower percentage of residents with high school diplomas than Florida and the national average. Jackson County has a significantly lower level of residents with a bachelor's degree or higher compared to the state and nationwide averages.

Jackson County has a higher percentage of homeownership than the state or national average. The median home price in Jackson County is far lower than the state and national median prices.

Income Demographics

Community	Household Income	Per Capita Income	Percentage in Poverty
Jackson County	$46,144	$23,210	17.5%
Florida	$67,917	$38,850	12.7%
United States	$75,149	$41,261	11.5%

Jackson County has a significantly lower household income than the state or federal average. The county also has a lower per capita income than the state and national average. The county has a significantly higher percentage of residents in poverty compared to the state and national averages.

Our primary takeaway is that the demographics indicate that affordability is likely an issue in the county. Consider the following:

- The county has significantly lower household and per capita incomes.
- The county has significantly higher percentage of residents living in poverty.
- To some degree, these issues are offset by lower housing costs, but overall, we expect there are a lot of residents in the county that will have trouble affording broadband at full list prices.

Income Statistics for the County

Both HUD and ACS collect nationwide data that is often used when awarding broadband grants. Both sets of data are used to identify lower-income parts of a community – areas that are often given preference in grants related to housing, economic development, and broadband deployment. Following is what HUD and the ACS say about the study area.

HUD (Department of Housing and Urban Development). The Department of Housing and Urban Development (HUD) was established as a Cabinet Department in 1965. HUD is the federal agency responsible for the national policies and programs that address America's housing needs, enforce fair housing laws, and look for ways to improve neighborhoods with below-average incomes.

HUD Distressed Cities and Persistent Poverty Technical Assistance Program (DCTA)

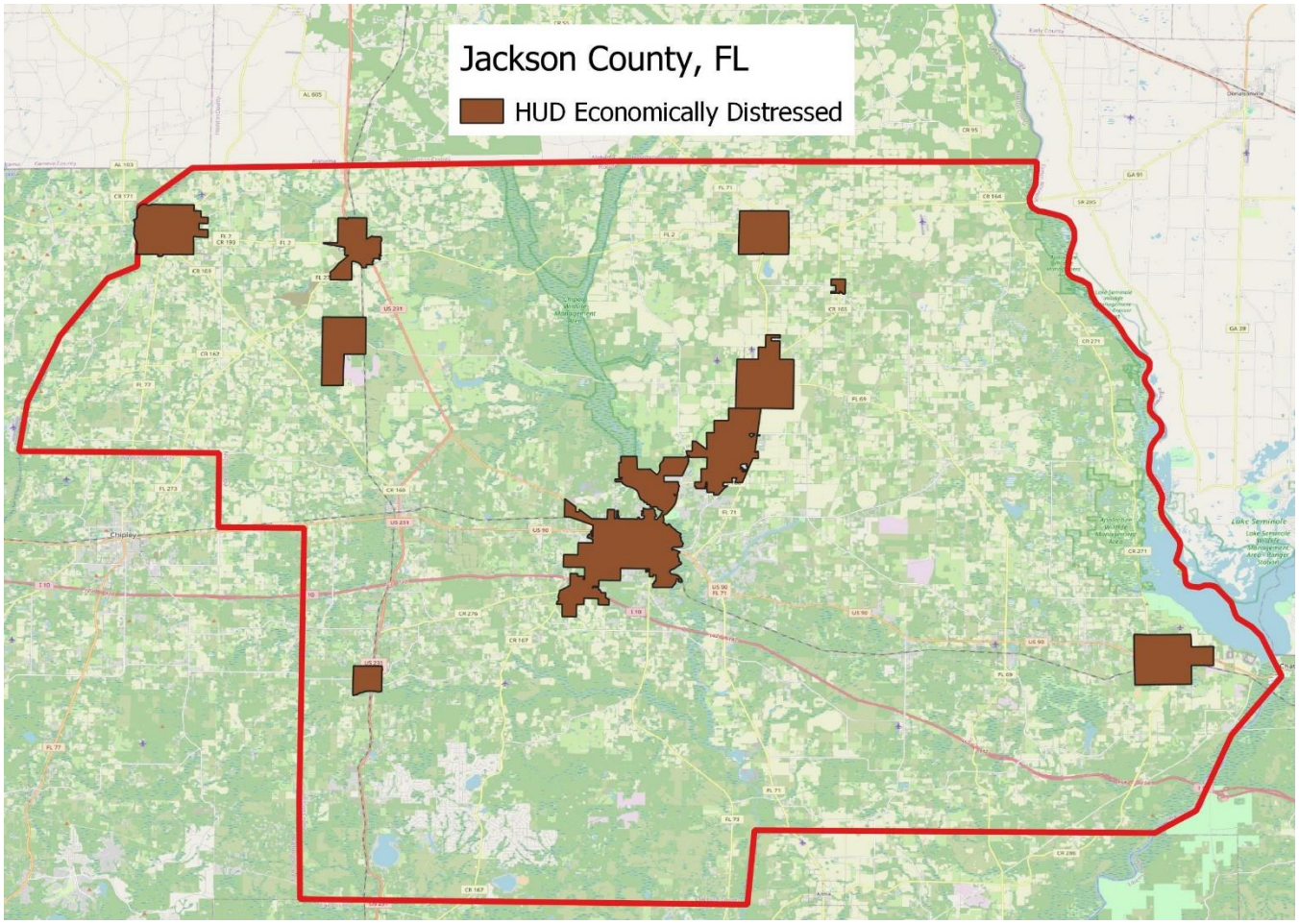
The Distressed Cities and Persistent Poverty Technical Assistance Program (DCTA) is a HUD program that identifies and aids local governments. As part of the DCTA program, HUD identifies two vulnerable categories for smaller communities. The two categories are economically distressed and persistent poverty.

Economically distressed local governments are governments with populations of less than 50,000, have an average unemployment rate of 9% or higher over the past three years using the American Community Survey (ACS) 5-year estimates, a poverty rate of 20% or higher among individuals not enrolled in higher education as of the most recent ACS 5-year estimates, or a population decline of 5% or higher between the 2010 Decennial Census and the most recent ACS 5-year estimate. According to HUD, there are several areas in the county that are considered to be economically distressed.

The second category for the DCTA program is persistent poverty. To qualify, local governments must have a population of less than 50,000. Persistent poverty is defined as a census tract with a poverty rate of 20% or higher over the past 30 years. According to the HUD, there are no areas in the county considered to be in persistent poverty.

According to HUD, the cities of Graceville, Campbellton, Jacob City, Malone, Bascom, Greenwood, Marianna, Alford, and Sneads meet the requirement for being economically distressed. This means that any project in these areas will potentially be given a higher priority for grant applications.

Economically Distressed

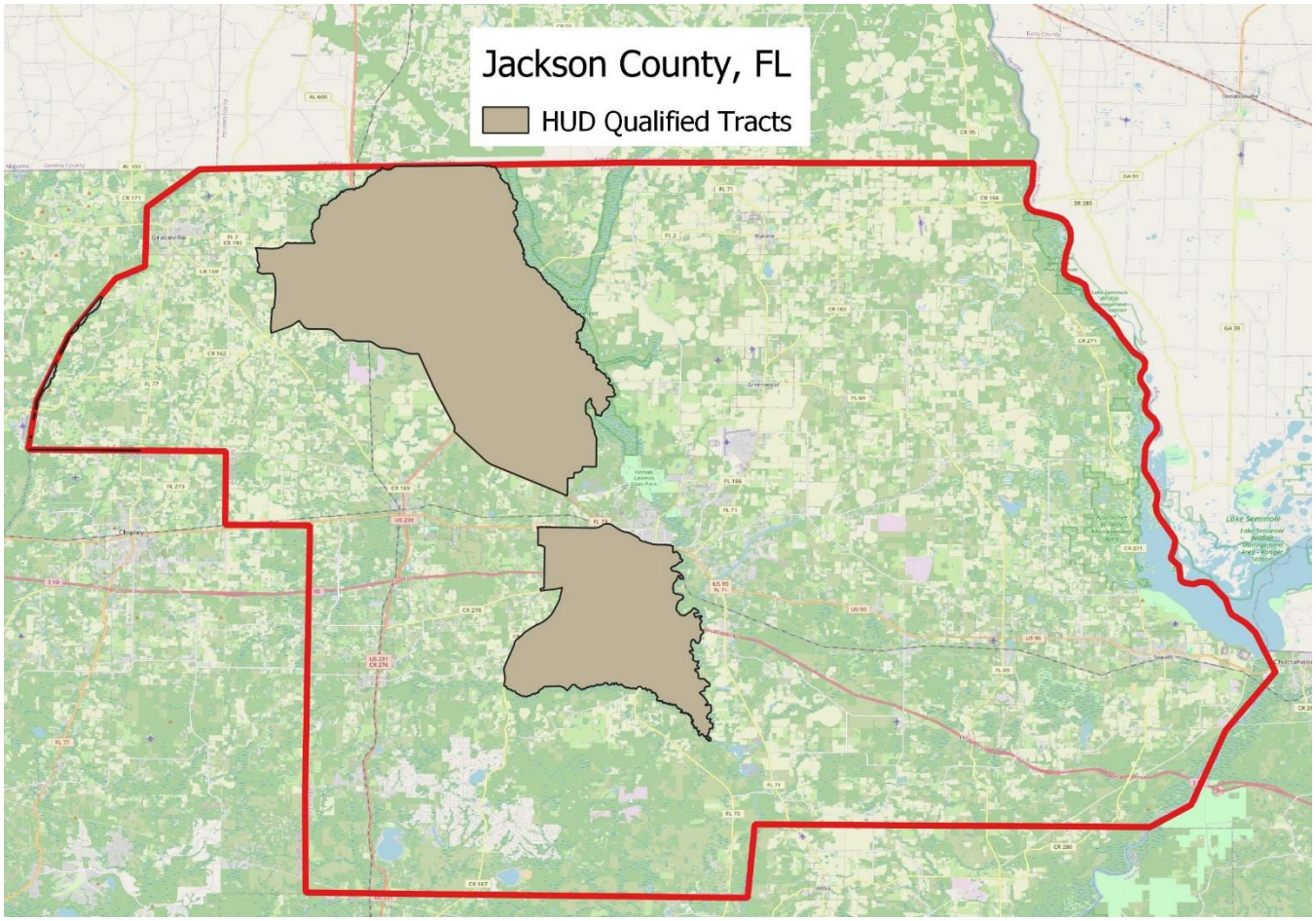


HUD Qualified Tracts

As part of the Low-income House Credit program, HUD identifies Qualified Census Tracts in communities. For a tract to qualify, it must have 50% of households with incomes 60% below the area median gross income. The 60% income standard is determined by:

1. Calculating the average household size of the census tract.
2. Applying the income standard after adjusting it to match the average household size.
3. Calculating the number of households with incomes below the income standard.

HUD uses its Very Low-income Limits to standardize the calculations. HUD then uses a mapping tool to specifically identify areas it labels as Qualified Census Tracts. These areas cannot exceed 20% of the area's total population. In Jackson County, two Census Tracts have been identified as qualified HUD tracts by meeting the requirement of having over 50% of the population with incomes below 60% of the area's median gross income.



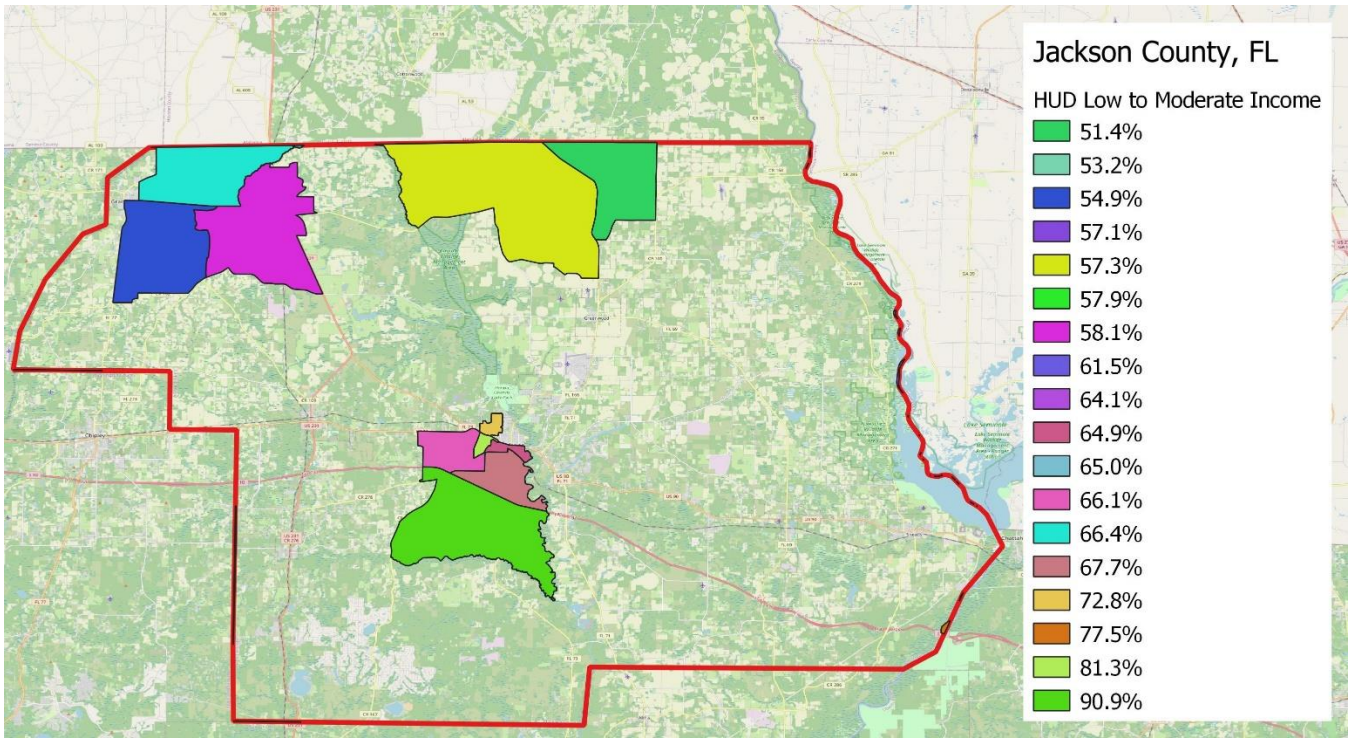
HUD Community Development Block Grant (CDBG). The Community Development Block Grant is a program that must actively benefit low and moderate-income (LMI) persons. The grants can benefit things like housing and jobs. Additionally, services may qualify for CDBG assistance if the activity will benefit all residents of a residential area where at least 51% of the residents are low- and moderate-income persons. The CDBG program is discussed in detail in the funding for broadband networks section of the report.

HUD uses two sources of statistical information to calculate income levels around the country. The first is the American Community Survey (ACS), and the second is the Income Limits for Metropolitan Areas and for Non-Metropolitan Counties.

HUD calculates the area median income for any area of interest and uses the sources to estimate a community's income. Income levels are classified into three categories:

- Low Income (up to 50% of the Area Median Income (AMI))
- Moderate Income (greater than 50% AMI and up to 80% AMI)
- Medium Income (greater than 80% AMI and 120% AMI)

CDBG identifies areas where 51% of the population is considered low or moderate-income. As seen in the map below, HUD has identified parts of the study area as having over 51% of the population as low to moderate-income.

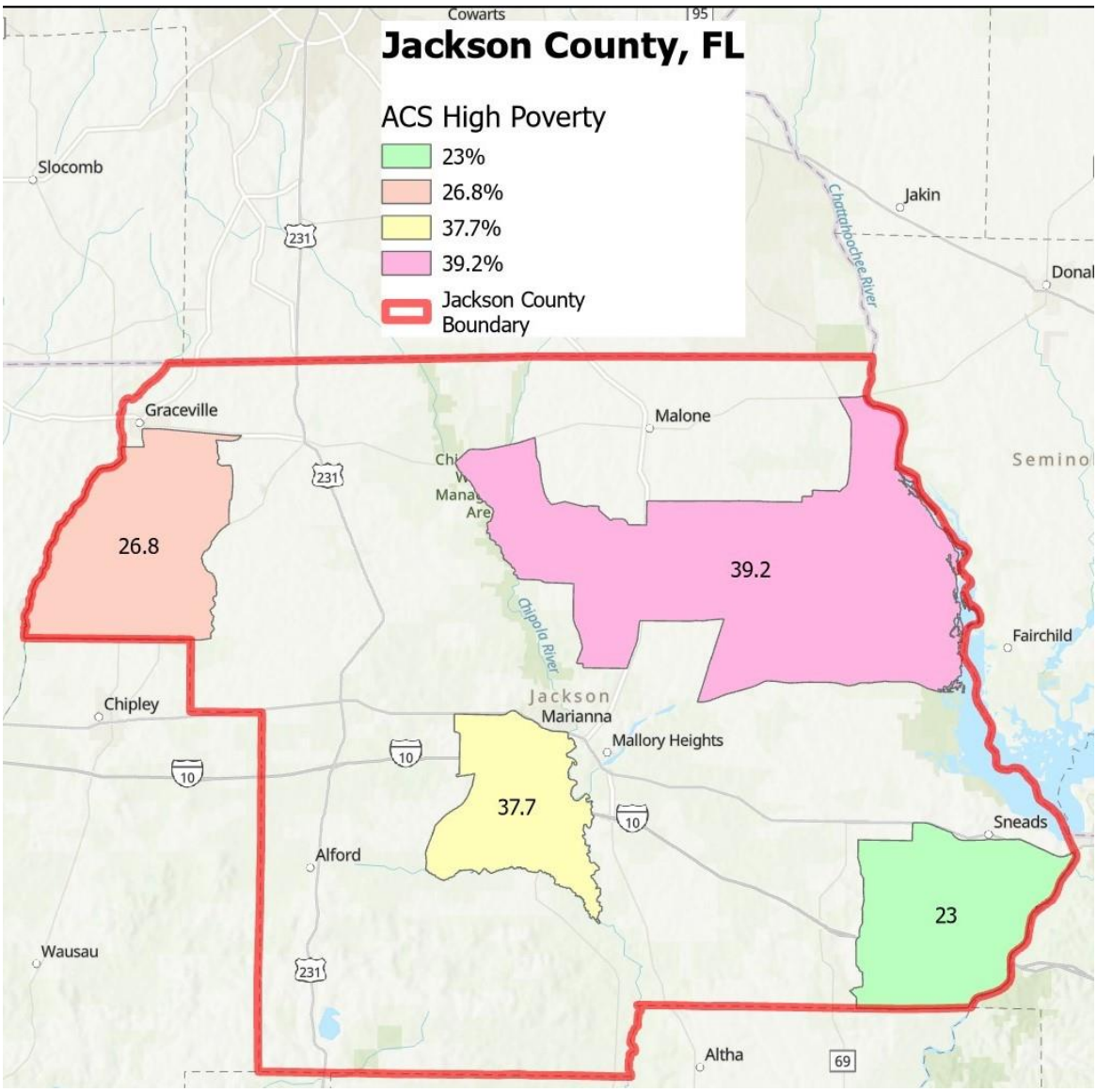


American Community Survey (ACS)

The American Community Survey (ACS) is an ongoing nationwide survey conducted by the Census Bureau that updates information about communities between the 10-year census periods. The ACS gathers information on jobs, occupations, educational attainment, veterans, whether people own or rent their homes, and related topics. The ACS helps local officials, community leaders, and businesses understand the changes taking place in their communities.

ACS Poverty. Household incomes are collected in the ACS survey to measure areas with poverty. This report has detailed the correlation between income and broadband adoption. Census data shows that areas with low incomes often have a lower rate of broadband adoption.

The ACS identified every Census Tract in the county as having over 20% of the population living in poverty. Families are classified as being in poverty if their household income is less than their poverty threshold calculated as a result of the ACS survey. The areas that are considered to have the most poverty are shown on the following map:



The poverty threshold varies by the number of family members. See the table below for the poverty thresholds for the year 2020, which is the most recent year of accessible ACS data.

Size of family unit	Weighted average thresholds	Related children under 18 years								
		None	One	Two	Three	Four	Five	Six	Seven	Eight or more
One person (unrelated individual):	13,171									
Under age 65	13,465	13,465								
Aged 65 and older	12,413	12,413								
Two people:	16,733									
Householder under age 65	17,413	17,331	17,839							
Householder aged 65 and older	15,659	15,644	17,771							
Three people	20,591	20,244	20,832	20,852						
Four people	26,496	26,695	27,131	26,246	26,338					
Five people	31,417	32,193	32,661	31,661	30,887	30,414				
Six people	35,499	37,027	37,174	36,408	35,674	34,582	33,935			
Seven people	40,406	42,605	42,871	41,954	41,314	40,124	38,734	37,210		
Eight people	44,755	47,650	48,071	47,205	46,447	45,371	44,006	42,585	42,224	
Nine people or more	53,905	57,319	57,597	56,831	56,188	55,132	53,679	52,366	52,040	50,035

Summary

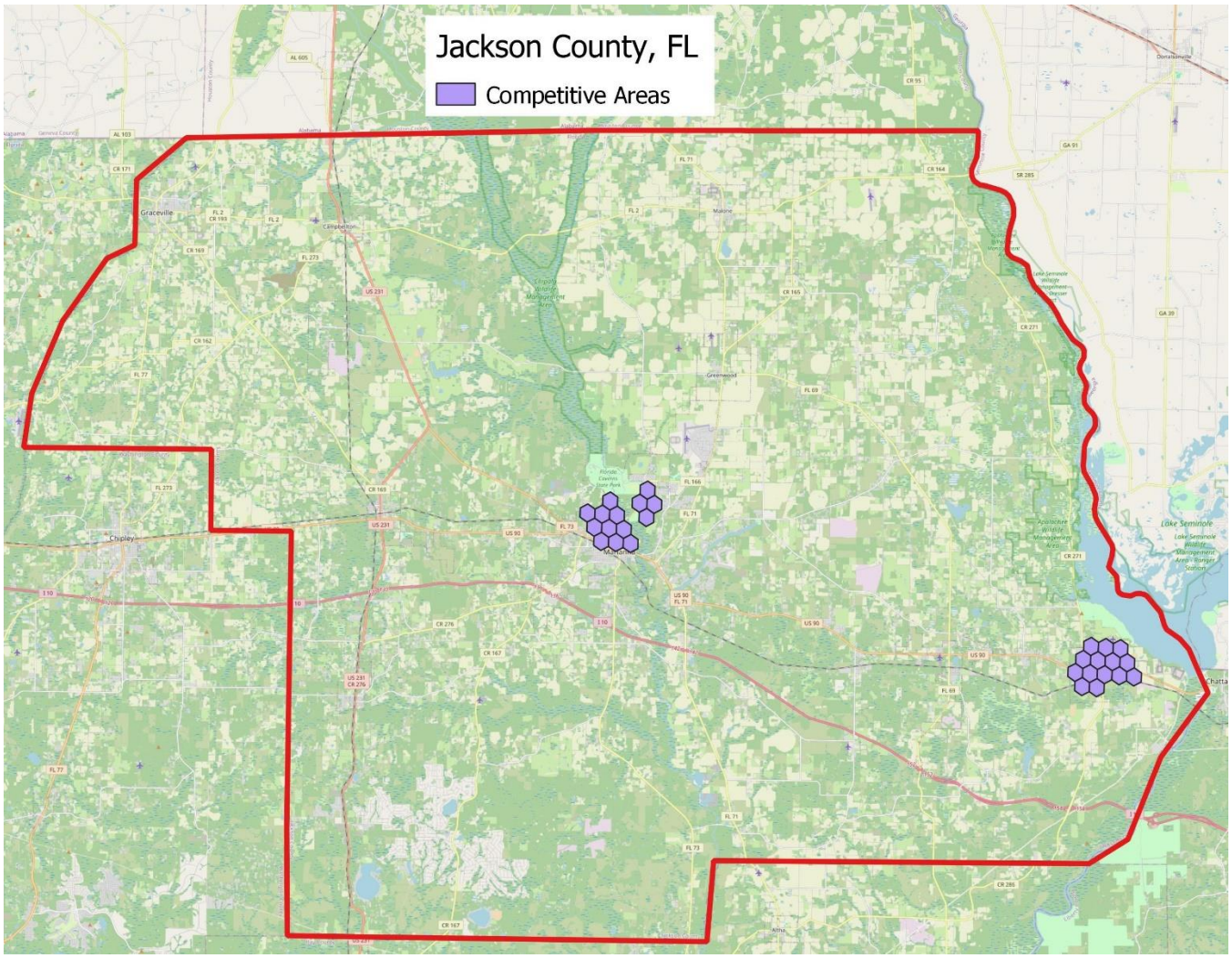
The demographic mapping and other information we gathered about the county show areas where grants will have a better chance of being funded due to the presence of low-income neighborhoods.

The Competition Gap

One of the first things we noticed about the county is that while most cities and some rural areas already have good broadband (places where at least one ISP offers speeds of 100/20 Mbps or faster), there is only one landline ISP offering fast speeds. This study focused on bringing fast broadband to the rural areas that don't have fast broadband – but those areas will likely also only have one fast ISP after grants are awarded.

We can't find more than a handful of places in the county where there is more than one competitor with a speed option greater than 100/20 Mbps. This means that most of the county has what we call a competition gap – where people don't have a choice between multiple fast ISPs. Consider the following:

- The only two fast landline technologies in the county today are hybrid fiber-coaxial network operated by Charter and Comcast and fiber technology deployed by CenturyLink.
- The is one wireless technology in the county that can deliver speeds of at least 100 Mbps download in some places. T-Mobile FWA cellular wireless claims 100 Mbps broadband around some cell towers. Verizon FWA cellular wireless claims 300 Mbps broadband around some cell towers. The fast broadband coverage for this technology is generally for an area within two miles of a tower. This creates some small pockets where residents can buy from a cable company and from one of the cellular providers.



The map above shows the areas where there is competition between fast ISPs in Jackson County. In and around Marianna customers can purchase fast broadband from Comcast, T-Mobile FWA, and CenturyLink Fiber. Residents living in Sneads can purchase fast broadband from Comcast or T-Mobile FWA.

Why does this matter? It is becoming clear nationwide that the majority of people and businesses want fast broadband. OpenVault reported that in December 2023, only 10% of broadband users in the country are subscribing to broadband products with speeds under 100 Mbps. Only 26% are subscribing to broadband products with speeds under 200 Mbps. At the other end of the speed scale, 33% of homes nationwide are now subscribed to gigabit broadband. This represents a huge shift from as recently as June 2021, when 20% of broadband users were buying speeds under 100 Mbps and 68% of homes were buying speeds under 200 Mbps. In June 2021, less than 11% of homes were buying gigabit broadband.

This represents a huge shift in broadband demand. A lot of the shift at the 200 Mbps speed comes because cable companies have been upgrading their basic broadband to speeds of 200 – 300 Mbps. But the shift to buy gigabit broadband mostly comes from the public's desire for faster speeds. Interestingly, the vast

majority of customers buying gigabit broadband are paying a premium price, so getting faster speeds is viewed as worth the extra price.

This study includes a residential broadband survey. One of the clear messages from that survey is that people in the county want more broadband choices. 51% of the respondents to the telephone survey said they would definitely buy broadband from a new network. Another 19% said they would probably buy, and 19% said they might buy. Significantly, more than half of the respondents to the survey clearly want to have a choice of ISPs.

The bottom line is there are very few places in the county where there are two or more ISPs offering speeds faster than 100 Mbps. This means that almost the entire county has little or no real competition.

There are ISPs that will dispute this fact and say that most folks have multiple choices of ISPs. This is backed up by the FCC broadband maps. If you look at most homes and businesses in the FCC maps, there are multiple ISPs that claim to be able to serve every address. But when you look harder at the details, you'll see that most broadband options other than cable or fiber broadband can't deliver the fast speeds that most of your residents and businesses are looking for. The other providers at most homes will use the following technologies:

- There are likely two high-orbit satellite providers listed as an option for most homes and businesses. Most people who have tried the broadband from Viasat and HughesNet find that the latency in the signal from a satellite that is 22,000 miles above Earth means that it's hard to do real-time functions like stream live video, maintain a Zoom call, or connect to a work or school server. Speed tests for these companies are also consistently under 100 Mbps. Finally, the fees for these companies are higher than the fees for landline broadband.
- Starlink will be listed as a broadband option. The speeds on Starlink have dropped steadily over the last year, and the average speed tests we see for the company in most places is between 50 Mbps and 70 Mbps. The pricing for Starlink starts at $120 per month, which is higher than landline broadband. The company still has a long waiting list in many places and can't connect too many people in a given neighborhood.
- There is one WISP in the county using fixed wireless broadband. Point Broadband claims speeds of 30 Mbps. Even if the technology gets faster, fixed wireless technology is mostly a rural technology and won't be bringing faster speeds to the towns and cities.

To be fair, not every resident in the county wants or needs fast broadband. There are households who are not interested in broadband. There are households that are light broadband users. There are also households that will accept slower broadband to get a lower price. A recent nationwide survey[13] released by *U.S. News and World Report* shows that 85% of households use the Internet every day, and 31% of households say that they are online constantly. Most regular broadband users want fast speeds if available and if they can afford it.

Why Choice is Important

There are real consequences of having only one fast ISP for most of the county. Neighborhoods and cities with only one choice of fast ISPs have no real competitive options, and the one fast ISP is effectively a

[13] https://www.usnews.com/360-reviews/services/internet-providers/internet-cost-speed-value-survey

broadband monopoly in that community. There are clearly documented consequences of being served by ISPs that have a virtual monopoly.

Broadband competition between ISPs of equal capabilities brings tangible and well-known benefits to a community. These benefits don't occur when the one fast ISP is competing against slower technologies like DSL. CCG Consulting has seen the following benefits for communities that get real competition between two or more ISPs that offer gigabit speeds:

- Lower Prices. For many years, the conventional wisdom was that competition lowers prices by at least 15%. That was based on several detailed studies done in the early days of fiber overbuilders. While the 15% savings is no longer a valid metric that can be used everywhere, it's rare when competition doesn't bring lower prices. Cable companies react to competition by offering low-price special promotions.
- Improved Customer Service. When a new competitor moves into an area that was previously a monopoly, it's almost inevitable that the former monopoly will step up its game. Calls to customer service get answered more quickly, technicians start showing up at the times that were promised, and repairs are made more quickly.
- Technology Upgrades. When fiber overbuilders started to build networks to compete against cable companies, the big cable companies put a lot of pressure on CableLabs, the research arm of the collective cable companies. When Google Fiber introduced gigabit speeds, most cable company networks had speeds that topped out at 250 Mbps download, and the most common broadband product sold delivered 60 Mbps. CableLabs accelerated the introduction of DOCSIS 3.1, and cable companies upgraded competitive markets as quickly as they could to offer gigabit download speeds. When the pandemic struck and suddenly created an upload bandwidth crisis, the cable companies put the same pressure on CableLabs to increase upload speeds. The ultimate upgrade will be DOCSIS 4.0, which is probably still a few years away from being market-ready. In the interim, CableLabs came out with a reasonable-cost upgrade to upload speeds using mis-split technologies. This increases upload speeds to the range of 100 - 200 Mbps, and the big cable companies are currently installing the upgrade in competitive markets.

  These two technology upgrades were implemented much sooner than would have happened without the rapid expansion of fiber. For example, most cable markets had been upgraded to gigabit speeds within a year or two before the start of the pandemic. At that time, big cable companies universally said they thought they wouldn't be making any more upgrades for at least a decade. But then the pandemic and the explosion of fiber construction happened, and cable companies are almost universally upgrading upload speeds and have plans for more upgrades when DOCSIS 4.0 becomes available. But these upgrades don't happen everywhere. The big cable companies don't necessarily make upgrades in smaller cities like rural county seats unless there is an active fiber overbuilder. CCG has run across some rural markets of Comcast and Charter that still haven't been upgraded to gigabit speeds. Competition pushes innovation and upgrades.

What Can the County Do to Promote Competition?

The only way to increase competition is to get ISPs to build competing networks in places where there is only one ISP today. This can take a lot of effort, but we see communities all over the country that are attracting competition. Following are a few ideas of how the County might help increase competition.

Work With Cities to Attract Fiber Overbuilders. Another approach is to work with cities in the county to help them look for a fiber overbuilder. This feasibility study concentrated on the unserved and underserved parts of the county. Cities can consider a similar process to gather the facts needed to attract a fiber overbuilder. It's not mandatory for a city to undertake a full feasibility study, but some might want to get an in-depth understanding of the broadband in the city before tackling a search for an ISP partner.

Even without a feasibility study, a city will need to ask and answer a lot of questions before undertaking a search for a new ISP:

- How much do the residents care about broadband, and do a lot of them want a competitive option? This probably means a survey at the city level.
- What's the approximate cost to build a fiber network in the city? Are there factors in a city that might contribute to a new network costing more than average? This might mean existing utility poles that are not adequate or factors that make burying fiber more expensive than normal, such as a lot of rock under streets and sidewalks. This requires some engineering analysis and advice.
- Are there local policies that are barriers or that increase the cost of building fiber? This means looking at things like the permitting process, construction inspection processes, rights-of-way, or franchise fees.
- Is the city willing to contribute towards the cost of a network? Is a city willing to excuse any of the normal fees associated with building a new network? Are there benefits a city might offer, such as being an anchor tenant on a network, providing land or building space, etc.?

If a city decides it wants to undertake finding an ISP, there are several processes that can be used for the search. The most common approach is to issue an RFI or RFP looking for an ISP partner – but there are other ways. That process is described later in this report.

Provide Infrastructure to Make it More Attractive to Build Last-Mile Fiber. One way to lure ISPs to build last-mile fiber is by providing low-cost connections through middle-mile fiber to reach neighborhoods that are lacking competition.

This idea is not always successful. Having middle-mile access to reach neighborhoods and towns with fiber is one of many factors that ISPs consider when looking at expanding their network. Middle-mile is considered to be the most useful if it helps to reach out-of-the-way towns and neighborhoods that don't have existing fiber paths to reach the Internet.

This is not to say that middle-mile fiber in the county might not bring last-mile benefits, but one of the first things to do before considering building fiber would be to see if existing ISPs find this to be of interest.

There are other reasons to consider middle-mile fiber. A lot of counties have built fiber networks that are used to satisfy local government purposes. A middle-mile network might be built to connect to County facilities, to connect to the government hub in each city, and to be built near important anchor institutions like schools, hospitals, 911 centers, public safety networks, etc.

There can be big advantages to having a private network for the County and cities:

- Savings. There can be significant savings from what is being spent with existing ISPs for broadband when connections are moved to a private network. As an example, rather than buying

individual broadband connections to each County facility, you could buy one large broadband connection and distribute it yourself to each location. The ultimate savings come if the County can act as its own ISP and not have to pay outsiders for broadband. Many communities have made the transition and say that the savings repaid the cost of the network in ten years or less.

- Redundancy. Increasing community redundancy, in this case, means having a second broadband connection so that the County and key facilities don't lose broadband if there are network outages. In one of the most dramatic examples of this concept, several counties in Colorado joined together to build a middle-mile network because the communities had suffered through several multi-day broadband outages when the regional CenturyLink network went down. Just a few days after the first legs of the new network were activated, CenturyLink had another major outage, but the hospital and the 911 center in Aspen did not lose connectivity because they were the first places connected to the new redundant network. Since that early start, a dozen communities have moved mission-critical facilities to the new fiber network.
- Consolidation of Duplicative Networks. If designed right, a countywide middle-mile network could incorporate and supplement existing networks used for roads and traffic, schools, public safety, etc.
- Large Bandwidth. One of the advantages of having a County-owned fiber network is that it can provide large bandwidth to your County facilities at little extra cost. A decade ago, CCG Consulting helped Anoka County, Minnesota establish a middle-mile network. This was one of the first local networks to provide 10-gigabit connections to schools and government buildings. A network built today would probably be designed to provide 100-gigabit broadband.
- Collaboration. One of the biggest benefits of larger-scale government networks is not just the broadband-related benefits but the mindset changes that can come when local governments start sharing a common network. For example, every city operates a lot of different software systems to provide government services, and there can be huge savings for buying and operating these systems for multiple cities. We've also seen counties able to lower the cost of IT functions by consolidating this so that each local government doesn't have to cover its own costs. In today's world of having to protect against malware – an approach for the whole county is a lot more cost-effective and safer than each city seeking its own solution.
- Benefit for Related Entities. A countywide network doesn't have to only benefit government entities.
    - ISPs. The earlier discussion started with the idea that middle-mile fiber might encourage more last-mile fiber construction. We've seen communities where small ISPs tackle tiny pockets of homes, only a few hundred – something that could be made possible with affordable middle-mile connections.
    - Non-profits. Many local governments extend government-owned networks to benefit the non-profit community.
    - Economic Development. Having your own network could bring in the option of offering free or low-cost fiber connections for companies bringing new factories or other large employment opportunities.
- Wholesale Revenue Opportunity. There are carriers and others that will be interested in leasing the use of a middle-mile network. This might include cellular carriers, existing ISPs looking for redundancy, state and federal agencies, large corporations, and nationwide fiber network providers. Over time, you'd be able to sell capacity on the network to such entities.

The Computer Gap

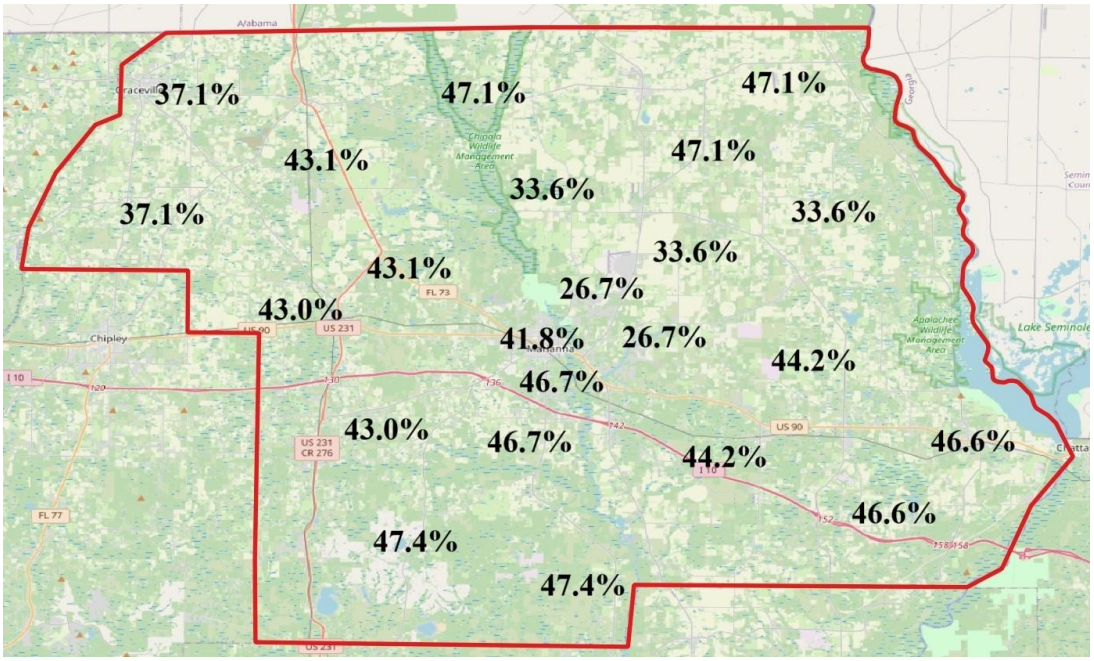
Digital inclusion advocates have learned it is often not enough to get affordable broadband to a home that can't afford a computer or other device to use the broadband. It's also now clear that cell phones are good tools for things like shopping online, but they are inadequate for students trying to do homework. Any plan to close the digital divide must find solutions for closing the computer gap.

A survey by the Pew Research Center in 2021 shows a huge disparity between income and technology adoption. Consider the following results of that poll:

	Less than $30,000	$30,000 to $100,000	Over $100,000
Home Broadband	57%	83%	93%
Smartphone	76%	87%	97%
Desktop	59%	84%	92%
Tablet	41%	53%	68%
All the Above	23%	42%	63%

Other studies have shown that the percentage of homes that possess any of these technology tools is even smaller than shown in the table for homes making under $25,000 per year. A big issue for low-income homes is that they can't afford both broadband and the cost of buying and maintaining a computer or similar device. Computers are some of the shortest-lived electronics we can buy and typically must be replaced every three or four years.

We created the following map to show the different levels of computer ownership around the county. This map comes from the U.S. Census and shows the percentage of homes that don't have a home computer in various parts of the county. The percentage of homes without computers varies from 26.7% to 47.4% in various parts of the area.



It is a challenge to bring broadband to a home that doesn't have a computer - a solution is needed to bring both. As will be discussed below, many homes also need computer training.

The historical solution to a lack of computers was to put computers in libraries and public places. However, in rural communities, this solution is inadequate for many reasons. First, it requires people to travel to where the computers are. In communities where a lot of students don't have computers, it's difficult to have enough computers to meet the demand. There is the additional issue that rural libraries often don't have good enough broadband to support multiple simultaneous users.

However, the best reason to get computers into homes instead of libraries is that numerous studies have shown that computers in the home have a huge positive impact on students compared to any other alternative. Computers have the biggest positive impact on students when they are a part of daily life and convenient to use when needed.

We can't forget that computers aren't only for students. Adults need computers to participate in the modern world. Computers are needed to hunt for a job. Computers are needed to pursue online training and education. Computers are needed to consider jobs that allow working from home. Computers are needed today to interface with many government programs.

The Gap in Broadband Skills

The current U.S. job market is robust due to the low unemployment rate, which is low by historical standards. However, a closer look at the statistics tells a different story.

Over half of all job openings in the country are classified as middle-skill jobs (with the three categories being high-skilled jobs, middle-skill jobs, and unskilled jobs). Middle-skill jobs generally don't require a college degree. An analysis by the Benton Foundation a few years ago showed that over 80% of middle-skill jobs require some degree of digital literacy. Unfortunately, a lot of people seeking middle-skill jobs lack the digital skills needed to land these jobs.

This lack of sufficient digital literacy to find middle-skill jobs is perhaps the best way to describe the broadband skills gap. These are not jobs that need coders but want employees to know basic computer skills like knowing how to use Microsoft Word or Excel. It means being able to type fast enough to do data entry, write emails, or do other expected tasks in the average workplace.

At the turn of this century, there were computer training courses available in most communities that taught basic computer skills. Today it is assumed that students graduate from high school with these skills. However, a student who has never had a home broadband connection or a computer and who only did homework on a cellphone probably doesn't have the needed digital skills. But over time, the number and quality of digital skills training classes have dropped almost everywhere.

There is now hope for solving the computer gap and the digital skills gap. There are now significant state and federal grants aimed at closing these gaps by providing computers for homes and the training to use them. These grants will be discussed in more detail in the report that discusses grant opportunities.

Future Broadband Gaps

This gap analysis above discussed existing broadband gaps. It's important to realize that there will be new broadband gaps coming in the future that we can already predict. One of the issues to consider when looking forward is that the need for good bandwidth is a moving target since the demand for residential and business bandwidth grows every year. This is not a new phenomenon, and the need for bandwidth has been growing at the same rate since the early 1980s. Home and business requirements for bandwidth have been doubling every three to four years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over just a few years, households needed more speed, and a 1 Mbps connections started to feel too slow; ISPs introduced faster generations of DSL and cable modems that delivered speeds like 6 Mbps, 10 Mbps, and 15 Mbps. Cable modem speeds continued to grow in capacity and eventually surpassed DSL, and in most cities, cable companies have captured the lion's share of the market by offering gigabit speeds.

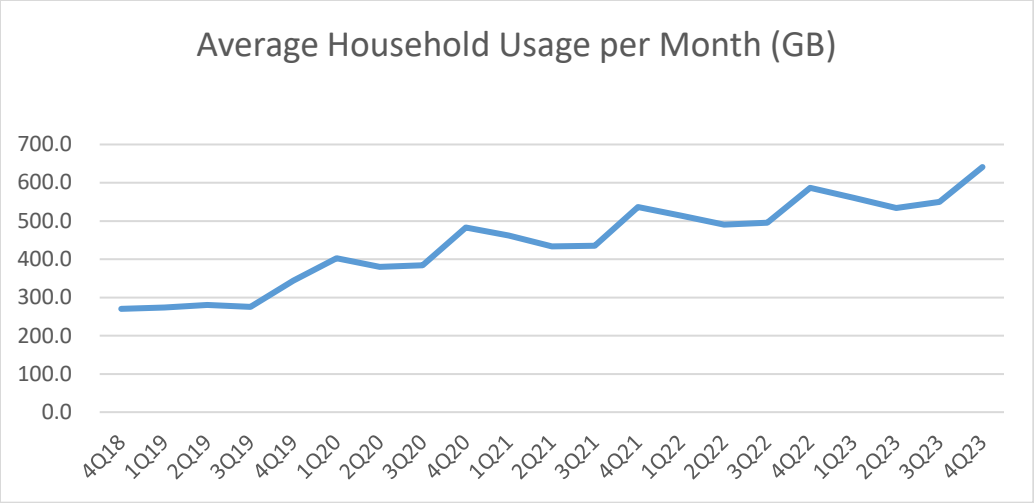
Bandwidth requirements are continuing to grow. Firms like Cisco and Opensignal track speeds achieved by large numbers of households by examining Internet traffic that passes through the major Internet hubs. Both companies estimate that home Internet demand for broadband speeds has historically been growing at about 21% annually. Business requirements for broadband speeds have been growing at 23% annually.

Broadband is not only measured by speed, and there are firms that track the volume of data that households and businesses use. The firm OpenVault measures total usage by households using software deployed by the biggest ISPs around the country and around the world. Consider the following statistics that show the average nationwide broadband usage by homes. These numbers combine download and upload usage.

1st Quarter 2018	215 Gigabytes
4th Quarter 2018	270 Gigabytes
4th Quarter 2019	344 Gigabytes
4th Quarter 2020	483 Gigabytes
4th Quarter 2021	536 Gigabytes
4th Quarter 2022	587 Gigabytes
4th Quarter 2023	641 Gigabytes

This data shows several things. First, it shows extraordinary growth in the average use of home broadband usage across the country. Even before the pandemic, broadband usage was growing rapidly. For example, there was a 27% increase from the end of 2018 until the end of 2019. Usage skyrocketed during the pandemic, and in 2020, broadband usage grew by 40%. In 2023, growth slowed to 9%.

The following chart shows the same data, by quarter, since 2019. As can be seen, the overall trend for home broadband has always been upward. The amount of usage measured at the end of quarters varies due to explainable factors. For example, at the end of June, most students are out of school, and broadband usage is less than during the school year.



OpenVault recently began reporting upload and download usage separately. The table below shows the download and upload data usage from December 2020 to September 2023. The table below shows that data usage (in gigabytes) fluctuates from quarter to quarter and spikes during the 4th quarter.

Average Monthly Household Usage in Gigabytes

	4Q20	4Q21	1Q22	2Q22	3Q22	4Q22	1Q23	2Q23	3Q23	4Q23
Download	483	504	481	460	464	551	525	504	514	601
Upload	31	32	33	31	32	35	36	36	36	40

One of the most startling numbers to come from OpenVault is what they call power users – homes that use more than one terabyte of data per month (1,000 gigabytes). Consider the following statistics showing the percentage of homes that use a terabyte or more of data per month:

4th Quarter 2018	4.0%
4th Quarter 2019	7.2%
4th Quarter 2020	14.1%
4th Quarter 2021	16.1%
4th Quarter 2023	21.6%

Within these numbers are also what OpenVault calls extreme power users, which are households that use more than two terabytes of data per month. That's grown from 0.3% of households in 2019 to 2.1% in the first quarter of 2022. In the fourth quarter of 2023, the percentage of households using two terabytes of data grew to 4.7%.

The most interesting recent statistic is the migration of customers to faster broadband tiers. The following table shows the percentage of nationwide households subscribed to various broadband speed plans in 2021 through 2023.

	June 2021	June 2022	June 2023
Under 50 Mbps	10.5%	5.7%	5.7%
50 - 99 Mbps	9.6%	8.5%	4.6%
100 - 199 Mbps	47.5%	10.1%	15.6%
200 - 499 Mbps	17.2%	55.4%	36.2%
500 - 999 Mbps	4.7%	6.0%	6.2%
1 Gbps	10.5%	14.2%	31.6%

Between June 2020 and June 2023, the number of households subscribed to gigabit broadband has doubled, while the number subscribed to slower speeds is dropping precipitously. Many millions of homes have upgraded to faster broadband plans.

OpenVault provides some clues as to why homes are upgrading to faster broadband. Consider the following table that shows the percentage of households using different amounts of total monthly broadband.

	June 2018	June 2019	June 2020	June 2021
Less than 100 GB	51.6%	42.7%	34.2%	29.5%
100 - 499 GB	37.7%	39.5%	37.6%	38.6%
500 - 999 GB	8.9%	13.7%	19.4%	21.1%
1 -2 TB	1.7%	3.7%	7.8%	9.3%
Greater than 2 TB	0.1%	0.4%	1.0%	1.5%

The percentage of homes using less than 100 gigabytes per month has dropped by roughly 43% over four years. At the same time, the number of homes using more than a terabyte of data per month has grown by 447% over four years. While there may be no direct correlation between having a faster broadband plan and using more broadband, total broadband usage is one of the factors leading residential customers to upgrade. Another key factor pushing upgrades is customers looking for faster upload speeds to support work and school from home.

The OpenVault data also validates what's been reported widely by ISPs – that the pattern of broadband usage is changing by the time of day. For the last decade, the peak period for broadband usage – the busy hour – was always in the evenings. During the pandemic, the volume of usage in the evenings remained flat while students and home workers increased broadband usage during the daytime.

OpenVault says that nationwide broadband usage peaked in the third week of March 2020. It will be interesting going forward to see how home usage changes. OpenVault doesn't have any better crystal ball than the rest of us, but they are predicting that broadband usage will never return to historical patterns. They predict that a lot of people will continue to work from home, meaning increased broadband demand during the day. They believe there will be continued pressure on the upload data paths. A lot of people now routinely use video calling, a practice that is likely to continue into the future. Companies and employees who realize they can be productive at home are likely to work more from home, even if only on a part-time basis.

These various statistics are a clear indication that the FCC should periodically increase the definition of broadband. The agency looked at broadband speeds in a docket in 2018 and 2020 and decided to keep the definition at 25/3 Mbps. However, there were a lot of compelling filings in that docket that argued that the definition of broadband should be 50 Mbps to 100 Mbps. In 2023, Jessica Rosenworcel, the FCC Chairperson, suggested to the rest of the FCC that the time has come to raise the definition of broadband to 100/20 Mbps.

The point of this section of the report is that we can't get hung up on the FCC's definition of broadband when looking at the broadband gap. Most people who use broadband would acknowledge that they download and upload a lot more data today than they did just a few years ago.

It's also important to look toward the future when considering broadband needs. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband requirements a decade from now. Consider the following chart that predicts broadband needs moving forward. The chart applies the 21% historical annual growth rate for broadband speed, assuming that 100 Mbps is the right definition of broadband in 2024. Forward-looking predictions are often criticized for being too aggressive, but when considering that the demand for broadband speeds has been growing at the same rate since the early 1980s, it is not a big stretch to predict broadband needs into the future.

Download Speeds in Megabits / Second

2024	2025	2026	2027	2028	2029	2030	2031
100	121	146	177	214	259	314	380

The download speeds in this table grow really large if extended even further into the future. If the demand for broadband download speed continues to grow at 21% annually, then the need in 2040 would be 2.9 Gbps. It's easy to say that such future speeds are not possible, but recall that just 20 years ago, a 1 Mbps DSL connection was considered to be blazingly fast broadband. The only current technologies that can keep up with this growth in demand are fiber and cable company coaxial networks. There is already fiber gear today that can deliver 10 Gbps download speeds, and coaxial networks are expected to have the same capabilities within five or six years.

For a cable company to meet future speed demands will require several major technology upgrades. DOCSIS 3.1 networks can deliver download speeds up to a gigabit today. However, the secret that cable companies don't want to talk about is that they can't give that much speed to everybody unless they build a lot more fiber and further reduce node sizes. There will mean upgrades to DOCSIS 4.0 to get speeds faster than 1 gigabit. Cable companies are already failing to meet the demand for upload speeds.

It's not hard to put this prediction into perspective. The large cable companies serve around 65% of all broadband customers in the country, and almost all now advertise a minimum speed of 200 Mbps or 300 Mbps. The marketing departments at cable companies have regularly been keeping ahead of the demand curve to keep customers happy.

It's not hard to imagine that seven years from now, the national definition of broadband ought to be around 400 Mbps. That doesn't mean that the FCC will continue to increase the regulatory definition. There is a political downside when the FCC increases the definition of broadband – it reclassifies millions of homes as not having broadband. Today, the 25/3 Mbps definition of broadband is ludicrously lower than the

speeds that households want to buy – but politics is always likely to keep a lower regulatory definition than what the market demands.

One of the conclusions that can be reached by this analysis is that any new network built today ought to be capable of meeting the expected broadband speeds for the next decade. The only technologies capable of meeting the projected future needs for download bandwidth are fiber-to-the-premise and cable company hybrid-fiber technology. Cable companies are only going to be able to provide speeds above 1 gigabit by implementing another round of expensive upgrades. There is a lot of speculation in the industry that cable companies will upgrade to fiber-to-the-home rather than make another expensive upgrade on old copper.

E. Benefits of Broadband

This section examines the overall benefits to a community of having good broadband.

Improved Education

Schools today want to be able to assign computer-based homework but can't when many students don't have good home broadband. An increasingly common practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from watching videos in class. The whole education process is increasingly moving to the web, and kids without access to the web lack the tools that their peers take for granted.

It's getting exceedingly hard to raise kids in a home without adequate broadband. The issue is not just data speeds but also the total amount of downloaded data that even elementary school students need to do homework. This is one of the major problems with satellite broadband, which has speeds up to 50 Mbps, but with tiny data caps and high latency, the satellite broadband is often inadequate for doing homework. The same is true with cellular hotspots, and we've heard horror stories of homes with kids with astronomical broadband bills for using broadband hotspots for homework.

The pandemic showed how hard it could be to connect to a school or the office from home. A connection between a student and a school is typically activated through the creation of a VPN (virtual private network). This is a dedicated bandwidth connection that is carved out of the Internet path – like the path that is created for a student or adult working at home. The connection remains open for as long as the connection to the school WAN is open. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. All broadband technologies other than fiber have much less capacity to tie up upload streams.

There are characteristics other than broadband speeds that matter. Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. Doing schoolwork from home also means using a significant amount of bandwidth during a month, and that raises the issue of data caps and overage charges.

Education is not only for K-12. Adults are using broadband to train for new job skills or to take advanced courses online. There is a huge range of undergraduate and advanced degrees that are offered mostly online. Online training courses require decent broadband speeds but also low latency when the training is done in real time.

The U.S. Bureau of Labor Statistics reported in 2021 that the average American baby boomer held 12.3 different jobs between the ages of 18 and 52. It's much harder to measure a change in careers, meaning a change to doing something drastically different than prior jobs, but researchers have looked at the data and said that most people change careers at least several times during their work life. The above statistics don't tell the whole story because many people are now working well past 65 years of age, including many older workers starting a new career.

Many new jobs and careers today require online training. New employees are often expected to complete online training courses at the start of a new job. Many out-of-work adults pursue online training to learn a new career. Anecdotal evidence suggests that taking training or educational courses from a distance (across the country) requires more bandwidth since it's harder to hold a VPN session when the bandwidth varies.

The biggest group of online learners (outside of the COVID-19 crisis) are students pursuing a post-secondary education online. There are almost 20 million college and graduate students across the country, many of whom routinely have a part of a college curriculum online, even if they attend live classes. Secondary education had already been in the process of migrating online before the pandemic. Eduventures estimates that the percentage of students already tackling an online degree before the pandemic was 29% of those pursuing an associate degree, 42% for a bachelor's degree, 27% for a master's degree, and 3% of those working towards a doctorate. The National Center for Education Statistics (NCES), an agency within the U.S. Department of Education, says that over 60% of students pursuing a bachelor's degree now take some of the coursework online, as do about 55% of graduate students.

There was another major study performed by NCES to look at what is being called the homework gap,[14] That study compared test scores for 8th-grade students both with and without a home computer. The results showed:

- On tests of reading comprehension, students who have a computer at home had an average score of 268 compared to a score of 247 for students without a computer.
- In testing for mathematics, students with a computer at home scored 285, while those without it scored 262.
- In testing science, students with a computer scored 156 compared to 136 for students without a computer.
- In testing competency in information and communication technology, students with a home computer scored 152, compared to 128 for students without a home computer.

There was another major definitive study that quantified the impact of the homework gap. The study was released in March 2020 and was done by the Quello Center, part of the Department of Media and Information at Michigan State University.[15] This is a definite study because it used study techniques that isolated the impact of broadband from other factors such as sex, race, and family incomes. The study involved 3,258 students in Michigan in grades 8 – 11 from schools described as being in rural areas. The study was done without violating student confidentiality.

[14] https://nces.ed.gov/pubs2017/2017098/index.asp

[15] http://quello.msu.edu/wp-content/uploads/2020/03/Broadband_Gap_Quello_Report_MSU.pdf

The study showed significant performance differences for students with and without home broadband. Students with no Internet access at home tested lower on a range of metrics, including digital skills, homework completion, and grade point average. Some of the specific findings include

- Students with home Internet access had an overall grade point average of 3.18, while students with no Internet access at home had a GPA of 2.81.
- During the study, 64% of students with no home Internet access sometimes left homework undone, compared to only 17% of students with a high-speed connection at home.
- Students without home Internet access spend an average of 30 minutes longer doing homework each evening.
- The study showed that students with no Internet at home often had no alternative access to broadband, such as a library. 35% of students with no broadband also didn't have a computer at home. 34% of students had no access to alternate sources of broadband, such as a library, church, community center, or the home of a neighbor or relative.

One of the most important findings was that there is a huge gap in digital skills for students without home broadband. To quote the study, "*The gap in digital skills between students with no home access or cell phone only and those with fast or slow home Internet access is equivalent to the gap in digital skills between 8th and 11th grade students*." Digital skills not only require competence in working with technology but also means the ability to work efficiently, communicate effectively with others, and manage and evaluate information. This is a devastating finding that students without home broadband fall three grades behind other students in terms of developing digital skills.

Lower digital skills correlate directly to performance on standardized tests. A student who is even modestly below average in digital skills (one standard deviation below the mean) tends to rank seven percentiles lower on the total SAT/PSAT score, five percentiles lower in math, and eight percentiles lower in evidence-based reading and writing.

The study also showed lower expectations for students without broadband at home. For example, 65% of students with fast home broadband have plans to pursue post-secondary education. Only 47% of students with no Internet access have such plans. Students with even moderately lower digital skills are 19% less likely to consider a STEM-related career (science, technology, engineering, and math).

Another survey[16] released by the Pew Research Center looked at the problems uncovered when we sent kids home to learn. 93% of parents in the survey said that K-12 children received some online learning during the pandemic. That alone is big news because it means that 7% of students didn't partake in any online learning.

30% of the parents that assisted students with online learning said that it was somewhat or very difficult to use the technology needed to take classes from home. The households that struggled varied by demographic. Low-income homes were twice as prone to struggle with technology, with 36% of low-income homes reporting the problem. Rural areas (39%) had more problems with technology and the Internet than other groups like urban (33%) and suburban (18%). But even one in five suburban kids – areas that likely have the best broadband – struggled with technology and the Internet.

[16] https://www.pewresearch.org/fact-tank/2021/10/01/what-we-know-about-online-learning-and-the-homework-gap-amid-the-pandemic/

About one-third of parents said that children experienced technology issues that were obstacles in completing schoolwork. 27% of parents said students struggled to do homework on cell phones. 16% said students did not have access to computers. 14% said that kids left home to use public WiFi to complete schoolwork and homework. 46% of low-income homes had the biggest technological obstacles compared to 31% of homes with mid-range incomes and 18% of homes with higher incomes.

Black teens were the most heavily disadvantaged during the pandemic. 13% of Black students said they were regularly unable to complete homework due to technical issues compared to 4% for white teens and 6% for Hispanic teens.

Household incomes affected the ability to complete schoolwork. 24% of teens from households making less than $30,000 annually said that the lack of a dependable computer or internet connection sometimes hindered them from completing schoolwork, compared to 9% of students living in homes making more than $75,000 annually.

Impact on Housing

Numerous studies show that homes without broadband are worth less than similarly placed homes with broadband. Realtors have been reporting across the country that broadband is at or near the top of the wish list for most homebuyers today. There are common news stories about people who buy a rural home and are shocked to find that broadband is not available.

CCG Consulting has interviewed hundreds of real estate agents who work in rural areas, and we have been told how difficult it is to convince people to move to rural places that don't have good broadband. Without a broadband solution, the rural parts of the county will become less desirable place over time.

Improved Medical Care

Telemedicine is becoming a routine part of healthcare. Telemedicine requires both a solid upstream and downstream connection and often requires more bandwidth than a connection to a school or office. In the past two years, telemedicine visits have skyrocketed. During March and April of 2021, the billings for telemedicine were almost $4 billion, compared to only $60 million for the same months just before the pandemic. By all industry accounts, the high level of telemedicine visits has continued as the pandemic ebbed.

The biggest benefit of telemedicine is being able to talk to a specialist without having to make a long trip to some distant city. Another common use of telemedicine is for non-intrusive assistance for things like counseling. Patients can make scheduled appointments without major disruption to work schedules.

A growing area of telemedicine is the use of medical telemetry devices, which can monitor patients after they've had medical procedures. For example, Saint Vincent Health System in Erie, Pennsylvania, has been using these technologies and has lowered the readmission rates of patients after surgery by 44%. CoBank sponsored a trial in Georgia a few years ago for rural diabetes patients that showed a significant improvement for patients who could be monitored daily and who could communicate easily with doctors.

Amazon invested $3.9 billion in 2023 to buy a healthcare company that concentrates on telemedicine. The company says that it's time to shake up the medical industry as a way to lower costs.

According to a report released by McKinsey & Company[17], we are on the verge of seeing a major shift toward health care performed in the home. The report says that as much as $265 billion in annual fees to Medicare and Medicare Advantage could shift to homes by 2025. This is significant because telemedicine and patient monitoring are a big part of home health care.

The report cites several changes in the healthcare industry that are contributing to the trend for more in-home healthcare:

- 40% of patients who have used telemedicine say they expect to keep using it in the future. It's a big burden on working families to try to get to a doctor's office during the workday, and telemedicine makes it easier for many families to seek health care.
- There are new technologies that make it easier to deal with remote patients. As an example, 20% of all medical practices in April 2021 were using devices that allow for electronic patient monitoring.
- There has been a huge investment made in the digital healthcare market. Venture capital for startup digital healthcare companies was $29.1 billion in 2021, up from $14.9 billion in 2020 and $8.2 billion in 2019. This has slowed a bit but is still significant, with $6.1 billion invested in digital health in the first six months of 2023.

Working at Home

A lot of jobs can be done at home today, even if only part-time. But people without adequate home broadband can't participate in this part of the economy. Increasingly, companies are willing to hire people who work out of their homes. The beauty of such jobs is that they can be done from anywhere. Working from home is one of the fastest-growing parts of the national economy. After years of experiments with telecommuting, companies have seen that employees are often more productive from home due to missing the various distractions that are in the work environment.

The COVID-19 crisis highlighted the need for good home broadband when as many as 30% of the nationwide workforce was sent home to work in March 2020. Across the country, employees who live in rural areas have been unable to work from home due to inadequate broadband. Working at home requires an encrypted VPN connection for most corporate and government WANs, in the same manner as described above for connecting to school WANs. Working at home is also coming to mean connecting by video conference with others as an alternative to face-to-face meetings. This requires a dedicated 1 – 3 Mbps connection for both upload and download – again, something that is a challenge for somebody working from home with a slow Internet connection.

Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it impossible to maintain real-time connections reliably over satellite broadband.

[17] https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/from-facility-to-home-how-healthcare-could-shift-by-2025

U.S.A Today reported on the results of the fifth annual survey of the State of Remote Work[18] conducted by Owl Labs and Global Workplace Analytics in 2021. The nationwide survey was done at a time when almost one-fourth of workers continued to work at least partially from home.

The survey showed a strong desire among employees to work from home, at least part-time. Here are a few of the most interesting findings from the survey:

- A little more than half of all employees would choose to work full-time from home. 74% of those interviewed said that working at home made them happier.
- Almost half of the workers said they would take a 5% pay cut to continue to work remotely, at least part-time.
- 91% of those working at home say they are as productive or more productive than when in the office. 55% say they work more hours at home than when they are in the office.
- Almost one-fourth of employees said they would quit their jobs if they couldn't work remotely. For context, this survey was done at a time when employees were quitting jobs at historic rates.
- A lot of employees changed jobs during the pandemic. 90% of them were looking for a better career. 88% also wanted a better work-life balance. 87% were looking for less stress. 84% wanted more flexibility for where they work, and 82% wanted more flexibility for when they work.
- The ability to work from home convinced millions of people to relocate during the pandemic. Two-thirds of employees who relocated were between the ages of 26 and 40. 63% of employees who moved from urban areas to rural areas were in this age group. More than half of those that moved from suburban to rural areas were also in the younger age group.

The results from this survey are similar to other surveys taken over the last few years. It seems that many people got a taste of working from home and decided that they liked it more than going to the office every day. A lot of employers are starting to demand that workers return to the office, and many have been reporting an exodus of employees who don't wish to come back.

This has a lot of implications for rural and suburban communities. Many people want to get away from the stress of urban life and lead a more relaxing lifestyle – but they need good broadband to do so. Remote workers can't tolerate mediocre broadband and need reliable broadband that enables them to always connect. 56% of younger workers said they would love to incorporate virtual reality and virtual meetings into the workday – something that will require fast upload and download speeds.

From an economic development perspective, work-from-home employees provide a huge economic boost to rural communities that have been aging and slowly losing population over time. Employees making good salaries provide a huge boost to local economies. For years, rural communities offered big tax incentives to try to attract new employers. It costs a lot less to attract one hundred remote workers than to lure a traditional employer that will bring a hundred jobs.

Taking Part in the Modern World

Households with good bandwidth routinely use broadband for things like watching videos on services like Netflix, talking to friends and family on services like Zoom, playing video games (most which have moved online), taking online courses, or just browsing today's video-rich Internet. Many of the businesses that people routinely interact with (utilities, insurance companies, shipping companies, doctors, etc.) assume

[18] https://www.usatoday.com/story/money/2021/11/11/workplace-survey-remote-pay-cut-covid/6367601001/

that people have broadband. Many people's social lives, for better or worse, have moved to the web. It is common to have friends all over the country based upon some shared interest instead of based upon geographic proximity. Homes without broadband can't participate in the many activities and services available on the web.

Taking part in the modern world has grown to mean a lot more than just watching videos. Consider some of the following ways that a lot of households routinely use bandwidth:

- Security. Millions of homes now have video cameras at the front door or elsewhere on their property that they can view remotely. A video camera requires a 1 – 3 Mbps upload connection for low-resolution cameras and up to 16 Mbps upload for an HD-quality camera.
- Machine-to-Machine Traffic. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes use services that automatically back up files and records in the cloud. Numerous appliances and devices in our home periodically connect with the cloud, whether providing updates or making sure the connection is still live. Many cars now communicate with the cloud when they get into range of a home broadband connection to provide a log of all car sensors and to upload driving data that can later be used by the car owner.
- Online Everything. Many routine functions have moved to the web – we can't begin to make a full list of things that are now online. This includes functions like applying for a job, applying for government benefits, making insurance claims, making reservations for a restaurant, banking, and a slew of other activities. Homes without broadband are being left out of numerous activities that everybody else takes for granted. Many of these functions can be done using a cellphone, but unfortunately, many of the rural places with poor broadband also have poor cellular coverage.

Keeping Talent at Home

An issue we often hear about in rural communities is what is called the "rural brain drain." Most rural counties don't have enough good-paying jobs to keep recent graduates at home, and so a large percentage of each graduating class migrates to larger cities and towns to pursue careers. One of the promises of reliable broadband is the ability to create new jobs and to provide the opportunity for people to either work at home or to create new businesses that allow them to stay where they want to live.

Entrepreneurship.

Many communities have success stories of companies that started in a home that are now significant employers in the community. Many communities have developed business incubator sites to support and promote start-up businesses. Good home broadband is essential for a start-up ecosystem.

Economic Development

Many communities claim huge economic development benefits from building fiber. Communities often tout fiber as part of the package used to attract new businesses and industries. An example is Lafayette, Louisiana, which leveraged fiber to attract several major companies that engage in computer animation – and much of the animation and special effects for movies are now created there. One of the biggest claims

for the benefits of municipal broadband is detailed in a study by Bento J. Lobo that quantifies the benefits of fiber in Chattanooga, Tennessee, to be $2.69 billion over ten years.[19]

But economic development successes don't have to be that dramatic. The pandemic has convinced millions of people that they no longer need to live in major cities. Almost every rural community that CCG is working with has seen some influx of people looking to live in smaller and less hectic communities. A giant piece of the new economy is folks who can work from home – and many of them can work from anywhere. Traditional economic development efforts would normally be thrilled to attract a new business with a hundred high-paying jobs. The same economic benefit can be achieved by attracting the same number of highly paid workers who work outside their homes.

Ubiquitous or Expanded Public WiFi

Many communities provide some WiFi access to citizens in places like libraries, city halls, parks, or other commonly used public spaces. A community with a fast broadband network can offer WiFi in many more places. This ability comes at a time when outdoor hotspots have improved significantly, and it's a viable idea to provide wide WiFi coverage. This idea also comes with a word of caution. Many cities have been sold on the idea that they can generate enough revenue from public WiFi systems to cover the cost of the network. We have never heard of a WiFi network that was able to generate enough revenue to cover costs. We recommend looking at WiFi as an awesome public benefit but not as a profit center.

More Efficient Businesses

One of the biggest beneficiaries of fiber broadband is the business community. CCG has conducted interviews with businesses all over the country both before and after they got fiber broadband. Universally, we find that fiber allows businesses to take advantage of all of the many online tools. Many of the benefits come from better upload speeds because businesses can be far more restricted by poor upload speeds than residents. The following are some of the most important ways that businesses use broadband. Faster, low-latency broadband makes it easier to do most of the following:

- Communicating with Customers. Businesses routinely have portals that make it easy for customers to place and track orders and communicate with the business. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly passing away, and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. A business that operates a busy e-commerce ordering site needs enormous amounts of bandwidth to make sure that all customers have a successful purchasing experience.
- Communicating with Vendors. Businesses also routinely use the portals of their own vendors and suppliers to buy whatever they need to operate.
- Communicating with Other Branches of the Company. Many businesses are part of larger corporations and maintain open data connections to communicate with other parts of the company and with headquarters. It's not unusual for a business to operate a constant VPN connection back to the parent company.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, Microsoft, or a private cloud available only to employees of the business. This

[19] https://assets.epb.com/media/Lobo%20-%20Ten%20Years%20of%20Fiber%20Infrastructure%20in%20Hamilton%20County%20TN_Published.pdf

is the change in the ways that companies operate that has created the biggest growth in the need for business bandwidth. Much of the routine software that companies use now works in the cloud, meaning that employees retrieve and save documents and data constantly to and from the cloud servers. A company that relies on the cloud comes to a halt when the Internet connection isn't working. This is leading businesses to seek broadband connections from more than one ISP.

- Security Systems. Businesses often have their security monitored by offsite firms. Security today also means the use of numerous video cameras used to monitor the inside and outside of a business. Video cameras can require significant upload bandwidth.
- Sending and Receiving Large Data Files. Most businesses report that the size of data files they routinely transmit and receive has grown significantly larger over the last few years.
- VoIP. Many businesses now provide voice communications between their various branches using Voice over IP. A reliable VoIP system needs to have guaranteed dedicated bandwidth that won't vary according to other demands for bandwidth within the business.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video conferences like Zoom. We saw a huge surge in this during the pandemic as students and employees increasingly used video conferencing services, but these services had already started to become routine for businesses before the crisis.
- Collaborative Software. While many businesses still rely on email, many have gone to more advanced communications systems that let parties connect in a wide variety of ways. Businesses are using collaborative tools that let multiple employees from various locations work on documents or other materials in real time. This software requires a steady upload and download data path.
- Supporting Remote Employees. Supporting employees who work from home is a major new requirement for many businesses. Communicating with remote employees is done by creating a virtual private network (VPN) connection with each employee. For a business, this means establishing both a dedicated upload and download link for each remote employee. These connections can vary between 1 – 3 Mbps per second in both the upload and download directions.
- Data Backup. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. Common uses of sensors might be for burglar alarm systems or manufacturing equipment. A lot of office equipment like printers, copiers, postage machines, and others only function when connected to the Internet.

Smart Government

Over the years, the idea of a smart government has evolved. A decade ago, the vision was to have a city full of surveillance cameras to cut down on crime and smart traffic systems to eliminate traffic congestion. But over time, the vision has expanded. Consider some of the following smart government applications:

- Environmental Monitoring. Sensors are used to monitor air, water, and noise pollution.
- Smart Watering Systems. This means using sensors to then water public parks and lands only as needed and only with as much water as needed. This reduces labor and saves water.
- Parking Management. Smart monitors can keep track of open parking spaces to make it easier for the public to park. Smart systems can also increase revenues from parking fees. Monitors can also identify illegal parking that might block first responders.
- Smart Lighting. Smart lighting can save money by turning lights on and off as needed. Smart lighting also identifies broken or burned-out lights.

- Waste Management. Public trashcans can signal when they need to be emptied. Some communities are also considering the idea of waste pickup on demand for businesses that generate a lot of waste.
- Outdoor WiFi. Communities are providing powerful and temporary WiFi networks to support street fairs, parades, and other outdoor events.
- Smart Traffic. It turns out that smart traffic systems are a lot harder to make work than once imagined. But we are seeing cities like Pittsburgh that are using software to reduce traffic congestion during rush hour by as much as 40%. Cities are automating public transportation to be more efficient.
- Smart Law Enforcement. Video is becoming a big part of law enforcement, and having a broadband network makes this easier and more functional. Many jurisdictions have gone to a virtual arraignment where prisoners don't have to be transported from jail to court to make an appearance before a judge. With broadband everywhere, this can be expanded to work from anywhere. We know courts during the pandemic that now allow virtual witnesses. Broadband sites around the community can make it easier for police to upload files from personal cameras. For example, the community can create numerous high-bandwidth hotspots in places that are convenient for squad cars. Files can be automatically uploaded by parking near these locations. Many communities are also partnering with citizens to create surveillance networks based on Ring security cameras. Emergency 911 systems are being expanded to allow for transmitting information to first responders, like a floor plan of a building that is on fire.

Smart Water Systems

It's been estimated that as much as 50% of drinking water is lost to leaks in some cities, with even good systems losing as much as 20% of water. A smart water system starts by placing numerous sensors throughout a water network to gather information on water flow and pressure. Once engineers understand the normal water flow in a system, they can spot deviations and drops in water pressure and pinpoint new leaks. Another big improvement is to upgrade to more accurate water meters that are connected to broadband. Engineers have estimated that as many as 40% of the meters used to serve high-volume commercial customers underreport the amount of water being used and consequently underbill for water usage.

Smart Grid

The smart grid concept encompasses a number of technologies used to improve the local power grid. Most of these technologies can be improved by better broadband.

- Smart Meters. Accurately measuring electric consumption gives customers the ability to monitor and change electric consumption easily.
- Load Controls. This allows the utility to understand usage by neighborhood. It allows utilities to turn off a customer's air conditioning at times of peak usage.
- Integrating Renewable Power. The characteristics of renewable power are far different than generated power. Smart grid technology helps to seamlessly integrate solar, wind, and generated power.
- Controlling Devices. The grid operator can monitor and control transformers, reclosers, and any other field electric device. This saves on truck rolls, speeds up outage repairs, and makes the grid more efficient.
- Monitoring the Network. Electric companies have historically monitored the performance of substations to identify when neighborhoods lose power. However, a ubiquitous fiber network can

effectively pinpoint power outages to the exact homes that have lost power and can significantly speed up restoring outages.

Resiliency

Having a widespread fiber network provides an alternative source of broadband for key anchor institutions like hospitals, schools, the 911 center, and fire stations. This can also be a vital benefit to large employers. Connecting the important parts of a community to more than one ISP can help ensure that critical services don't go offline.

We have seen fiber networks stay connected when other networks fail. As an example, the municipal fiber network in Lafayette, Louisiana, was the only network that didn't go dark during Hurricane Katrina. Both the telephone and cable TV companies went dark for several days. Part of this reason is that fiber wires are smaller, lighter, and stronger than some other kinds of wires - fiber doesn't break as easily from falling limbs. But fiber also doesn't carry electricity, and the loss of electrical power is often the reason that other networks go dead.

Specific Industries

Every part of the economy has unique and specific uses for broadband. The following are two examples that we think are germane to the county. We could make a similar list for dozens of major industries, so the following are just a few examples of how various industries have adopted software and processes that require broadband.

Agriculture Goes Digital

CCG has interviewed farmers who say that they feel more like an IT professional than a farmer since modern farms have automated many functions that need broadband connectivity, including the following:

Controlling Equipment and Machinery. Almost all farm equipment used for plowing, seeding, weeding, and harvesting is now available as self-driving units. Broadband is required to direct the equipment precisely where to operate. Many farms still send along a person to make sure the equipment does what it's supposed to, but we already see farms where the equipment works autonomously. There are also many other forms of automated equipment, like corn dryers, watering systems, etc. that have been automated and can be controlled by the farmers from anywhere.

Tracking Soil Conditions. Many farms now do an annual census of soil conditions to identify the nutrients and other important aspects of each part of every field. These censuses are done using tractors or drones and can develop terabyte-sized files that must be loaded into the cloud to be analyzed by agronomists. We are getting close to having 24/7 field monitoring through sensors scattered around fields.

Monitoring Herds. Livestock farms are the most advanced in terms of automation. Dairy farmers track the status of each cow in detail in order to keep cows in top health to produce the most milk.

Tracking the Market. Farmers have gotten sophisticated and can directly sell their crops on worldwide markets, which means staying abreast of crop prices across the world market.

Supporting Farm Workers. Farmers who need seasonal labor are in competition with other farmers since there is a shortage of workers. Farmers that can provide broadband so that workers can stay in touch with their families have a better chance of finding the help they need. There are also online forums for finding workers.

Smart Factories

New factories have become highly sophisticated in terms of automation, which usually requires connections to cloud software. Some of the ways that smart factories need broadband include:

Controlling Robots. Modern factories have automated as many manufacturing processes as possible. Moving materials around the factory, assembling, packing, and shipping are automated as much as possible. The workforce in a modern factory is there to perform the functions that can't be automated and to maintain the automated equipment. Many of the instructions that control machinery come from the cloud in real-time.

Controlling Manufacturing Processes. Processes that involve the mixing of chemicals and other complex processes have been automated as much as possible. This allows for precisely following the detailed steps needed for chemical processes, which allows for the manufacture of complex drugs and other chemicals and materials that can't be done manually.

Customization of Products. Smart factories are adept at customizing products and tracking each permutation of a project from start to shipping.

Supply Chain Management. Factories are saving a lot of money by not having to warehouse raw components and materials. The goal is to have components show up at the factory only when needed. This requires a highly sophisticated ordering and shipping program.

II. ENGINEERING DESIGN AND COST

Existing Technologies

There are at least eight broadband technologies used in the study area today to deliver broadband. Each of these technologies will be explained below.

- AT&T, and Brightspeed provide DSL for broadband using copper telephone wires.
- Mediacom, Optimum, and Sparklight use Hybrid Fiber Coaxial (HFC) technology.
- Aire Internet, Rise Broadband, Total HighSpeed, Wifinity, Net Vision, Intellilink, and Wisper ISP use point-to-multipoint fixed wireless technology.
- Craw Kan Telephone , eCarthage, and GTC Broadband have built fiber in the study area.
- Some rural homes buy broadband from satellites, including the new low-orbit satellites offered by Starlink.
- We've recently started to see a new broadband product offered by cellular companies – home broadband using 5G spectrum. There are older similar products called 4G hotspots, which are still in use by will be phasing out.
- Some residents get all of their broadband from their cell phone data plan.
- Metro Ethernet is used to bring fiber directly to large businesses, schools, cell towers, etc.

The first section below looks at the existing broadband service in the study area. After that is a discussion of the issues that affect broadband performance on any technology. Next is a discussion of fiber technology, followed by a discussion of the other broadband technologies in use in the study area today. Finally, there is a discussion of the specific rate design used in the study area to determine the cost of a fiber network.

A. Existing Provider Analysis

The broadband study looks at the existing, funded, and proposed deployment of broadband across Jackson County, FL, and what it would cost to bring robust broadband solutions to the areas of the county that do not currently have access to 100 Mbps / 20 Mbps broadband, or where ISPs have committed to building broadband either with committed grant funding or private funding.

The analysis started with an in-house review of available broadband mapping data, as discussed earlier in the report. Sam Tennant of Finley Engineering performed a field review in the County in December 2023. A final competitive analysis was done using all data to determine the extent of broadband deployment. This included interviews with ISPs, the investigation into grant awards, and other analyses about broadband availability.

Our team wanted to understand the broadband available today from the incumbent providers. In addition, we wanted to understand claimed broadband deployment in enough detail to determine where to begin looking for infrastructure capable of providing broadband. Finally, we will determine if there are places in the county where we think the speeds claimed on the FCC maps are overstated.

The review examined the claimed speeds and the technology codes that ISPs reported to the June 30th, 2023, FCC National Broadband Map. We also compiled a list of technology that should have been

installed from various grant and subsidy programs, such as looking at the FCC RDOF, RUS ReConnect, E-ACAM, and Florida State Grants. Finally, we examined the detailed Ookla proprietary and publicly available speed test data that shows provider-specific and location-specific speed test data from December 2022 through December 2023.

This information was compiled to create a GIS map for the Jackson County field review. Our initial analysis contained an onsite inspection of 56 planned locations where we documented more than 99 specific locations with broadband assets. While reviewing the locations on our map, we found other broadband assets near the review points as we traversed the county.

We drove extensively through Jackson County and identified existing broadband infrastructure, like electronic sites supporting the AT&T, Brightspeed, and Charter networks. The review team also looked at local factors impacting the cost of building a new fiber network in Jackson County. One of their primary goals was to understand the ground conditions for constructing buried fiber networks in areas that will need investment to provide broadband and the conditions of the poles for ISPs that want to consider building aerial fiber.

We reached out to all ISPs operating in Jackson County, Florida to ask about existing infrastructure, expansion plans, market opportunities, and other strategic priorities. CenturyLink and Point Broadband responded to our questionnaires and also participated in an interview. Comcast responded to our questions but could not schedule a time to speak on the status of broadband in Jackson County. The following ISPs did not respond to our outreach – Charter Communications, WOW!, Consolidated Communications, AT&T, and Verizon.

Our team completed a competitive review of each ISP, where we brought together everything we had learned about each provider's networks, planned broadband investments, and whether the ability to deliver speeds greater than 100 Mbps / 20 Mbps exists.

AT&T

AT&T is primarily in the Northwest part of the county, covering Graceville, Campbelton, and the west side of Highway 231. The AT&T network is a mix of copper DSL and licensed fixed wireless. The traditional DSL copper network is a mix of buried and aerial. Customers are primarily being offered DSL with 10 Mbps download and 1 Mbps upload. The Ookla speed tests taken throughout the county suggest they have upgraded their fixed wireless in other parts of the county. There are also speeds recorded above 200 Mbps / 200 Mbps that would suggest some of their copper network has been upgraded to fiber. Some of the pictures we gathered would indicate that as well.

Buried Cable/Copper Cabinet (Tri-County Rd & Cooley Rd)

Evidence of Aerial HFC Cable/Fiber (Everett Rd & Hwy 77)

CenturyLink

CenturyLink is the incumbent telephone company in most of the county. The company has a copper network that has reported speeds to the FCC that range from 0 Mbps download to 100 Mbps download and 10 Mbps upload. In small sections in a few towns the company has upgraded a few locations to symmetrical gigabit fiber. Our team was unable to ascertain any expansion plans on the near horizon. Still, based on surrounding areas, they have been upgrading their copper systems to fiber nationwide, depending on priority.

In the interview, CenturyLink indicated that their network was mostly bonded DSL with speeds 10/1, 40/3, and some pockets of 100+ Mbps. They mentioned that they had been slowly upgrading their legacy copper to fiber, prioritizing dense enterprise-driven neighborhoods and educational institutions.

CenturyLink is not interested in deploying new aerial assets and has no pending expansion plans in Jackson County. The company encouraged the County to become more flexible on permitting and shared conduit requiring professional engineering certifications.

Regarding funding programs in Florida – they have been an RDOF receipt in the State of Florida and hold this commitment as paramount, with some experience in the CPF program in Florida and the small broadband opportunity program in Florida – they mentioned they will keep an eye on reoccurring or new State funding opportunities to make their bottom line feasible and will always consider proposals in the form of public-private partnerships in the area.

Buried Copper (City of Alford)

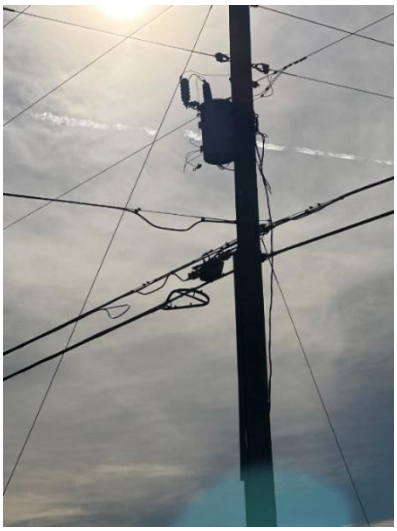
Evidence of Aerial Fiber (City of Sneads)

CenturyLink Central Office (City of Malone)

Charter Communications

The Charter Communications (Spectrum) network serves residents and businesses using a hybrid fiber-coax system. Charter indicated that it serves in only a small sliver of the county but is interested in expanding with help from county, state, or federal funding. Charter currently serves a slight stretch in the Northwest corner of the county, starting in Graceville and going south down Hwy 77. Our review of their system and customer speeds shows that they are reaching well above the 100 / 20 Mbps threshold, with speeds up to 1 gigabit download and around 35 Mbps upload.

Aerial Fiber (Hwy 77 & Tri-County Rd.)



Spare Fiber indicating expansion (Hwy 77 & Tri-County Rd.)

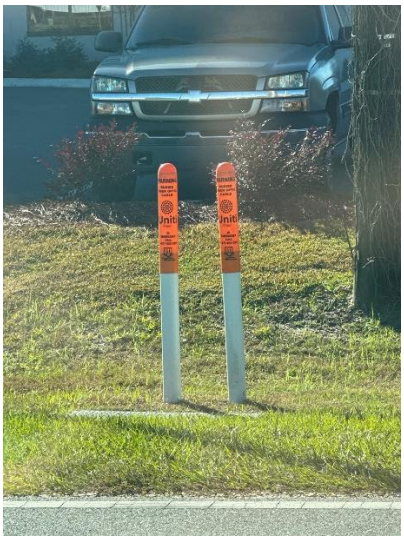
Consolidated Communications

Consolidated Communications is a copper-based telephone company serving in the southeast portion of the county, covering only a tiny portion of the cities Rock Creek, Sink Creek, and Alliance. They have a small footprint that still uses a legacy copper network which is capable of speeds of 10/1 Mbps.

Spare Fiber indicating expansion (Hwy 77 & Tri-County Rd.)

Southern Light

The Uniti Group recently acquired the assets of fiber provider Southern Light. In our drive through the county, we noticed Uniti, FL DOT, and Southern Light Fiber pedestals in most areas. DOT is working with the company to provide middle mile fiber throughout the county. There may be an opportunity to collaborate. The former GM of Southern Light, Andy Newton, has continued to a C-level position at Uniti Group through the acquisition. He would be a good point of contact for a public-private partnership opportunity, as he is familiar with his pre-existing plant.



Point Broadband Fiber Holdings

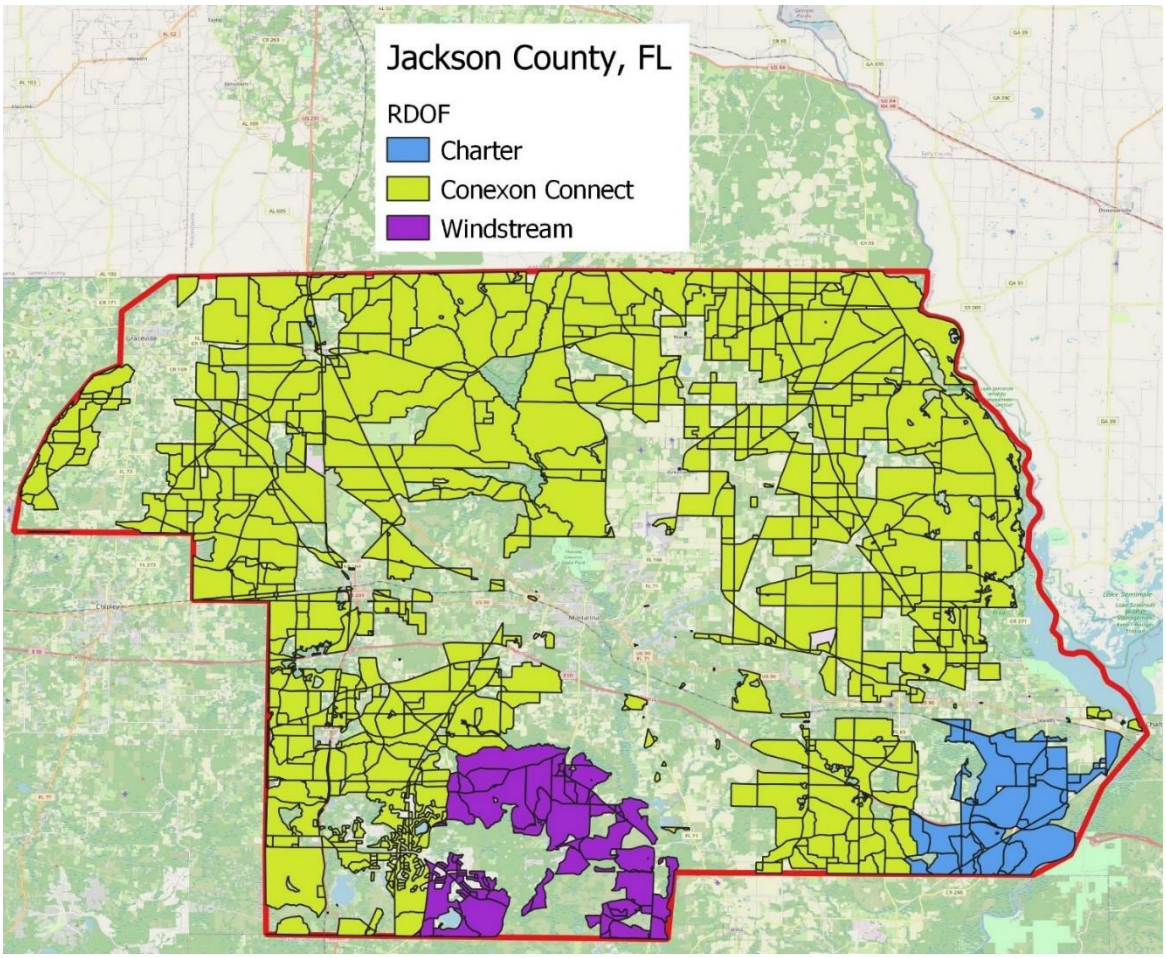
During our field review we could not identify any of Point Broadband's assets, but they are close to the area and seem to be a good potential partner. Finley spoke to the VP of Corporate Partnerships at Point Broadband Fiber Holding, who had this to say about their priorities:

- Point is a newer ISP. They are in 10 States, predominately in the Southeastern USA, and are mostly considering opportunities in Florida and Texas. They are not as established in the major metros, have been aggressive in RDOF builds, finishing roughly two-thirds of their RDOF, and are gearing up for BEAD. They are looking to protect and continue their wireless offerings. They also look to build fiber and fund projects in BEAD-comfortable counties like Jackson, where they seek investors who want to partner with communities. They mentioned several times on the call that "these are the type of markets that we like to play in."
- Their predominant concern is the cost per passing needed to construct networks in the southeast.

Conexon Connect.

The Rural Electric Cooperative Consortium (Conexon Connect) won $10,487,547 to serve 6,838 locations in Jackson County. Conexon Connect was founded in 2021 to operate and manage fiber-to-the-home networks for electric cooperatives and investors. Conexon Connect typically partners with electric cooperatives to construct the RDOF award areas. But we know that in Jackson County, the partnership with the electric cooperative has not been formed.

Finley Engineering and CCG Consulting talked with Conexon multiple times during the last year and quizzed them about their plans to fulfill the RDOF obligation. Conexon has said repeatedly that it intends to build the required fiber. Conexon won RDOF throughout Florida, and won RDOF to cover most of Jackson County, as shown in this map, in yellow.



There has not yet been any fiber construction in the County for RDOF. Unfortunately, FCC rules allow the company to measure it's completion project on RDOF at the state level and not at the county level. At the state level, an RDOF winner must complete 40% of the construction by the end of 2024, 60% by the end of 2025, 80% by the end of 2026, and everything by the end of 2027.

Conexon is building first in Counties where it has partnerships with electric cooperatives, so counties without partnerships, like Jackson County will be at the end of the line.

The County is rightfully concerned that Conexon will walk away from the RDOF obligations. There has been a lot of inflation since the end of the RDOF auction as a result of the pandemic and the ensuing economic upheaval, and it's harder for every year for an RDOF winner to justify building rural fiber.

B. Issues That Affect Broadband Performance

There are several factors other than speeds that affect the quality of a broadband connection. It's easy to take a simplistic view and assume that all broadband signals are the same – that a 100 Mbps connection on any technology is basically identical. That is not the case, and this discussion explains how factors like latency, jitter, oversubscriptions, and technology can impact broadband performance.

Latency. Latency is a measure of the time it takes for a data packet to travel from its point of origin to the point of destination – for example, from a Netflix server to your home. Another way to describe latency is that it measures the delay in the broadband signals between networks.

The following are the primary kinds of delays in broadband signals:

- Transmission Delay. This is the time required to push packets out the door at the originating end of a transmission. This is mostly a function of the kind of router and software used at the originating server. This can also be influenced by packet length since it takes longer to create and send long packets than it does to create many short ones. These delays are caused by the originator of an Internet signal (like Netflix).
- Processing Delay. This is the time required to process a packet header, check for bit-level errors, and figure out where the packet is to be sent. These delays are caused by the ISP of the originating party. There is an additional processing delay any time a packet is transferred along the way to a new ISP. There is also processing delay each time that a packet passes through electronics between the originating ISP and the terminating ISP.
- Propagation Delay. This is the delay due to the distance a signal travels. It takes longer for a signal to travel from Tokyo to Arizona than it takes to travel from Los Angeles to Arizona. This is why the companies that perform speed tests try to find a nearby server to eliminate delays that are due to distance. These delays are mostly a function of physics and the speed at which light signals can be carried through fiber.
- Queueing Delay. This measures the amount of time that a packet waits at the terminating end to be processed. This is a function of both the terminating ISP and also of a customer's router, computer, and software.

Total latency for a given broadband connection is the combination of all of these delays. As can be seen, latency can be introduced anywhere along the path between the originator and the receiver of a broadband signal.

The technology used in the first-mile or last-mile has the biggest impact on latency. The big web companies like Netflix and Google, which generate most of the content on the web, purposely place their network hubs in data centers that are located in places that minimize the first-mile latency.

A few years ago, the FCC did a study of the various last-mile technologies and measured the following ranges of performance of last-mile latency, measured in milliseconds (ms): fiber (10-20 ms), coaxial cable (15-40 ms), and DSL (30-65 ms). These are measures of the average latency between a home and the first node of the local ISP network. It is these latency differences that cause people to prefer fiber. The lower latency on fiber makes a connection feel faster. If somebody were to make two simultaneous side-by-side connections – one on fiber and one on a cable network - it's likely that the user would say the fiber connection is faster.

Latency is the primary reason that some technologies 'feel' slow to users. For example, cellular latencies vary widely depending upon the exact generation of equipment at any given cell site. 4G cellular latency can be as high as 100 milliseconds – which is one of the reasons that it feels slower to visit a website on a cellphone.

The next biggest factor influencing latency is the network path between the originating and terminating end of a signal. Every time that a signal hits a network node, the new electronics must examine the packet header to determine the route and pause to perform other checks on the data. The delays of hitting network routers or changing networks are referred to in the industry as hops, and each hop adds latency. The longest path of a signal in the broadband world comes from the path used for high-orbit satellites that are over 20,000 miles above the Earth. In the FCC tests, satellite latency was measured to be as high as 650 milliseconds.

The delays from slow latency are manifested as poor performance. When latency gets above 100 milliseconds, a customer will begin experiencing trouble with real-time applications on the web. High latency can make it hard to stream live sporting events. High latency makes it hard to maintain a connection to a school or work server from home. High latency can make it hard to connect to a voice-over-IP call or to participate in a Zoom session. It can even be hard to shop online and do other routine web events if the latency delay is too long.

A lot of complaints about Internet performance are due to latency issues. It's sometimes hard to diagnose latency issues that can appear and reappear from one second to the next as the routing of data coming to a given customer changes. What is clear is that the lower the latency, the better the performance of the broadband connection.

Jitter. Jitter is the variance in the delays of signals being delivered through a broadband network. Jitter occurs when the latency increases or decreases over time. The broadband signal coming into a home is incredibly erratic. From millisecond to millisecond, the amount of data hitting the home network varies widely. Measuring jitter means measuring the degree of the variance of this network chaos.

Jitter increases when a broadband network gets overwhelmed, even temporarily. Delays are caused in any network when the amount of data being delivered to any point in a network exceeds what can be received and processed. There are a few common causes of increased jitter:

- Not Enough Bandwidth. Low bandwidth connections experience increased jitter when packets from the outside world exceed the capacity of the broadband connection. This effect can be a double whammy for somebody with a slow broadband connection because the network is already slow, and the increased jitter slows things down even more.
- Hardware Limitations. Networks can bog down when outdated routers, switches, or modems can't handle the volume of packets. Other issues like old or faulty cabling can cause delays and increase jitter.
- Network Handoffs. Jitter can increase at any network bottleneck. The most common bottleneck in homes is the device that converts incoming broadband to WiFi. Even the slightest hiccup at a bottleneck can negatively impact the speed of the entire network.

All of these factors help to explain why old technology like DSL performs even worse than might be expected. Consider a home that has a 25 Mbps download connection on DSL. If an ISP were to instead deliver a 25 Mbps connection on fiber, the same customer would see a significant improvement in performance even at the same download speed. A fiber connection would avoid the kind of jitter that is inherent in antiquated DSL hardware. We tend to focus on speeds, but a 100 Mbps connection on a fiber network will typically have a lot less jitter than a 100 Mbps connection on a cable company network. Customers who try a fiber connection for the first time commonly say that the network 'feels' faster – they are noticing the reduced jitter.

High jitter can be deadly to real-time connections – most people won't care if higher jitter means it takes a little longer to download a file. But high jitter can play havoc with real-time events like a Zoom call or a TV signal during a big sports event. It's easiest to notice jitter when a real-time function hesitates or fails. A home might have plenty of download bandwidth, and yet a spike in jitter can drop an online connection.

ISPs have techniques that can help to control jitter. One of the more interesting ones is to use a jitter buffer that grabs and holds data packets that arrive too quickly. It may not feel intuitive that slowing a network can improve quality. But recall that jitter occurs when there is a time delay between different packets on the same transmission. There is no way to make the slowest packets arrive sooner – so slowing down the fastest packets increases the chance that Zoom call packets can be delivered evenly.

Fully understanding the causes of jitter in any specific network is a challenge because the causes can be subtle. It's often hard to pinpoint a jitter problem because it can be present one millisecond and gone the next. But jitter is something that should be talked about more. A lot of the complaints people have about their broadband connections in rural areas are made much worse by high jitter.

Oversubscription. Even when the latest and best technology is deployed, speeds can vary widely in real life due to something called oversubscription. Oversubscription comes into play for any technology where customers share bandwidth somewhere in the network. Oversubscription is why a home broadband connection might get worse when many neighbors are using broadband at the same time.

The easiest way to understand the concept is with an example. Consider a passive optical fiber network. The most commonly deployed fiber technology for the last decade has been GPON, where up to 32 homes share 2.4 gigabits of download bandwidth (in a neighborhood node called a PON).

If an ISP sells a 100 Mbps download connection to 20 customers on a 2.4 gigabit PON, then in the aggregate, these customers can use as much as 2 gigabits of download data (20 customers X 100 Mbps), meaning this sample PON has unused capacity. In this example, every customer is guaranteed to be able to use the full 100 Mbps connection. However, if an ISP instead sells a gigabit connection to 20 customers, then there are 20 gigabits of potential customer usage that have been pledged over the same 2.4 gigabit physical path. The ISP has sold more than eight times more capacity to customers than is physically available, and this particular PON has an oversubscription ratio of eight to one.

When people first hear about oversubscription, they are often aghast – they think an ISP has done something shady and is selling more bandwidth than can be delivered. However, ISPs understand how customers use bandwidth, and they take advantage of the real behavior of customers in deciding on an

oversubscription ratio. ISPs know that a home subscribing to a gigabit connection almost never uses the full bandwidth capacity. A home doesn't use much bandwidth when people are asleep or away from home. A gigabit subscriber might spend the evening watching a few simultaneous Netflix video streams and barely use any bandwidth. The ISP is relying on the normal behavior of its customers in determining a safe oversubscription ratio.

Most of CCG's ISP clients using GPON say they average a 40% to 50% utilization rate – meaning all of the customers on a PON collectively only use about 40% - 50% of the 2.4 gigabits of capacity at any given moment. The extra capacity is there for those times when a neighborhood gets busier than normal. We know from working with hundreds of ISPs that every customer on a GPON network can be given gigabit speeds, and the network will still deliver full speeds to customers more than 99% of the time.

To stick with this same example, even if the ISP using GPON gets too busy, it would only happen for a short time. For example, if a few doctors lived in this neighborhood and were both downloading big MRI files at the same time, the neighborhood might temporarily cross the 2.4 gigabit available bandwidth limit. But broadband transactions happen quickly for a gigabit customer, and the overuse of the bandwidth would not last long. Even in this example, most neighbors of the doctors wouldn't see a perceptible difference in performance.

Oversubscription is different for business customers. Businesses might use steady bandwidth, such as connecting VLANs to multiple branches, using software platforms in the cloud, using cloud-based VoIP, etc. An oversubscription ratio that works in a residential neighborhood might not work in a business neighborhood. An ISP gets to know its customers and decides how to configure the PON in a business neighborhood according to the characteristics of the businesses in that neighborhood. There are a number of ways that an ISP can make sure that business customers get enough broadband.

The above example describes oversubscribing a fiber network. All broadband technologies must contend with oversubscription issues. Anybody who uses a cable company for broadband can remember a decade ago when cable broadband slowed to a crawl when homes first started watching Netflix in the evening. The cable company networks were not designed for steady video streaming and had hundreds of homes sharing the same neighborhood node. It became routine for the bandwidth demand for a neighborhood to significantly surpass the network capacity, and when that happened, the whole neighborhood experienced a slowdown. Since then, cable companies have reduced the number of households sharing each neighborhood node to reduce oversubscription problems.

One of the major reasons that DSL and fixed wireless networks have slow speeds is from oversubscribing the neighborhood nodes. There is often far more demand from customers than the bandwidth being delivered to a neighborhood.

Oversubscribed networks became a big issue during the pandemic. The issue became the upload link instead of the download link. The upload link in a neighborhood gets overloaded when multiple people simultaneously connect to tasks that require uploading, like working or schooling from home. It was widely reported across the country during the pandemic that people had trouble making and keeping connections to work and school servers and Zoom calls. This didn't just happen with older technologies like DSL, and there are many reports of this happening on the networks of the big cable companies.

Customers were rightfully upset if they were buying 100 Mbps or larger download speeds and still couldn't reliably work from home.

To make the issue even more complex, the sharing of bandwidth at the neighborhood level is only one place where oversubscription comes into play in a network. Any other place inside the ISP network where customer data is aggregated and combined can cause the same oversubscription issues. The industry uses the term chokepoint to describe any place in a network where bandwidth can become a constraint. There are a minimum of three chokepoints in every ISP network, and there can be many more. In addition to a chokepoint in the neighborhood node, there is also always a chokepoint in any network at the point where all of the neighborhood nodes come together in the core. The other big chokepoint is the connection point to reach the Internet, and it's possible for a company to not have enough bandwidth to the outside world to satisfy the aggregate demand of all customers collectively. During the pandemic, many ISPs suddenly found themselves having oversubscription problems at multiple chokepoints.

Other Issues That Affect Broadband Speeds

The primary issue affecting broadband speeds is the specific broadband technology being deployed and the way it is deployed. Any network can experience problems if it is configured poorly. It's easy to think that fiber networks are immune from these issues, but that's not always true.

Sections II.C. and II.D. below have a more detailed description of the various broadband technologies. The range of expected download speeds available on the various technologies are as follows:

- DSL delivered on one copper pair can deliver speeds as fast as 25 Mbps for a mile or two from the DSL transmitter, assuming the copper is in good condition and other factors are ideal. There are older and slower types of DSL deployed that might have maximum speed capability of 3 Mbps, 6 Mbps, or 12 Mbps. DSL configured to use two copper pairs can deliver twice as much speed as basic DSL. We've seen ISPs that are combining multiple copper pairs of wires to get speeds as fast as 100 Mbps download. But the faster the speed being configured on DSL, the shorter the distance before the speed starts to degrade.
- High-orbit satellite broadband can deliver speeds as fast as 75-100 Mbps in ideal conditions. Satellite broadband speeds are slower for customers without a full view of the open sky – like customers with trees around their homes or who are located near hills and mountains. The primary problem with high-orbit satellites is the delay (latency) since the signal that has to travel over 20,000 miles each way to and from the satellite.
- Fixed point-to-multipoint wireless technology is evolving rapidly. Technology from just a few years ago can deliver reliable download speeds up to 100 Mbps. There are claims from vendors for newer radios that can deploy speeds up to a gigabit, although most engineers think it's likely that top speeds will be half that in a real-life network. The primary issue with fixed wireless is that the speed delivered varies by customer. Customers who have an unimpeded path to the radio tower can get the best broadband performance, but performance degrades with any impediments in the radio path, such as trees or weather. Speeds also vary with the distance between a customer and the tower. ISPs can overcome distance by using more power or larger channels, but at some distance, the broadband will significantly degrade.
- A hybrid-fiber coaxial system (used by cable companies) can deliver fast download broadband speeds. Networks using the DOCSIS 3.0 standard can deliver download speeds up to around 400 Mbps. Networks that have been upgraded to DOCSIS 3.1 can deliver speeds of up to 1.2 Gbps.

Cable companies are using an upgrade called a mid-split to increase upload speeds to 100-200 Mbps. The newest technology that is just now entering the market uses the DOCSIS 4.0 standard and is touted as being able to deliver symmetrical speeds of multiple gigabits.

- Fiber networks can deliver the fastest broadband speeds today. Fiber networks with the older BPON technology are limited to speeds of about 200 Mbps. The most widely deployed technology is GPON, which can deliver speeds up to a gigabit. The newest XGS-PON technology can deliver download speeds as fast as 10 Gbps.
- FWA cellular broadband that uses cellular frequencies for home broadband can deliver speeds today up to 300-400 Mbps download. The big limitation of this technology is the distance between the customer and the tower. The fastest speeds are available within a mile of a tower. By the third mile from the tower, the current technology struggles to deliver 100 Mbps download speeds. Cellular carriers are experimenting with the use of C-Band spectrum, which several claim could double or possibly triple speeds – but distance will still be an issue.

There is an even bigger difference between technologies for delivering upload speeds. Fiber is the only current technology that can deliver symmetrical speeds – the same speeds up and down. All of the other technologies have slower upload speeds. Some of this is restricted by technology standards. For example, there is a maximum upload speed possible on a cable network that is cooked into the specifications for the technology. Other technologies have the ability to set a range of upload speeds, and both DSL and fixed wireless providers almost always choose to provide more download speeds since that is of the highest importance to most users.

C. Competing Broadband Technologies

This section of the report looks at the various broadband technologies used in the county today.

Technology is Improving. Technology constantly evolves, and most broadband technologies are better now than just a few years ago.

Consider fiber-to-the-home (FTTH). This study discusses the use of XGS-PON, which can deliver 10 gigabit speeds to homes and businesses. While this technology has been around for a few years, the technology was originally too expensive and cutting-edge to be considered by most ISPs. AT&T and Vodaphone built enough of the technology that the price for the hardware dropped to be comparable to widely used GPON technology. Last-mile FTTH is now a 10-gigabit technology rather than a 1-gigabit technology.

Last-mile fiber technology continues to evolve. There is an industry consortium headed by CableLabs that is currently creating specifications for the next generation of last-mile passive optical networks, called CPON, that will use 100-gigabit lasers.

Cable company technology has improved over the last five years. During that time, a lot of urban areas saw the upgrade to DOCSIS 3.1 with download speeds of up to 1.2 gigabits. Cable companies are implementing other upgrades to improve speeds. There is an upgrade called a mid-split that can be used to improve upload speeds. The biggest cable companies have implemented this improvement in multiple markets and are seeing upload speeds between 100 Mbps and 200 Mbps. Several large cable companies

are experimenting with DOCSIS 4.0 technology that will allow for multi-gigabit speeds for both upload and download speeds.

There have been big improvements in fixed wireless technology. Some of this improvement is due to the FCC providing more spectrum for rural fixed wireless. During the last three years, the agency has approved the CBRS spectrum, which is now being routinely used in rural deployments. The FCC also approved the use of the 6 GHz WiFi spectrum in 2021 and recently modified the rules to allow the spectrum to be widely used. There have also been big improvements in the radios. There are vendors today that are claiming the ability to deliver near-gigabit speeds using fixed wireless in ideal conditions.

Cellular broadband speeds have gotten much faster across the country as cellular carriers have introduced additional bands of spectrum. Cellular broadband speeds over the last five years have improved in cities from 20 Mbps to well over 100 Mbps. The transition to faster cellular speeds is spottier in rural areas. Cellular FWA technology delivers broadband speeds up to 300-400 Mbps.

Three years ago, the low-orbit satellites from Starlink were just hype, but Starlink now has over 5,000 satellites in orbit and well over one million customers.

DSL technology over copper has even gotten better. There are new versions of G.Fast that are being used to distribute broadband inside apartment buildings with speeds up to 500 Mbps – for short distances.

The following will look at all of these technologies except fiber, which is discussed in the next section of the report.

DSL over Copper Wires. Telephone companies in the county that still use copper wires deliver broadband using DSL (Digital Subscriber Line). The copper networks were mostly built between the 1950s and early 1970s. The copper networks were originally expected to have an economic life of forty years and have now far exceeded the economic life of the assets. The copper networks are deteriorating as a natural process of decay due to sitting in the elements. Even more importantly, the copper networks have deteriorated due to neglect by the big telcos that started to cut back on the maintenance of copper in the 1980s as the companies were deregulated from some of their historical obligations.

DSL works by using frequency on the copper that sits just above the frequencies used for telephone service. There are distinct kinds of DSL standards, each of which has a different characteristic in terms of the amount of bandwidth that can be delivered and how far the signal will travel. The most efficient forms of DSL can deliver up to 24 Mbps service over a single telephone wire. Most of the DSL in the county is of older varieties and delivers slower speeds.

The most important characteristic of DSL is that data speed delivered to customers decreases with the distance the signal travels. The general rule of thumb is that most types of DSL can deliver a decent amount of bandwidth for about two miles over copper – that's miles of copper wires, not two miles as the crow flies. DSL signal strength is also affected by the quality of the copper – newer copper and larger gauge copper wires mean better bandwidth.

Hybrid Fiber Coaxial Network. Cable companies use a technology called Hybrid Fiber Coaxial (HFC). Hybrid refers to the fact that an HFC network uses a fiber backbone network to bring bandwidth to

neighborhoods and a copper network of coaxial cables to deliver service to customers. HFC networks are considered lean fiber networks (meaning relatively few fiber strands) since the fiber is only used to deliver bandwidth between the headend core and neighborhood nodes. At each node is a broadband optical receiver that accepts the fiber signal from the headend and converts it into a signal that is sent over coaxial cable to reach homes and businesses.

The coaxial copper wires in most HFC networks are aging, and much of the coaxial networks were built in the 1970s. Coaxial cable networks exhibit signs of aging sooner than telephone copper networks because the wires act as a huge antenna, and older networks attract a lot of interference and noise that make it harder to transmit signals through the wires.

An HFC system delivers customer products differently than an all-fiber network. For example, in an HFC network, all of the cable television channels are transmitted to every customer, and various techniques are then used to block the channels a given customer doesn't subscribe to.

There is a distance limitation on coaxial cable. Unamplified signals can't be transmitted more than about 2.5 miles over a coaxial network from a network node. Amplifiers are needed to boost the signal strength, starting as close as a few thousand feet from the core. Modern cable companies try to limit the number of amplifiers on a coaxial route to five or fewer since adding amplifiers reduces broadband speeds.

In an HFC network, all of the customers in a given node share the broadband in that node. This means that the number of customers sharing a node is a significant factor - fewer customers in a node means a stronger and more reliable broadband signal. Before cable systems offered broadband, they often had over 1,000 customers on a node. But today, the sizes of the nodes have been "split" by building fibers deeper into neighborhoods so that fewer homes share a fiber for a given neighborhood.

The amount of bandwidth available to deliver broadband that is available at a given node is a function of how many "channel slots" of video the cable company has dedicated to broadband. Historically, a cable network was used only for television service, but in order to provide broadband, cable companies had to find ways to create empty channel slots that no longer carry TV programming. Most cable systems have undergone a digital conversion, done for the purpose of freeing up channel slots. In a digital conversion, a cable company compresses video signals and puts multiple channels into a slot that historically carried only one channel.

The technology that allows broadband to be delivered over an HFC system follows a standard called DOCSIS (Data Over Cable Interface Specification) was created by CableLabs. Most of the large cable companies upgraded about a decade ago to the DOCSIS 3.0 standard, which allows them to bond together enough channels to create broadband speeds as fast as about 400 Mbps download. By now, most big cable companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically can produce broadband speeds as fast as 8–10 Gbps if a network carried only broadband and had zero television channels. Since there are still a lot of TV channels on most cable systems, most cable companies have increased the maximum broadband speeds to between 500 Mbps and 1.2 Gbps using DOCSIS 3.1.

One limitation of a DOCSIS network is that the standard does not allow for symmetrical data speeds, meaning that download speeds are much faster than upload speeds. This is an inherent design characteristic of DOCSIS 3.0 and DOCSIS 3.1, where no more than 1/8 of the bandwidth can be used for upload. Most

cable companies have allocated even less than the allowable bandwidth to upload. Poor upload speeds became an issue for many customers during the pandemic, and cable companies are searching for ways to increase the upload bandwidth.

One of the interesting design parameters of a cable network is the use of radio frequencies to transmit data, meaning a cable network can best be described as a captive radio network kept inside copper coaxial wires. As such, the signals inside a coaxial system share the same characteristics as any wireless network. Higher frequencies carry more data bits than lower frequencies. All of the signals are subject to interference if external frequencies leak into the cable transmission path.

The DOCSIS specification for cable broadband sets aside the lowest frequencies in the system for upload bandwidth – the frequencies between 5 MHz and 42 MHz. This happens to be the noisiest part of cable TV frequency – it's where outside sources like appliances or running engines can cause interference with the signal inside the cable network.

The DOCSIS 3.0 specification, released in 2006, allows for other parts of the spectrum to be used for upload data speeds, but very few cable companies took advantage of the expanded upload capability. The DOCSIS 3.0 standard allowed a mid-split option to increase the frequency for upload to 85 MHz or a more aggressive high-split option to assign all of the bandwidth up to 204 MHz for data upload. DOCSIS 4.0 is going to offer an even wider range of upload speeds, as high as 684 MHz of spectrum.

Several of the big cable companies are currently implementing the mid-split option to increase upload speeds. This can mean replacing some of the key components of the network, including neighborhood nodes, amplifiers, and power taps. It could even mean replacing cable modems. Cable companies are clearly listening to customer complaints about the lack of upload bandwidth and also want a way to fight back against speed claims from fiber providers.

CableLabs has developed a new DOCSIS 4.0 standard that was released in March 2020. The DOCSIS 4.0 standard allows for a theoretical transmission of 10 Gbps downstream and 6 Gbps upstream. A few cable companies have started to deploy networks that include some of the DOSCSIS 4.0 standard, but it will still be a few years until fully standard-compliant hardware is available.

There is also the bigger issue that the copper plant in cable networks is aging in the same manner as telco copper. There are already portions of many cable networks that underperform today. Increasing the overall bandwidth of the network might result in the need for a lot of copper replacement. And that is going to create a pause for cable company management. While the upgrade to DOCSIS 3.1 was expensive, it's going to cost more to upgrade again to DOCSIS 4.0. At what point does it make sense to upgrade to fiber rather than undertake another costly upgrade on an aging copper network?

When the DOCSIS 4.0 technology was announced in 2020, most of the CTOs of the big cable companies were quoted as saying that they didn't foresee the implementation of the new standard for at least a decade. But the problems their networks experienced during the pandemic had a lot of them rethinking the timeline. A few cable companies like Cox, Midco, and Altice have announced plans to convert properties to fiber rather than tackle this upgrade. Charter is building a huge amount of fiber as part of implementing broadband grants.

A Primer on Wireless Technologies. All technologies that use wireless spectrum to transmit data share some key characteristics that define both the strengths and weaknesses of broadband delivery. Wireless broadband technologies include fixed wireless, cellular, outdoor WiFi, and satellite technologies – all are wireless and differ by the frequencies of spectrum used and the location of the radio transmitters. The following is a description of some of the basics that apply to any wireless technology.

Frequency**.** Wireless technologies use electromagnetic waves to transmit data. The primary characteristic of a given frequency is the length of the radio wave. Radio waves can be as long as a football field or as short as a subatomic particle. As an example, the length of a radio wave used for an FM radio station broadcasting at 90 kHz is about ten feet long. Some of the higher frequencies now used for cell phones are only a few millimeters long.

Frequency is measured in units called hertz, which quantifies the number of times per second (oscillation rate) that a radio wave is transmitted. One hertz equals one cycle per second. The frequencies defined as radio frequencies vary between 9 kilohertz (kHz), or 9,000 cycles per second – which would be long radio waves, up to 300 gigahertz (GHz), or 300 billion cycles per second, which would be extremely short waves. In the middle of this range are the kilohertz (kHz) frequencies that transmit at millions of cycles per second. The entire electromagnetic range extends far beyond radio waves to include things like light waves and X-rays.

How Digital Radios Transmit Data. At the simplest level, there are two ways that radio waves can transmit data. Both methods vary the radio waves by creating differences in the signal. A digital radio receiver software interprets these differences as a series of 1s and 0s – the basis for all digital communications.

One basic method is amplitude modulation (AM). A radio using this method will vary the strength of the radio signal from moment to moment to represent digital 1s and 0s. The other basic transmission technique is frequency modulation (FM). A radio using this technique will alter how often radio waves are transmitted, with changes in the spacing of the transmissions interpreted as 1s or 0s.

Modern radios use far more complex transmission patterns to transmit data but are still based on the two basic transmission methods. For example, QAM (Quadrature Amplitude Modulation) can transmit more data by modulating the amplitude of two or more radio waves simultaneously, providing a much greater opportunity to introduce the tiny differences that represent the digital 1s and 0s.

In general, the higher the frequency, the greater the amount of data that can be transmitted. This is because higher frequency means more radio waves in a given time span, which translates into more opportunities to create 1s and 0s.

Characteristics of Radio Frequencies**.** The characteristic of any specific frequency is determined by nature. For example, the radio waves used for AM radio travel easily through obstacles like buildings. AM radio signals can also travel great distances – I remember, as a kid in Appalachia, listening late at night to a radio station in Chicago. Other frequencies are unable to penetrate obstacles, with an extreme example being the millimeter-wave frequencies used by Verizon a few years ago to demonstrate gigabit-speed cellphones. These radio waves are short and are blocked if the body of a user is between the cellphone and the transmitting tower.

The key characteristics that determine the usefulness of any specific frequency for transmitting data are distance, power, channel size, the nature of the upload/download links, and interference.

Distance. All radio transmissions disperse over distance. In simple terms, this means that the path of a radio transmission widens with distance. This is most easily understood with the following simple diagram that shows how a radio signal spreads from a tower. A receiver placed right at the tower would easily be able to receive the full transmitted signal. But as the receiver is placed further from the tower, not as many transmitted data bits reach the receiver.

One example of this that is familiar to most people is the large dishes placed along major highways that are part of microwave radio systems. The microwave signal is tight and densely packed at the transmitting tower, but the receiving tower needs a large dish to gather the signal that was sent. The signal may originate at a centimeter wide but disperses to several meters wide after 10 miles.

Power. The FCC determines the power level that can be used for any wireless application. To put it simply, increasing the power of a wireless transmission will increase the distance of the transmitted signal. The FCC restricts the power to reduce the risk of radio signals interfering with each other. A good example is the AM radio transmissions mentioned above. The reason I was able to listen to a Chicago radio station late at night is that the FCC allowed some stations to increase the power in the evening after competing local stations stopped transmitting for the day.

Channel Size. A wireless transmission path for sending data doesn't use a single frequency but a range of frequencies. The wireless technology that is most widely used is WiFi. The 2.4 gigahertz WiFi band includes the full range of frequencies between 2401 – 2484 GHz. The FCC has divided the 2.4 gigahertz band into eleven channels of approximately 20 megahertz in width. For example, channel 3 uses frequencies from 2411 – 2422 GHz. This contrasts significantly with the newest WiFi spectrum in the 6 Gigahertz spectrum band, where the largest channel is 160 megahertz wide. Everything else being equal, a larger channel means the capacity to transmit more data on a single channel.

Uplink/Downlink. The method used for handling two-way radio transmissions impacts the amount of data that can be transmitted. This isn't an issue for one-way transmissions like AM radio or broadcast TV, which transmit signals but don't receive them. But communications links require a

signal path in both directions. There are two different technologies used to create a two-way communication path.

- Frequency Division Duplexing (FDD) uses separate frequencies for the uplink and downlink path.
- Time Division Duplexing (TDD) uses one frequency for the links in both directions. The signal can be shared since the two links use different time slots. A TDD radio fluctuates rapidly between a burst of send and a burst of receiving.

Interference. Interference is any phenomenon that can reduce the efficiency of a radio link. There are many sources of interference.

- Natural Interference. This is caused when naturally occurring events like solar flares, northern lights, and other electromagnetic activity interfere with radio transmissions. While not natural, interference can also come from man-made noises from engines and other devices.
- Internal Interference. The most common source of radio interference comes when factors inside of a network cause interference. The radios used for broadband are complex, and there are many reasons why a radio might cause internal interference. It's also common for incompatible hardware at towers to cause interference.
- External Interference. There are numerous ways that external factors can disrupt radio transmissions:
    - Co-channel Interference is when more than one radio is operating at the same frequency. FCC rules are created to minimize such interference for licensed frequencies, but co-channel interference is common with unlicensed frequencies when multiple wireless ISPs use the same channels at the same time in a market.
    - Adjacent Channel Interference comes when a radio transmission on neighboring channels uses some of the same frequencies. Radios are often not precise devices and can transmit in frequencies slightly outside the desired channel. The channels in WiFi overlap and share some frequency with neighboring channels – two nearby locations using adjacent channels will interfere with each other.
    - Spurious Emissions come when radios transmit frequencies far outside of the intended range.
    - Intentional Interference. This comes from jamming that is intended to cripple a specific radio transmission.

The FCC's Role in Regulating Spectrum**.** The use of radio frequencies is highly regulated around the world and in the U.S. by the Federal Communications Commission (FCC). The FCC began regulating spectrum after the passage of the Radio Act of 1927, which was enacted to bring order to the overcrowding and interference in the AM radio band. This law established the basis for the way that spectrum is still regulated – establishing blocks of spectrum and licenses for use that are intended to serve the public interest. Under this regulatory scheme, the FCC assigns frequency in specific bands for specific uses. The agency decides who can be licensed to use spectrum, as well as defines the operating characteristics like the level of power allowed for various uses. The FCC also regulates, monitors, and approves devices that use spectrum.

Over time, the FCC developed two models for regulating spectrum. One is a market approach that licenses spectrum to a specific license holder for a fixed number of years. During the life of the license, the user

has ownership rights in the spectrum. The most widely used licensed spectrum is the various bands used to deliver signals to cell phones. The other model is a commons approach of opening a spectrum for anybody to use without a license. The most common use of unlicensed spectrum is WiFi, which is used in the homes and offices of most broadband users. There is a more recent FCC model that sits between the two regulatory methods, where spectrum can be shared by multiple users only under specific rules and circumstances.

Fixed Wireless Technology. This technology is used by a large number of wireless ISPs (WISPs). The key to making this technology work is to use multiple bands of wireless spectrum to maximize the bandwidth to each customer based on local conditions. There are several current frequencies of spectrum that can be used for this purpose:

- WiFi: WiFi is a marketing term used to create a public-friendly term that was easier to remember than the 802.11 series of names. The FCC has currently set aside three swaths of frequency for WiFi: 2.4 GHz, 5.7 GHz, and 6.0 GHz. In a point-to-multipoint network, these three frequencies are often used together. The most common way is to use the higher 5.7 and 6.0 GHz to reach the closest customers and save the lower frequency for customers who are farther away.

  In practical use, in wide-open conditions, these frequencies can be used to serve customers up to about 6 miles from a transmitter, although WISPs often deliver slower speeds for a greater distance.

  The WISP industry is counting on 6 GHz spectrum to improve broadband performance. The FCC authorized the use of the spectrum in 2020, but only on a limited basis and at low power. The FCC recently approved full-power use of outdoor 6 GHz spectrum under the control of an automated frequency coordination (AFC) system. This is a process that coordinates and balances the use of the 6 GHz spectrum in any given location with any pre-existing users of the spectrum. This means the spectrum won't be usable everywhere, but it should be available in most rural markets. The biggest benefit of the 6 GHz spectrum is the large channels that might support wireless speeds as fast as 1 Gbps in ideal conditions.

- CBRS Spectrum - 3.5 GHz: In 2019, the FCC approved the use of the 3.5 GHz spectrum band known as the Citizens Broadband Radio Service, or CBRS. This is a huge swath of spectrum covering 150 MHz of spectrum between 3550 and 3700 MHz.

  The FCC has set aside 80 MHz of this spectrum for public use, similar to WiFi, and auctioned the remaining spectrum of 70 MHz in June 2020. In all cases, this spectrum is shared with the military, which always gets priority to use the spectrum.

  The public spectrum also must be shared among users in the public space – something that will be monitored by an authorized SAS administrator. The FCC has named five administrators: Amdocs, CommScope, Federated Wireless, Google, and Sony. It's expected that the cellular carriers will heavily use the free public spectrum to deliver 5G, so in many places, this spectrum might be too busy to allow for a point-to-point application. However, in rural markets, the public spectrum might go unused, in which case it would be available to boost the speeds for fixed wireless broadband.

There are already rural ISPs using the public portions of the spectrum for fixed wireless service. This spectrum sits in the middle between the 2.4 and 5 GHz WiFi bands used for fixed wireless today and has great operating characteristics.

There are several factors that are critical for the successful deployment of point-to-multipoint radios for rural broadband:

- Using Multiple Frequencies. The newest radios are much improved over radios from just a few years ago because they use spectrum bands including 2.4 GHz, 3.5 GHz, 5.0 GHz, and CBRS spectrum. Having more spectrum bands matters because each frequency band has different operating characteristics in terms of distance and ability to penetrate obstacles. Using multiple frequencies provides an increased opportunity to find a workable solution for each customer in the service area.
- Adequate Backhaul. The best fixed wireless coverage comes when there is fiber at the transmitter that supplies the needed bandwidth. Customer broadband speeds are diminished if a tower doesn't receive enough bandwidth – lack of backhaul bandwidth is the primary reason many WISPs deliver slow speeds.
- Terrain/Topology. There are often physical barriers like hills or heavy woods that can limit or block customer bandwidth. Most spectrum used for fixed wireless broadband requires a good line-of-sight, meaning that there must be a clear, unimpeded visual path between the tower and the customer. Customers who live in valleys or behind hills often can't get service. If the signal passes through trees to reach a customer, the strength of the signal is diminished.
- Height of the Tower. The taller the transmitting radio, the better because the high placement of the antenna provides a better opportunity to look down on homes without having to pass through trees.

There are a few other issues to consider with fixed wireless:

- When there is more than one WISP operating in the same market, there is interference when WISPs try to both use the same channel
- Interference translates into slower broadband speeds. The biggest drawback of using unlicensed spectrum is the fact that other WISPs can use the same frequencies, and by being unlicensed, there is no entity that can settle disputes between WISPs. The WISP environment in crowded markets is often described as the wild west, where a WISP grabs channels and spectrum to make its own signals better to the detriment of other WISPs. This results in a never-ending wrestling match for frequency and means that customer speeds go up and down.
- Compared to fiber technology, a wireless radio system has a short, expected life. Most radios have to be replaced every seven years or less.
- Wireless equipment is often not eligible for federal or state grants.

Geostationary Satellite Broadband. Viasat (which was formerly marketed as Exede or Wildblue) and HughesNet provide broadband using geostationary satellites (GEO). The technology is called geostationary because the satellites sit in a parked location over 22,000 miles above the Earth. For both, the availability depends upon a customer having a clear line of sight from a satellite dish at a customer location to a satellite.

The most limiting aspect of GEO satellite broadband is latency, which means a delay in the signal. Latency comes from the distance to and from a satellite. The latency on GEO satellites can make it hard or

impossible to do real-time transactions on the web. GEO satellite latency can be as high as 900 milliseconds, and a latency above 100 milliseconds creates a problem with real-time applications such as streaming video, voice-over-IP, gaming, online education, or making connections to corporate WANs (for working at home). Any website or service that requires a constant connection will perform poorly, if at all, with a satellite connection. Satellite broadband also comes with tiny data caps, meaning a customer is highly limited by the amount of data they can send or receive during a month.

Low Earth Orbit Satellites. The newest satellite technology places satellites in orbit between 300 and 800 miles above the Earth. Low-orbit satellites have one major benefit over geostationary satellites. By being significantly closer to the Earth, the data transmitted from low-orbit satellites have a latency of around 35 milliseconds—about the same as experienced in a cable TV broadband network. This is much better than the current latency for high-orbit satellites. The low-orbit satellites can easily support real-time applications like VoIP, video streaming, live Internet connections like Zoom, or distance learning.

One of the most interesting aspects of the technology is that a given satellite passes through the horizon above a given customer in about 90 minutes. This means that there must be a large fleet of satellites so that there is always a satellite in the sky over a customer.

Starlink and its rocket launching company SpaceX is the only low-orbit satellite company offering retail broadband in the U.S. 2020. Starlink has over 5,400 satellites in orbit. The company hit over two million customers worldwide at the end of 2023. Starlink claims it will eventually launch 30,000 satellites and will need over 11,000 to complete the first constellation.

Starlink promises faster speeds for businesses with the HP business antenna. This antenna has a 35% better field of view, is less sensitive to hot weather, handles rain better, and melts snow faster. The company now claims the following speeds on its website:

	Download	Upload
Residential	25 – 100 Mbps	5 – 10 Mbps
Business	40 – 220 Mbps	8 – 25 Mbps
RV	5 – 50 Mbps	2 – 10 Mbps

Interestingly, the speed claims above from the Starlink website are a lot slower than what was promised as recently as September 2022. For example, residential customers in 2022 were told that download speeds would be between 50 – 200 Mbps with upload speeds of 10 - 20 Mbps. Customers have been saying online that speeds are getting slower – something that is validated by Ookla speed tests.

4G Hotspots. All of the major cellular companies sell a home broadband product using 4G LTE, which is popularly referred to as a hotspot. This technology uses the traditional spectrum that has been used to deliver broadband to cell phones. Cellular data speeds get significantly slower as the distance between a cell tower and a customer increases. While customers living close to towers report speeds in the range of 50 Mbps, speed tests show that customers living further from towers can get speeds as slow as a few megabits per second.

5G Home FWA Broadband. For the last two years, cellular carriers have been deploying a new generation of home cellular broadband products. The cellular carriers are calling this new product FWA

(fixed wireless access). Adoption of the new home broadband products is growing quickly. In the last two years, T-Mobile added over 4.2 million customers to the technology, and Verizon added over 2.7 million. AT&T recently claimed to be adding 2,000 customers per week.

The FWA technology is using the new cellular spectrum that each company has labeled as 5G. The technology being used for the product is still 4G LTE, and the 5G name is a marketing way to distinguish these products from the older hotspot technology.

There are some natural limitations of the new technology. The strength of the broadband signal and speeds depends upon the distance between a customer and a cell tower – the speeds get progressively slower as the distance between a tower and a customer increases.

Carriers are claiming speeds in the FCC maps for the two products that range from 100 Mbps to 300 Mbps download. CCG has done extensive research on the FWA product, and we have found that the fastest speeds are only available to customers located near the transmitting cellular tower. If speeds near the cell tower are 300 Mbps, then after a mile the speeds might top out at 100 Mbps. And after two miles, speeds will be 50 Mbps or slower.

The cellular carriers are selling this product to monetize the excess capacity at cell towers. However, the primary product for these companies is selling broadband to cell phones, and both T-Mobile and Verizon warn customers that the speeds will be throttled and slowed any time there is a lot of demand at a cell tower for cell phone bandwidth. Customers have reported that in the worst cases, the bandwidth almost disappears.

Cellphone Broadband. Some households elect to use their cell phones as the only source of home broadband and don't buy a home landline broadband connection. Cellular companies operate two side-by-side cellular networks – one labeled as 4G LTE and the other as 5G. Not all cell sites, particularly in rural areas, have been upgraded for 5G delivery. The difference between the two networks is the frequency of spectrum being used. A customer must have a 5G-enabled phone to receive the 5G spectrum. A recent survey by Deloitte showed that about 60% of U.S. cell phones are now 5G enabled.

There is a gigantic difference between cellular broadband speeds in major cities and the surrounding rural areas. Cellular data speeds are faster in cities for several reasons. First, there are more cell sites in cities. Since the data speed on a cell phone is a function of how far the customer is from a cell site, urban cellular customers get fast speeds because they are usually within a mile of a cell site. Rural customers can easily be miles from the nearest tower. Cellular carriers have also introduced additional bands of spectrum in urban areas that are not available outside cities.

The biggest problem with using cell phones for broadband is the tiny monthly data caps. Anybody using a cell phone for home broadband is, by definition, a light broadband user.

D. The Network Design

Evaluating the Network Options

In our evaluation of Jackson County, we considered the design and construction of an all-fiber broadband network. In the design work, we completed a fiber-to-the-premise network design for the parts of the study area that do not have wireline service (cable/fiber) capable of reaching 100 Mbps download speeds and 20 Mbps upload speeds and which do not have a funded obligation to construct a wireline broadband network capable of those speeds. In Jackson County, the areas that don't meet those speeds are primarily rural.

Our evaluation considered the following criteria that are necessary elements of a broadband solution:

- A review of the existing broadband providers' current deployments and funded broadband deployment obligations.
- The type of construction required in each area: plowing, boring, and presence of rock, aerial installations.
- Bandwidth capacity.
- Cost of the network.
- Expected lifecycle of the technology.
- Resiliency and redundancy of the network

Before tackling the design, we needed to research to understand the study area better. Some of this investigation was described earlier in the Mapping section of the report. We started by analyzing the broadband mapping information available from the FCC, which provided us with a snapshot of where ISPs claim service today. We focused on areas where ISPs do not claim fast broadband, but we also looked at the rest of the county to see if we agreed with the claims made by the ISPs. For example, we looked for inconsistencies between the technologies reported to the FCC and the claimed speeds. We also looked at a full year of Ookla speed test data to see how the customer experience matches ISP claims. All this work culminated in a broadband map for the county that defines the areas that don't have adequate broadband.

Our work with the mapping identified all of the ISPs operating in the county, and we attempted to have a conversation with each ISP. Our team interviewed 50% of the last-mile ISPs, and many attempts were made for the other 50% with no success. These were technical discussions asking about the current broadband networks and to see if the ISPs would share any plans for network expansion. We wanted to learn if ISPs have won any grants to fund expansion. Finally, we wanted to find out if each ISP was interested in working with the County to improve broadband.

After the ISP interviews, we traveled to the county to conduct a field review. Before the trip, we made a list of 56 areas we specifically wanted to examine to investigate the presence of specific technology from specific ISPs, collecting over 99 images of existing broadband and wireless infrastructure. We used a cellular GIS mapping service to identify and geo-reference the work done by our field team so that we could locate the findings from the field review on a map. This allowed our field team to snap pictures of the equipment or cable used at each location. The goal of the field team was to validate if the information reported by ISPs was correct regarding areas served and the technology being used. This work allowed us to draw boundaries around areas with good broadband coverage to delineate where the areas without broadband started.

Before starting the design, we made a last pass to determine if ISPs have won any recent grants or broadband subsidies to build faster broadband. This included reviewing state broadband grant awards and federal grants and subsidies like RDOF, ACAM, ReConnect, etc.

Fiber Network Design

The design process started with primary assumptions, fiber architecture, and optical equipment decisions. These assumptions are discussed in more detail below.

FTTP Architecture:	Centralized Split Passive Optical Network (PON)
Fiber Type:	Armored fiber cable
Aerial Fiber Placement:	Hung on existing utility poles 18" below the neutral
Buried Fiber Placement:	None in this design – 100% aerial
Cable Fill Factor:	1.5 fibers for every existing service location
Huts / Cabinets:	One Hut Site and 35 Equipment Cabinets
Internet Backbone:	Existing connections from providers
Fiber Drop:	Consideration of Aerial and Buried fiber drops
Network FTTP Equipment:	XGS-PON (10 Gigabit symmetrical technology)
Premise FTTP Equipment:	XGS-PON (10 Gigabit symmetrical technology)
Percentage Buried Fiber:	100% for the initial design.

We analyzed the unserved areas and determined that the most efficient fiber network would be to define seven distinct serving areas for construction and serving customers.

Currently, two primary technologies- passive and active- are used for last-mile fiber networks. Finley chose a passive network for several reasons that are discussed below. We also include a comparison of active and passive fiber technology.

Overall Design Criteria

A high-level map of the designed network is included below.

The design of fiber networks and the associated electronics is straightforward. The goal is to define the fiber size that must be built along each road and street in the study areas. However, every network design differs in the details of how the network will be deployed, the method of construction, geography, topography, the number of customers, and the long-term goals of the ISP.

Our goal in the design is to create a cost estimate for constructing a network that is accurate enough for ISPs to make business decisions or to decide to file for a grant. The cost estimates will always get refined later when it's time to construct a network and when engineers will walk and examine every foot of the planned network.

The network design started by locating every potential customer on a map to see where we need to bring service. The number of potential customers in the telecom industry is called "passings." We utilized Jackson County GIS and address data to capture the location information best. This allows us to visualize and determine how many locations are residential, business, or community anchor institutions.

This network utilizes a centralized PON architecture for high-level design purposes. PON stands for passive optical network and is most easily described as having one laser in the network core that serves a neighborhood cluster of customers. In a centralized PON, each customer has a fiber connection from the service location to the PON cabinet, where optical splitters are utilized to serve up to 64 customers. In this design, we used a splitter capable of serving 32 customers to reduce optical loss and retain a higher level of bandwidth available per customer.

One of the interesting aspects of a modern PON network is that the technology can also be used to create a dedicated broadband path to any given customer – meaning that the network can take advantage of the best attributes of an active network to be able to serve large business customers, cell sites, or schools.

We also considered future growth when determining the needed network capacity. We know from years of building fiber networks that planning for increased fiber utilization over time is prudent. We always think of a fiber network as a hundred-year investment, and there is no way to know what might happen to the local economy over many decades from now. The network was designed to accommodate growth, if it ever appears, even decades from now.

The primary way we planned for growth was to multiply the number of locations by 1.5 in determining the fiber cable size required, typically rounding up to the next industry-standard fiber size. We carried this factor throughout the network from the core hub to the customer locations. We would also point out that PON networks are the most easily expandable networks. Expanding a network at the edge is possible by placing a new cabinet supporting an additional serving area. This kind of expansion can theoretically be extended forever, although the fibers at the core would need to be updated at some point.

There are two major components of a fiber network:

Backbone Fiber. This particular design included little backbone fiber. We utilized an edge-out design strategy where last-mile fiber would be extended from existing fiber networks that will already be built by somebody else using subsidies or grants. One of the key requirements of a grant-funded network is that the owner of the network must make it easy for other ISPs to traverse the network.

Last-Mile Fiber Network. The last mile fiber network extends from each hut, remote, and PON cabinet location to reach customer locations. The total fiber network, including the backbone fiber, covers 232.7 miles of fiber network construction.

The total cost of the network includes both the backbone and last-mile fiber. Our pricing for the network is based on recently constructed fiber projects in similar areas. For the basis of our cost estimate, Finley utilized similar projects that used standard fiber cable sizes for the fiber network design. The fiber cable sizes were 12, 24, 48, 96, 144, and 288 fibers in a bundle. We always try to design using standard fiber sizes since such fiber is more readily available from contractors and vendors for additional network construction and repair. Also, standard-sized fiber is priced more competitively.

Our design determines the right-sized fiber cable for each route. One of the most significant costs of deploying fiber is the cost of labor needed to splice fibers together, so our goal is not to include unneeded

fiber pairs to limit the required number of splices. Every splice in a network also adds a small amount of signal loss, so the ideal network includes the least number of splices.

PON Cabinet placement is based on the total distance between electronics at the equipment cabinet and customers – the ideal is to keep this distance under twelve miles. This distance limitation is the factor that led us to create six separate serving areas.

The biggest cost component of deploying fiber is labor. Labor costs vary around the country due to differences in hourly wages. Local wage differences can be a big factor in choosing between the different construction methods. In this study, we have used cost assumptions from other projects recently constructed in your area and around Florida to estimate the labor, soil/rock conditions, and material rates.

The study also looks at the difference in cost for using the existing market rate for labor and the higher wages that come from using Davis-Bacon prevailing wages, which are required for BEAD and other grants.

Optical Electronics Design

There are two technologies used today to deliver last-mile broadband to customers. Active Ethernet technology has been widely used for over thirty years, and passive optical network (PON) technology has been used for over fifteen years. These are both mature technologies that are widely used and well-understood.

Finley Engineering is technology-neutral, and we considered the pros and cons of the two technologies for deployment in our analysis.

Passive Optical Network (PON) Technology

PON technology is most easily described as having one laser in the network core that serves a neighborhood cluster of customers. That means one laser at the core communicating with a neighborhood laser at each customer, or to put it another way – one laser to many customers.

The industry standard for passive optical networks has been GPON (Gigabit PON) for the last fifteen years. The GPON technology delivers a 2.4-gigabit data stream for download and 1 gigabit for upload to a neighborhood of up to 32 customers. The newest PON technology is starting to see widespread use is XGS-PON technology. This new technology can deliver 10 gigabits of both download and upload bandwidth to a cluster of customers. A neighborhood cluster is called a PON in the industry, and with GPON, the typical size of a PON has been set at 32 customers. With XGS-PON, the neighborhood PON can include up to 128 customers. An ISP deploying XGS-PON to a cluster of 32 customers would provide four times more download bandwidth and ten times more upload bandwidth than GPON.

As recently as 2020, there was at least a 15% or greater price penalty for buying XGS-PON technology. However, we've seen recent quotes for XGS-PON that are identical in price to buying the GPON, which has been the industry standard. In the broadband industry, that pricing point represents a tipping point where XGS-PON is quickly becoming the new standard. The price has dropped because some large ISPs like AT&T and Vodaphone are installing millions of new customers per year on the new technology.

XGS-PON is not a new technology and has been around for about five years. But until recently, the price differential stopped most network owners from considering the technology.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, DZS, Nokia, Juniper, and Calix. The following are the primary pros and cons of using PON technology.

PON Advantages

- No electronics in the field. PON uses passive splitters to distribute the bandwidth over the fiber to the customers. There are only two active components in the PON distribution network – the Optical Line Terminal (OLT) and the Optical Network Terminal (ONT). The OLT sits in an environmentally controlled hut or building, and the ONT sits on the side of the home or inside of the home.
- Less field maintenance and more reliability. Because PON uses passive splitters in the field, there are fewer powered network elements in the distribution network. This equates to less maintenance, fewer field personnel required, more reliability, and fewer managed network elements in the distribution network. A PON network also means less land and rights-of-way required due to less need for large powered huts.
- Less fiber is needed. PON uses significantly fewer fibers than an active system. A PON network can carry up to 128 customers on the fiber leading to the neighborhood. In GPON technology, most ISPs configured the network to have 32 customers in a PON. There is not yet an industry-wide consensus for the ideal size for an XGS-PON PON cluster. The one fiber carrying the traffic from many customers differs drastically from an active network that requires one fiber between the core and each customer. Less fiber means lower construction costs, less loading on poles, quicker fiber installations with less splicing, and smaller fiber management systems.
- Higher density electronics. Because PON electronics have only one optical port for many customers, the PON chassis in the OLT can serve a large number of customers in a small space. This means less space for electronics, less power usage, less air conditioning, and reduced backup power requirements.
- Ability to still use active Ethernet. Most PON manufacturers offer the option to serve some customers on active Ethernet in the same chassis by the use of a separate core card.
- Location Flexibility There are a lot more options for locating passive devices and placing them close to customers. Network owners can deploy both large, centralized splitter sites and widely distributed tiny splitter cabinets.
- Takes the best advantage of oversubscription. All of the customers in a neighborhood node share the bandwidth delivered to the node. This is a more efficient use of bandwidth than sending a dedicated amount of bandwidth to each customer.
- Network Expansion. The most important benefit of PON is that it's far easier to accommodate future growth. Fiber networks are expected to last for far more than fifty years, and with a PON network, it's easy to add new homes in a neighborhood or a whole new subdivision or neighborhood that appears in an unexpected place. A PON network can be expanded for small expansion by adding new splitters. For major expansion, a new hut can be added to the network allowing for a huge expansion outward. This is drastically different from an active network where an individual fiber is needed from the core to reach each new house in existing neighborhoods.

PON Weaknesses

- Distance Limitation. Customers have to be within 12 miles of the OLT core electronics. This can present a challenge in large rural networks.
- More Complex Engineering. Because of distance limitations and splitter requirements, a PON network requires an engineering plan for the placement of electronics and splitters. This is not a major issue since industry engineers are well-versed in designing PON networks.
- More customers are affected by a single fiber cut. Cutting one neighborhood fiber can knock more customers out of service.

Active Ethernet (Active E**)**

In an Active E network, one fiber goes from the core electronics directly to each customer. The following are the pros and cons of Active Ethernet.

The primary vendors in the Active E equipment market are Cisco, Calix, Adtran, and Nokia-Alcatel-Lucent. Since PON equipment has won a much greater market share than Active E equipment, this part of the industry has been in a bit of a decline for a few years.

Active Ethernet Strengths

- Greater distance. Where a PON has a 12-mile limit between the core electronics and the customer, an active connection can reach over 50 miles.
- Less engineering and planning. Since every fiber run is a home run between the electronics chassis and the customer, there is less engineering and planning needed to design and deploy an AON network. Engineering means just planning one fiber per passing.
- Pure IP Network. The active Ethernet network delivers pure native IP, meaning it could be plugged directly into customer modems or switches.
- Can deliver greater bandwidth. Lasers are available that can deliver speeds greater than 10 Gbps. Such lasers can be expensive, but they are easy to integrate into an active network.

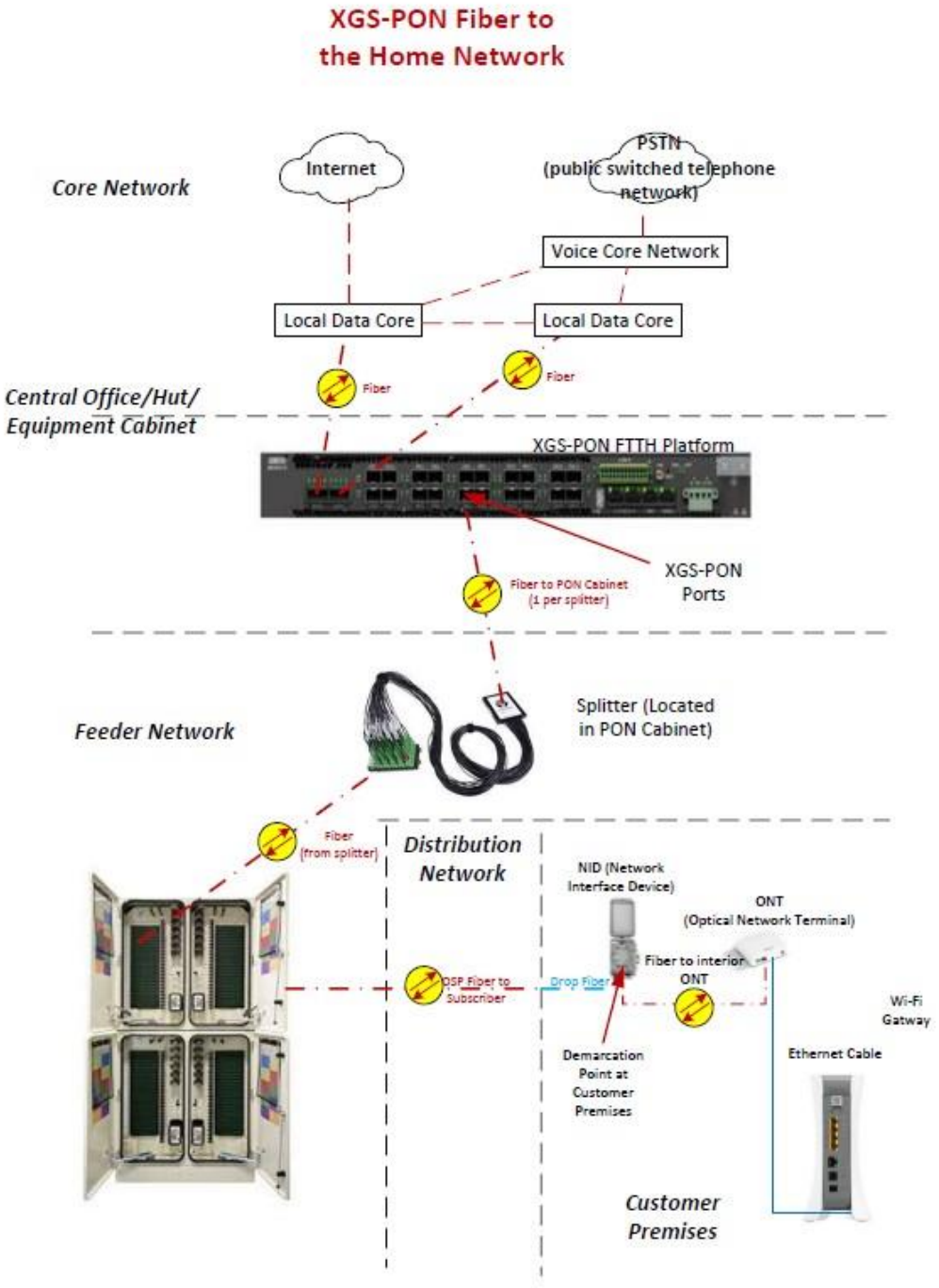
Active Ethernet Weaknesses

- Higher Cost. Active Ethernet typically costs around 15% more to build than a passive network. This comes from needing more fiber and also more lasers.
- Uses more fiber than PON. With one fiber home run per customer, Active networks require significantly more fiber. This means larger fiber bundles to the same number of electronic chassis. This has an effect on capital costs, pole loading, conduit, and hand-hole sizing, etc. Larger fiber bundles require larger field huts to handle the larger fiber entrance. In a densely populated area, the size of the fibers can be unwieldy.
- Less dense electronics. Since there is a core laser for every customer connection, the electronic chassis supports fewer customers in the same rack space. This means a larger chassis and more rack space, which equates to more air-conditioned space and more and larger power and backup power at the electronics locations.
- More powered network elements. There are more field locations that require power. This means more failure points in the network, more field huts, more power, more battery backup, and more generators.

- Expensive growth after construction. This may be the biggest drawback. It can be expensive to add new customers in the middle of an active network because that means somehow bringing more fibers to an area where all fibers are in use.

The Components of a PON Network

The following diagram shows the basic components of a PON fiber network. A description of each component follows the diagram.



A PON network can be designed in numerous configurations, but all designs include the same key elements. All networks start at a network core where the connection is made to the Internet. At this core, the ISP inserts the signals for the various products being delivered to customers. The following diagram shows the configuration of the network that originates with one of the hub sites and ends at a customer premise.

From the core, there are direct fibers to Optical Line Terminal (OLT), which are the devices that provide the light source for customers. These OLTs can be located in the same location as the fiber core or can be spread around the city in neighborhood nodes, in huts or large cabinets.

There is one fiber leaving an OLT for each "PON," which is the local network consisting of up to 32 customers. These fibers go to splitter cabinets, where each fiber is then split into 32 separate fibers that go to customers. The splitter cabinets can be located at the same location as OLT electronics, or they can be moved deeper into the network to be closer to customers. The name passive for the technology comes from the fact that the splitter site doesn't require electronics or power – the splitting is just what it sounds like – one fiber is spliced and split into many individual paths. The paths between the splitter and each customer are home runs, meaning that there is a single dedicated fiber between a splitter site and each customer.

Connection to the Internet. Ideally, a last-mile network will have access to more than one feed to the open Internet. It's not unusual in rural areas for the needed connections to be limited. An important aspect of any network design is to try to find the needed redundancy.

Optical Line Terminal (OLT). The electronics used to light the fiber to customers is called an optical line terminal (OLT). OLTs must be powered, and so each OLT location must contain the equipment needed to provide power, including batteries and other backup power to keep the network functioning in case of a power outage.

An OLT functions using circuit cards, each serving between 128 and 256 subscribers. Multiple cards can be installed in each OLT chassis, and multiple chassis can be installed in a remote hub site, meaning that it's easy to scale the network to accommodate future growth.

There are multiple vendors that provide an all-inclusive PON solution combining the cabinet and FTTP equipment solution. All vendors meet industry standards, and all of them are priced similarly.

PON Splitters. The next component on the network diagram is a PON splitter. This is a device that can split one fiber in order to connect up to 32 customers. On the diagram, you can see that there is only one fiber between the OLT and the GPON splitter. This is the place in the network where significant fiber can be saved since one fiber coming into the splitter can serve up to 32 customers. The splitters do not require power, which is why they are referred to as passive. The splitters can be located anywhere in the network where fiber splits are needed to reach customers. Generally, some of the splitters are located in the central office core or at the various network nodes, but many are located in small neighborhood cabinets located closer to customers.

PON Cabinet. Associated with a splitter cabinet is a PON cabinet. The purpose of the cabinet is to arrange and manage the fibers coming into or out of the splitters to make it easy to identify which fiber serves which customer. The primary purpose of the PON cabinet is to accumulate customer connections at strategic points with the design goal that no fiber in the network needs to be larger than 288 fibers. Below is a picture showing the insides of a typical PON cabinet site. This site includes both a PON equipment cabinet and a splitter cabinet.

Fiber Drops. The local distribution fibers are built to reach from a PON cabinet site to every customer location. Our design provides a place to add fiber to reach each location in the serving area, even though not all customers will buy service. To connect a customer to the fiber network, a fiber drop is built from the street to connect to the outside of a customer premise building. The customer drop is a two-fiber cable that is fusion-spliced to a single fiber of the main-line cable. These splices are housed in a splice case that is sized for each location depending upon the number of homes or businesses that can be served.

At the Customer Location. The piece of customer electronics used to serve customers is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser that connects back to the OLT in the huts or the central office. The ONT receives optical light signals from the fiber network and converts the signal to traditional Ethernet on the customer side of the device.

Historically, ONTs were only placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. But today, there is also an ONT that can be placed indoors and is powered by plugging it into an outlet, much like the cable modems used by cable companies. The cost of the two kinds of units is identical.

Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other providers are electing internal units since they are protected from the weather. The industry is split on this choice, but internal units are becoming the most predominant choice for new construction.

One of the major contributing factors that favor indoor ONTs is that ISPs are tying the ONTs to indoor WiFi routers to provide good wireless connectivity within the home.

ONTs are available in multiple sizes that can be categorized into units designed to serve homes and small businesses and units designed to serve large businesses. The study assumes that the smaller unit will be used for most customers, including most small businesses. These units provide one to four Ethernet streams, which is sufficient for most customers.

Historically, many last-mile fiber networks were designed with battery backup for the ONT. The batteries were installed to power telephones in case of a power outage. Old copper-based phones received power from the copper line and would function when the power was out. However, there is no power delivered with fiber, and customers need some type of battery backup to maintain phone service. In 2015 the FCC ruled that every voice provider must offer an optional battery backup solution for customers that buy telephone service that is not delivered on copper.

Regardless of the type of ONT (indoor or outdoor), it is necessary to drill through the side of the home to bring the broadband indoors. ISPs have widely differing ideas on the best way to do this – but most ISPs look for the installation method that requires the least amount of work inside of the customer premise.

Aerial Versus Buried Fiber

The preliminary design for Jakson County uses 100% aerial fiber. It's impossible to know at a feasibility study level how ISPs will actually build fiber. We think aerial fiber is a good choice in the County for several reasons.

First, in the rural areas covered by this study, practically all existing utilities like electric and telephone lines are already on poles. Additionally, there was a huge amount of damage to utility poles in the county in 2018 from Hurricane Michael. As a result of that damage, a lot of poles were replaced. This means the poles in the county are better than what we normally see.

It turns out that the cost of aerial fiber construction in the rural parts of the county doesn't look to be significantly cheaper than burying fiber. Aerial fiber has higher material costs for make-ready, but somewhat lower labor costs. The cost of burying fiber is lower than in many other places since there are many rural areas that look to be suitable for plowing fiber, which is the lowest cost method of construction when it is available.

Construction costs are considered when deciding to build aerial fiber, buried fiber, or a mix of both. While it's assumed that buried fiber is more expensive to construct, this is not always the case. If a contractor finds places where it costs less to bury the fiber, we assume they will do so.

There are two primary cost drivers that affect all fiber construction:

> Access Density. This refers to the number of connections that will be made to a fiber. There is a significant cost for preparing fiber to connect to customers. The more customers in a neighborhood, the higher the cost to prepare the cable to make the needed connections.

Labor Costs. Hourly labor rates vary regionally and can also often vary between urban and rural construction in the same region.

There are also specific cost drivers unique to buried and aerial fiber:

Major Cost Drivers for Buried Fiber Construction.

Condition of the Substrate. The number one factor that affects the cost of burying fiber is the condition of the substrate – the soil that is three to four feet below the surface. All burying techniques are the least costly when the substrate is mostly soil with few other impediments. However, many rights-of-way were filled with rocks or other materials when a road was first constructed. Cobble is substrate that includes small rocks of six inches or less. Construction is harder if the original contractor used large boulders to fill the ditches when creating a street or road. Some locations have surprising impediments – we know of a project where somebody buried an old tractor in the right-of-way that made it impossible to bore – the contractor had to excavate and remove the tractor. In the worst cases, the substrate is composed of native rock that has never been excavated. It can easily cost ten times or more per foot to bore through rock than through softer substrate.

The Chosen Construction Method. The lowest construction cost would be achieved by using the lowest-cost construction method for each segment of a fiber project. However, contractors don't like to combine multiple construction methods in the same local project unless there is no alternative. Each construction method requires different heavy equipment and crews with different talents. This means that a contractor will sometimes spend more to build some portions of a network as a trade-off for trying to accommodate different construction techniques.

The Major Cost Drivers for Aerial Fiber Construction

Conditions of Existing Poles. The condition of the existing poles determines the make-ready costs. Almost every fiber route has some make-ready – make-ready can be as simple as having to trim a few trees or as costly as having to replace a substantial number of poles. The conditions that drive high-make-ready costs include poles that are too short to accommodate a new fiber, poles that have deteriorated and have to be replaced, and poles where the existing attachers did not follow industry standards to allow enough space for the next attacher.

Network Design. There are several aspects of network design that impact fiber cost. Fiber routes with larger-count fibers usually have higher material and splicing costs. The fiber bundles for an active Ethernet fiber design will contain more fibers than a network using passive optical electronics.

Aerial Fiber Construction Basics. Aerial fiber construction is the process of adding fiber onto poles. The process of putting any wires on poles is highly regulated.

Pole Regulation**.** Utility poles are owned by a wide variety of owners. The largest owners of poles in the country are electric companies since they built the first poles in most communities. There are places where

a telephone company will own most of the poles. There are some communities where the local government owns the poles.

The FCC was given authority to regulate poles by Congress in Section 224 of the Telecommunications Act of 1934. The FCC established basic rules for attaching to poles but initially took a light-touch regulatory approach and allowed various parties that shared poles to negotiate a joint-use agreement that defined the rules and fees for sharing poles. The FCC rules followed nationally accepted standards for poles, which have been developed by associations of engineers. The standards were created to make it safe for technicians to work on poles, particularly during or after storms. The national standards defined things like the minimum distances required between different types of wires. The joint-use agreements also defined the fee for any pole attachments that were due to the pole owner. As might be imagined, the joint-use agreements differed across the country.

In response to the widespread deployment of networks by cable companies, Congress passed the 1978 Pole Attachment Act. The Act assigned regulation of poles to the Federal Communications Commission (FCC). The intent of the 1978 Act was to set affordable rates and terms for cable companies to use the poles since some pole owners were making it impractical for a cable company to get onto the poles. Interestingly, the 1978 Act applied only to poles owned by investor-owned electric or telephone companies – the new rules did not apply to poles owned by state and local governments, cooperatives, or railroads. The 1978 Act gave States the right to 'reverse preempt' the FCC and establish state-specific pole attachment rules and rates. At the end of 2022, there were 23 states that asserted jurisdiction over poles. The remaining states, including Florida, elected to remain under FCC pole rules.

Pole Attachment Agreements. Anybody who wants to hang a new wire on a pole must first sign a pole attachment agreement with the pole owner. A pole attachment agreement is a contract that specifies the specific rules for connecting with the pole owner. For example, the pole attachment agreement will describe the paperwork process needed for hanging a new wire. The pole attachment agreement also specifies the various rates and costs associated with being on a pole.

In some markets, there may be several different pole owners, and a new attacher must have a separate agreement with each pole owner. Pole owners may require attachers to meet specific requirements before attaching to any poles. For example, a pole owner may require an attacher to be registered as a carrier at the state regulatory commission. A pole owner may require a monetary deposit before any work on poles is allowed.

Space Between Wires. Section 23 of the National Electric Safety Code defines the clearances that are required for wires hanging on poles. The standard clearances are intended to provide safe working conditions for technicians working on poles. Most of the cost and the controversy associated with adding fiber onto poles is finding a way to add fiber to a pole while continuing to meet the spacing and clearance codes. A highlight of the key clearance distances is as follows:

- Bottom clearance. The bottom wire on a pole must be at least 4.8 meters (15.5 feet) above any area where there is vehicular traffic. The bottom wire must be at least 2.7 meters (9 feet) above areas that have only pedestrian traffic. There are many exceptions to the rules, such as requiring higher clearances for crossing a railroad track. Many pole owners expect higher clearances, and the numbers cited above are the minimum national requirements.

- Safety Space. National codes require a Communication Worker Safety Zone of forty inches between the lowest electric wire and the next highest wire under the electric wire. This zone was created to keep technicians working on non-electric wires away from high-voltage electric wires.
- Within the Communications Space. Most pole owners require a gap between different attachers in the communications space of 12 inches – meaning the space between the telephone company and a cable company or a fiber provider.

One key aspect of the spacing requirement is that the distance between wires is supposed to be the same across the whole span of two wires between adjacent poles. If you've ever looked up at poles, you'll notice that the wires sag between poles. The sag is intentional and provides the ability for wires to move during heavy winds without breaking. A new attacher is expected to match the sag of the existing wires so that the spacing is the same along the whole distance between poles.

Make-Ready. The construction can become complicated when there is not sufficient space to add the proposed fiber. This initiates a set of processes that the industry called make-ready, which is shorthand for making the pole ready to add the new fiber. There are two aspects of make-ready that cause problems for a fiber attacher – cost and time.

The cost issue comes from a regulatory decision that the new pole attacher must pay the full cost of making a pole ready to attach a new fiber. This often seems unfair when the problems on existing poles come from past attachers that didn't follow the national standards. For example, a cable company may have added coaxial wires on a pole in the 1970s that violated the clearance rules, and that means there isn't room for the new attacher. New attachers are unhappy when they must pay to correct for poor past construction done by others.

The cost of getting onto a pole can be extreme. For example, if there is no space that can be created for a new fiber attacher, the new attacher is expected to pay for the cost of building a new taller pole and moving the existing wires to the new pole. That can be costly, and we've seen estimated costs as high as $30,000 to connect to a single new pole.

Slow Pole Processes. One of the biggest complaints of ISPs building aerial fiber is that pole owners take too long. A lot of that is due to the regulatory rules associated with the make-ready process. Sometimes, adding fiber to poles is easy if there is enough room for a new fiber. But it can get complex, and construction might involve moving the wires of multiple attachers. It might mean constructing a whole new taller pole if there is no solution for creating more space.

Unfortunately, the changes needed to accomplish the make-ready can take a long time. Some pole owners give each existing attacher a chance to move its own wires (which is then billed to the new attacher). Or the pole owner may do the work with its own staff. The process of notifying other attachers and coordinating work can take a while. If there are multiple attachers involved, the rules usually allow each attacher to do the work sequentially, which means giving each attacher a fixed time to make the needed changes. It's not unheard of for it to take as long as a year to complete the make-ready work for a single complex pole.

The problem with the additional time for make-ready is that a new attacher can't add fiber to a given route until all of the poles are updated and ready. Consider a street with twenty poles in a row where most have

no make-ready or only minor make-ready - but a few require a lot of work. The new attacher can't run fiber down this street until all poles are ready. Imagine this happening with groups of poles all over a market, and it's easy to see how make-ready can delay fiber construction.

Hanging Aerial Fiber. There are two different types of fiber to match the two primary methods of hanging fiber. Catenary fiber is intended to be attached to some sort of supporting structure. Catenary fiber is attached to either a messenger wire (strand), which is a metal cable that is strong enough to support the fiber or is lashed onto existing wires that are already on a pole, such as existing telephone company wires.

The second type of fiber is self-supporting, meaning it doesn't need to be attached to a messenger wire. The most common kind of self-supporting fiber is ADSS (all-dielectric self-supporting) fiber that is typically used in the power space. ADSS is rigid with a strong, non-conducting outer sheath since the fiber in the power space is not allowed to conduct electricity as a safety measure. There is another kind of self-supporting fiber called figure-8 fiber, which has the messenger wire and the fiber prewrapped into the same bundle to speed up the installation process.

Buried Fiber Construction Basics. There are several different techniques used to bury fiber. The different construction methods are chosen to meet two criteria. The first is customer density, and different methods are used in streets with dense housing versus roads where there are far fewer customers per mile. The more important consideration is the condition of the soil and substrate under highways. Burying fiber can be extremely labor-intensive and expensive in soil that contains a lot of rock. The engineering analysis includes the following types of construction:

Trenching. Trenching fiber is digging an open ditch and laying the fiber into the open hole. Trenching is usually chosen in two circumstances. This is often the least expensive way to bury conduit and/or fiber in places where there is an open stretch of right-of-way with no driveways or other impediments. It's often less expensive to dig a quick ditch with a backhoe or ditch witch than to bore through an area. The second use of trenching is in greenfield areas of new construction, where the conduit can be put into the ground before the homes or businesses are built.

Trenching is the messiest and most disruptive type of fiber construction since it excavates the ground deeply enough to place the fiber. Most contractors would not choose to do this in a residential neighborhood because of the mess and inconvenience for homeowners. Trenching is also not chosen for areas where the contractor expects to uncover major rock. Trenching also has a higher chance of hitting other existing utilities if it is done with a backhoe.

The trenching process is straightforward. The path for the fiber will be excavated to the proper depth. The conduit or shielded fiber cable is laid in the trench, and the trench is refilled with backfill dirt – done carefully to not damage the fiber. The contractor will pack down the construction area, clean up and remove any excess dirt or mud, and restore the right-of-way to the original condition as needed. This might mean laying sod or gravel.

Plowing. Cable plowing is a construction method that uses a heavy vehicle called a cable plow to directly bury fiber or small conduit into the ground as the plow drives along the right-of-way. Fiber plowing is done almost exclusively when burying fiber cable along a route where the fiber will be placed in unpaved rights-of-way, such as along a country road. The right-of-way must be open and

not wooded to allow access to the cable plow. A cable plow is a large, heavy vehicle that is similar to a bulldozer. The plow is on treads instead of wheels to be able to navigate a range of different terrain conditions. Having a heavy vehicle is important because the force of the plow is used to force a path in the right-of-way as the plow drives forward.

The plow is configured so that there is a reel of fiber mounted on the front of the plow, situated so that it can turn as fiber is removed from the reel. Behind the plow is an arm with a blade that is extended into the ground and digs a narrow trench as the plow is moved forward. Some cable plows use a vibrating blade, while others use a heavy static blade. The fiber is unwound from the reel as the plow moves forward and is inserted into the trench, just behind the blade, as the plow moves forward. The fiber used with a cable plow has a tough sheath that can easily withstand the plowing process. There are fibers built that are particularly suitable for the plowing process.

Boring. Boring fiber is referred to by several different names - horizontal boring, trenchless digging, or directional drilling. The technique can be used to construct a fiber network underneath rights-of-ways, streets, driveways, and sidewalks without disturbing much of the surface.

Boring uses specialized equipment that deploys a heavy carbide drill bit to create a temporary underground hole that is large enough to pull through one or more conduits. The boring technique can be used anywhere that a contractor wants to place conduit. This would be boring along a residential street to bring fiber to homes, underneath yards to bring fiber from the street to a home, or underneath driveways and other impediments involved in trenching or plowing of fiber.

Boring is almost always the most expensive construction method. It's time-consuming to bore a hole, then pull conduit into the hole, and then pull fiber into the conduit. Boring involves digging holes in the right-of-way or cutting holes in concrete to insert the boring machine – and these areas must be restored to the original condition after the construction is done.

Microtrenching. Microtrenching is a construction method that cuts a narrow and relatively shallow trench in a street or sidewalk into which to place fiber. Microtrenching is often less costly than boring.

Microtrenching involves cutting a hole in the street or sidewalk that is 1.5 to 2 inches wide and typically 12 to 14 inches deep. The cutting is done using a heavy-duty saw that is mounted under a heavy work vehicle. The vehicle moves slowly down the street, and as the saw cuts into the street, the material being removed from the road is vacuumed into a trailing vehicle for removal. The cutting process is loud, but it doesn't create a lot of debris or initial mess.

It's possible to do the entire microtrenching process on a given street in one day. But it's more typical to stretch this out over two or three days. The microtrenching process typically requires closing a street (or at least one lane of a street) to provide the needed access for the microtrenching vehicles and crews. Microtrenching crews in cities will deploy full safety protocols of using cones to block off areas from vehicles and using flag personnel to direct traffic as needed. Since the top of the trench is only an inch or two wide, cars can safely drive over the trench during the construction process.

After the construction is complete, the contractor will blow fiber through the conduit. Blowing fiber means shooting or propelling a small ball through the conduit that pulls along the fiber wire. Modern fiber-blowing techniques can bring fiber along the street and also into each access device. Once the fiber reaches the handhole, a technician connects the fiber to the handhole in the same manner as would be done with other buried fiber techniques.

E. Cellular Broadband

We learned through our interviews and surveys that cellular coverage in the rural areas is as poor as broadband coverage. There are many areas with poor or no cellular coverage. A cell tower can typically provide broadband up to 3-4 miles surrounding a tower and voice services up to 5-6 miles. In both cases, the signal decreases in strength as the distance between the tower and a customer increases. The broadband available to a cellphone (or hotspot) is much stronger for a customer within a mile of a tower compared to a customer three miles from the same tower.

Signal strength also varies by other factors. The signal strength is generally significantly stronger outside a home than indoors (which is why many rural folks have to go outside to make a cellular call). Cell strength is diluted when connected to somebody in a moving vehicle. Like all wireless technologies, there are also cellular dead spots created by impediments in the terrain, such as hills.

The FCC has theoretically started to address the rural cellular issue. In October 2020, the FCC voted to create a $9 billion fund to bring better 4G and 5G coverage to rural America. This money would be distributed over a decade to provide funding to subsidize the creation of cell towers in rural America.

The money will be awarded to cellular companies using a reverse auction, with the company that asks for the least amount of funding winning the subsidy in a given geographical area. The funding will consist of $8 billion for nationwide support, including $680 million of that set aside for Tribal lands. The last $1 billion will be saved for a second reverse auction, along with any monies not awarded in the first auction. The second phase might give priority to supporting precision agriculture.

The FCC has not set a timeline for the auction but is considering launching the reverse auction before the end of 2024. The primary issue with distributing the funding is the cellular broadband maps. When the FCC created the new BDC maps for broadband, it also created a second similar set of maps for cellular broadband coverage. There are complaints around the industry that the FCC cellular maps include a lot of problems. This might mean that the auctions won't be held until the maps get better.

Cellular companies filed comments in 2022 saying that the $9 billion is not enough money to solve the rural cellular coverage issue. The primary problem from the perspective of cellular companies is that a lot of rural cell sites don't have enough customers or revenues to sustainably fund maintenance. The carriers believe that the FCC must create some kind of permanent subsidy if the agency wants the most rural locations to have sustainable cellular coverage.

Local communities like yours face a dilemma. It might be years until the FCC holds the reverse auction to create new rural cell sites. There is no guarantee that the maps used for that process will show that your area is worthy of the subsidy, particularly since the 5G Fund is going to rely on cellular coverage maps that may never be accurate.

It's also likely that the cellular carriers will have a multiple-year window to build the new towers. In the RDOF reverse auction used for rural broadband, the FCC gave ISPs six years from the date of the auction to build the promised networks in each state. If the FCC does the same for the cellular reverse auction, it could be seven or eight years until all new cell towers are built.

We are often asked if there is something that can be done locally to increase the chances of getting new cell towers through this program. We also hear from communities that don't want to rely on this FCC program and that want to tackle a solution before then. We know of other communities that have tackled this issue, and the following are a few ideas on how to address the problem.

- Document the Need. There is a way for local folks to help fix the FCC cellular maps. The FCC has cellular maps includes data from the public that is created by folks taking a speed test using the FCC cellular speed test app.[20] The FCC only considers speed tests collected through this app – not speed tests taken on other speed test websites.

  Unfortunately, the FCC requires a lot of speed tests in a given neighborhood before the FCC will consider the results. That means there has to be a concentrated effort made to get folks to take the FCC speed test in rural areas where the cellular coverage is poor. This also means getting folks who subscribe to different carriers to take the test. You're going to want AT&T, T-Mobile, and Verizon customers to use the FCC app.

  The County needs to promote the FCC speed test. You want folks to take the test often, particularly in rural areas – it's not going to do any good if folks only take the test one or two times.

- Build New Towers. Another solution is to consider partnering with cellular companies to construct new cell towers in the rural areas where cellular coverage is the worst.

  There are a few ways we've seen this be effective:
  - We've seen communities that have been able to lure a cellular carrier to a public safety tower. This will probably mean giving them free access to the tower. This could also be done as part of the process of expanding public safety towers – work with cellular carriers first to see if there are locations they would use if you build the tower.
  - The other approach is to directly fund new towers directly for cellular carriers to use. You always want to have a contractual guarantee that cellular carriers will use a new tower before it's constructed.

  The primary issue with building new towers is finding the funding. There are no current broadband grants we know of that will fund towers, so that means finding a local solution to raise the needed funding.

  The other issue with building new cell towers is that the carriers are going to want the needed normal amenities. They are going to want fiber at the new tower. They will appreciate having at least a small hut at the base for housing electronics and power equipment.

[20] FCC Speed Test App. https://www.fcc.gov/consumers/guides/fcc-speed-test-app-tip-sheet

III. FINANCIAL PROJECTIONS

A. Financial Assumptions

This section of the report looks at financial projections that were created to understand the feasibility for an existing ISP to bring fiber to the unserved parts of the county. There are several reasons why we undertook the financial analysis.

First, the analysis lets us look at whether an average ISP can afford to build in rural areas. That's not an automatic given, and in some rural areas, the cost of building a network is so high that it's hard for any ISP to justify operating, even with grant funding. That leads to the second reason for the analysis – to try to quantify the amount of grant that is needed to make the network expansion work. This is an important analysis because grants don't cover the full cost of constructing a network, so the ISP accepting the grant must also pay for a share. For example, the upcoming BEAD grant might finance up to 75% of the cost of the network, meaning an ISP must fund 25%. Our goal is to understand if an ISP can make a reasonable business case if they win a 75% grant. More importantly, the chances of winning grants increase if an ISP can request less than the fully available amount – so we calculate what we call a breakeven amount of grant, which is the lowest amount of grant needed to make a business case.

Finally, the analysis explores what we call a sensitivity analysis. In doing this, we explore the impact of changing key variables in our projections. For example, we will quantify the impact of having the interest rate be 1% higher than expected. We hope that ISPs will find the incremental impacts to be valuable information.

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. The business plan assumptions represent our best estimate of the operating characteristics of such a business. As a firm, CCG has assisted hundreds of ISPs that provide rural broadband, and this has given us a lot of insight into how rural ISPs operate. We believe that the financial results shown in these models are characteristic of similar operations elsewhere, and we believe our assumptions are realistic.

We analyzed two scenarios for this study. First, we looked at the impact of constructing the networks at market labor rates. This means the labor rates that are normally charged by construction companies in the region. We also look at a scenario that contemplates prevailing wages. These are labor rates that are mandated for contractors working on federal and state grant projects and are higher than the local market rates. For example, the upcoming BEAD grants require the use of prevailing wages since the funding that created the grants is considered a jobs bill. The authors of that legislation want the workers who build networks to benefit from the government funding.

Incremental Analysis. All of the projections were made on an incremental basis. This means that the studies only consider new revenues, new expenses, and new expected capital costs. This is the most common way that businesses of all sorts look at potential new ventures since an incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover its costs.

It's important to understand what an incremental analysis shows and does not show. An incremental analysis is basically a cash flow analysis. It looks at the money spent to launch and operate a new venture and compares those costs to the revenues that might be generated from the venture.

An incremental analysis is different from a prediction of what the accounting books of a new venture might look like. For example, if one of the existing ISPs in the area were to undertake one of these business plans, they would allocate some of their existing overhead costs to the new venture for accounting purposes. The classic textbook example of this is that some of the existing costs of the general manager of the ISP would be allocated to the new venture in the accounting books. However, the salary of the existing general manager is not considered to be an incremental cost in the analysis since that salary is already being paid by the existing ISP business. If these studies were to show an allocation, we would not be showing the true incremental cash impact of pursuing the new opportunity.

Our analysis all starts with the assumption that existing ISPs would bring the new broadband. The incremental costs would be significantly higher if a new ISP were created just to bring broadband to your rural areas.

Timing. Timing is critical to any business plan. The faster that a business can start generating revenues, the sooner it can cover costs. These studies are conservative in the predictions of the speed of the roll-out of the business venture. That means that if an ISP can get customers faster than predicted by the projections, it can have better results than we've shown.

Following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that the financing is available in January 2025. This is illustrative only and could be changed to any other future date.
- Construction. Fiber construction is assumed to last for three years. We assume that it will take four years to connect all of the customers.
- First Customer. We've assumed that the first customer will be added to the network in October of the first year.

Pricing Strategy. There is a lengthy discussion of industry practices for setting broadband rates in Section I.A. of this report.

We assumed a simple rate structure for broadband. For example, our analysis includes only three broadband speed tiers for residential or business customers.

One of the major factors is choosing rates for the analysis is based in the rates being charged for broadband in the county today:

Provider	Technology	Download	Upload	Price
AT&T	DSL	5 Mbps	1 Mbps	$60 + $10 router
	DSL	10 Mbps	1 Mbps	$65 + $10 router
	DSL	25 Mbps	2 Mbps	$60 + $10 router
	DSL	50 Mbps	10 Mbps	$65 + $10 router
	DSL	75 Mbps	20 Mbps	$65 + $10 router

	DSL	100 Mbps	20 Mbps	$65 + $10 router
	Fiber	100 Mbps	100 Mbps	$60 + $10 router
	Fiber	300 Mbps	300 Mbps	$65 + $10 router
	Fiber	1 Gbps	1 Gbps	$80 + $10 router
	Fiber	2 Gbps	2 Gbps	$110 + $10 router
	Fiber	5 Gbps	5 Gbps	$180 + $10 router
	FWA Cellular	40-140 Mbps	Best Effort	$60
CenturyLink	DSL	Best Effort	Best Effort	$50 + $15 router
	Fiber	500 Mbps	500 Mbps	$50
	Fiber	1 Gbps	1 Gbps	$75
Consolidated	DSL	20 Mbps	Best Effort	$30 + $10 router
	DSL	50 Mbps	Best Effort	$60 + $10 router
	DSL	100 Mbps	Best Effort	$90 + $10 router
Comcast	Cable	50 Mbps	5 Mbps	$53 + $15 router
	Cable	100 Mbps	5 Mbps	$83 + $15 router
	Cable	300 Mbps	5 Mbps	$93 + $15 router
	Cable	600 Mbps	15 Mbps	$103 + $15 router
	Cable	900 Mbps	20 Mbps	$113 + $15 router
	Cable	1200 Mbps	35 Mbps	$123 + $15 router
Charter	Cable	300 Mbps	10 Mbps	$84.99
	Cable	500 Mbps	20 Mbps	$104.99
	Cable	1 Gbps	35 Mbps	$124.99
Point Broadband	Fixed Wireless	5 Mbps	1 Mbps	$66 + $13.99 router
	Fixed Wireless	10 Mbps	1 Mbps	$76 + $13.99 router
	Fixed Wireless	20 Mbps	3 Mbps	$106 + $13.99 router
	Fixed Wireless	30 Mbps	3 Mbps	$126 + $13.99 router
Verizon	Hotpot	50 Mbps	4 Mbps	$20 - $110
	FWA Cellular	300 Mbps	20 Mbps	$45 - $60
T-Mobile	Hotspot	25 Mbps	3 Mbps	$20 - $50
	FWA Cellular	100 Mbps	20 Mbps	$65

In the forecasts, we used $65 as the starting price for broadband. This is a significant discount from the big cable company prices. The starting product for Charter is $84.99. It's a challenge for customers to buy the 50 Mbps product from Comcast, and the 100 Mbps product is priced at $98.

The survey showed that more than half of residents are spending more than $80 today for broadband, with many spending more than $100.

The forecasts assume some rate increases over time. Rates must be increased to keep up with expense inflation. The model is conservative and assumes that rates increase 5% every fifth year, which works out to a little less than 1% per year. The big cable companies like Charter have been raising rates by $3 to $5 every year – a much larger increase than assumed in the analysis.

Introductory Rates. Some big telcos and cable companies are well-known for advertising low introductory rates that increase dramatically after a term contract of one or two years. Most of the advertised rates for

these companies are the introductory rates, and the real rates of these companies are buried in the small print if shown anywhere.

Most small ISPs do not offer introductory rates. They've found that introductory rates are a lot of work since customers must sign a contract. More importantly, introductory rates teach customers that an ISP is willing to negotiate rates.

Low-Income Pricing. This is covered in more detail in Section I.A. of this report. Most ISPs do not offer a low-priced product for low-income households. An increasing number of ISPs instead participate in federal programs that provide qualified low-income customers with a monthly discount from list prices.

Rates Used in This Study

Telephone Rates

The studies assume a single residential telephone product – a telephone line with unlimited long-distance for $20.00. The product includes a full package of features like voice mail, caller ID, etc. These rates don't include taxes on the telephone service, such as the tax that supports 911. The average revenue for business customers is estimated at $55. This higher revenue reflects the fact that businesses often buy multiple phone lines. Unlimited long-distance will be welcome in households that have poor cellular coverage since the telephone companies still charge long-distance rates for calling outside of the local area. The unlimited calling plans today usually include Canada, Mexico, and even some other international locations.

Cable TV Products

We did not include cable TV in the feasibility assessment. Millions of households nationwide have been dropping traditional cable every year and are instead using streaming video services. Even should an ISP decide to bring a TV option, there is little margin on the product, so adding cable TV would make little difference to the financial analysis.

Broadband Products

The three speeds below are arbitrary, and an ISP might use these prices but a different set of speeds. We have used a 3-tier pricing structure with a $15 price step between tiers. The broadband products are all assumed to have symmetrical download and upload speeds.

Residential Fiber Broadband	Price	Percentage
100 Mbps	$ 60	60%
250 Mbps	$ 75	33%
Gigabit	$ 90	7%
Business Fiber Broadband		
100 Mbps	$ 95	50%
25- Mbps	$110	40%
Gigabit	$125	10%

This pricing is conservative compared to national trends. OpenVault recently reported that over one-third of residential households are now subscribing to gigabit broadband. We kept that assumption low due to the low incomes in the county. Below in the sensitivity analysis we show that revenues would increase by $2.5 million over twenty years if 25% of residents purchased gigabit broadband.

Most ISPs charge higher rates to businesses, and the studies assume a $35 additive to business rates. The financial models assume that the data products don't have data caps and provide unlimited broadband usage to customers. If there were data caps, then customers that exceed those caps would be charged more than the basic prices. Some big ISPs like Comcast have data caps. Most cellular and satellite broadband have data caps.

Managed WiFi. ISPs have found that the biggest quality problems with home broadband are due to obsolete or poorly placed WiFi routers in the home. A poor WiFi router translates to a poor broadband experience.

Many ISPs are now offering managed WiFi. This product places carrier-class WiFi routers in the home that are placed and operated by the ISP. High-quality routers and the placement of multiple routers for larger homes usually mean better broadband coverage throughout the home. ISPs often assist customers when adding a new device to the wireless network. The managed WiFi routers provide a secondary benefit to an ISP because they provide a network monitoring location inside the home, meaning that the ISP is more easily able to pinpoint problems.

The studies assume a monthly rate for managed WiFi of $5 for residences and $10 for businesses. It's further assumed that 70% of residents would buy this product and 60% of businesses.

Large Broadband Products. There are entities in the market that buy larger bandwidth products. The studies are conservative and predict modest revenues in this category. In the county, the larger bandwidth products would be sold to cellular towers, schools, and a handful of large businesses.

Cell towers are an interesting challenge. In some parts of the country, we have clients with rural fiber networks that get almost every cellular tower as a customer. But we have other similarly situated clients that get none of this business. Cellular carriers like to buy large volumes of connections from a single regional provider, and they often already have long-term contracts for large areas. The new opportunity for cell towers will be for small cell sites. These are smaller cellular transmitters that are placed on utility poles or light poles and that bring improved cellular service into neighborhoods.

Network Capital Costs. The telecom industry uses the term capital costs to describe the cost of assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering analysis described in Section II of this report.

Below is a summary of the specific capital assets needed for each base scenario. Capital for broadband networks includes several broad categories of equipment, including fiber cable, fiber drops, fiber electronics, huts and buildings, and customer devices like WiFi modems. In addition to capital needed for the network, there are operational capital costs for assets like furniture, computers, vehicles, tools, inventory, and capitalized software.

Our goal in the forecasts is to be realistic but a little conservative. For the past decade, the prices for components in the industry have been stable, and we've been able to make estimates that got within 5% of the cost of building a network. It's harder to estimate the cost of the network today because of inflation.

We started our analysis by using the most current component costs we know about. Some of these costs are already 20% higher than costs from a year ago.

Below is a summary of the cost of the needed assets to support the two options we studied. These investments are at the end of the fourth year of operations – the time when the ISP business achieves full market penetration. The estimates below represent the assumption that a new fiber ISP would eventually gain a 60% market penetration.

The first version shows the cost of the network at normal market labor rates. The second shows labor rates at prevailing wage rates.

	Market Labor	Prevailing Wage
Fiber	$12,992,234	$15,252,949
Drops	$ 1,984,945	$ 2,212,644
Electronics	$ 1,322,494	$ 1,400,646
Operational Assets	$ 425,613	$ 425,613
Total	$16,725,286	$19,291,852
Passings	2,689	2,689
Cost per Passing	$6,220	$7,174

Note that these costs represent a network that is 100% aerial. It's possible that some portion of the network will have to be buried for places like railroad crossings. But generally, a contractor will only choose buried fiber in cases where it would save money or where there is no other choice.

There are ways that an ISP can lower these costs. The largest component of fiber and fiber drops is labor, so an ISP that tackles some of the construction can generally save money compared to these estimates. Contractors, by definition, build profit into the cost of construction, and building with staff removes the profit. We've seen that contractors are charging a premium price to build drops in today's market because they would rather use these technicians to build fiber in some other market.

Customer Costs. Residential Fiber Electronics Costs: The assumed cost for the customer electronics (ONT) includes the installation labor. Our assumption is:

$580 for an ONT and installation at market labor rates
$618 for an ONT and installation at prevailing wage.

It might be possible that installations could cost less if they were done by ISP personnel and not contract laborers. Our analysis assumes that most businesses use the same ONT electronics used to connect to homes. Only larger businesses would require a larger ONT with more data ports. We've assumed that a WiFi modem is included in the cost of the ONT. This is a middle-of-the-road price, and there are both more expensive and less expensive ONTs available.

Fiber Drops: Fiber drops are the fiber that connects from the street to a customer premise. We have included conservatively high costs for fiber drops. The assumption has been made that with the volume of drops needed plus the anticipated speed of network deployment, the drops during the first four years of the project would be installed by external contractors. It would be possible to build drops for less using ISP staff, but the huge volume of installations during the first five years is probably more than what company personnel can handle.

$1,203 for aerial drops at market labor rates
$1,341 for aerial drops at prevailing wage.

One of the biggest factors in determining drop costs is the average distance from customers to the road. In the rural parts of the county, homes are further from the road in the rural areas compared to the towns and cities.

Customer Penetration Rates. One of the most important variables in the assessment is the customer penetration rate or the percentage of the homes and businesses in the county that will buy broadband service.

The analysis looks at customer penetration rates in several different ways. The base scenario begins with what we call expected rates. We used an expected penetration rate of 60% to begin our analysis. We think this is a conservative penetration rate because a fiber provider would win a large majority of customers over time. We also look at a range of other penetration rates to demonstrate the impact of penetration rates on financial performance. We normally expect this to be the most important variable.

Expense Assumptions

Expenses are the recurring costs of operating the business once it's built. The forecasts represent our best estimate of operating expenses and are not conservative. As mentioned earlier, expenses are estimated on an incremental basis, meaning that the forecasts only consider new expenses that are needed to open a new market. In an incremental analysis, we don't show a share of the costs of the accountant who would be keeping the books if that position already exists and is on the payroll. An incremental study would assume, for example, that an existing ISP is already paying for positions like an accountant and not include those costs in the analysis.

An existing ISP is already going to have the processes in place to be an ISP. It will already have the software needed to take orders and bill customers. It will already have the systems in place to track inventory and customer locations. It will already have functions like network monitoring, responding to customer troubles, and numerous other systems in place. An existing ISP will have an executive team in place who will operate the business, handle accounting, human resources, insurance, legal, etc. It's unlikely that adding the customers from this project would drive an existing ISP to hire any new people for the backoffice functions. If an ISP is already operating in your area, it's likely that they would only add technicians in trucks and customer service representatives.

Following are a few of the most important expense assumptions.

Inflation. We've used an annual inflation rate of 2.5%. That has been the average historic inflation rate over the last several decades. We know there are years when inflation will be higher than that. If inflation stays higher than the historical average, an ISP will have to raise rates to cover the impact of inflation.

Employees: Labor is one of the largest expenses of operating a broadband network. The models assume that an ISP will need to hire additional staff to take care of the new customers. We have assumed salaries at market rates with an annual 2.5% inflation increase for all positions. We've assumed that the benefit loading is 40% of the basic annual salary. That would cover payroll taxes and other taxes like workers' compensation, as well as employee benefits. At a minimum, expanding an ISP to cover the county will require the following incremental new employees:

Customer Service Representative. This is the staff that takes new orders and answers customer questions about billing, services, etc. We've assumed the business will require the following new positions:

Existing Commercial ISP	1 new CSR

Install/Repair Technician. These technicians provide maintenance and repair calls. The technicians would maintain both network electronics and facilities as well as customers. We've assumed the business will require the following new positions:

Existing Commercial ISP	1 new outside technician

We assumed that construction contractors would build the fiber network. We've also assumed that customer installations will be outsourced during the construction process and for a year after. However, once the bulk of customers has been added, the forecasts assume that the ISP will do future installations.

Start-Up Costs: To be conservative, there are some start-up costs included in each scenario. There are one-time expenses associated with launching a new business or new market, and rather than listing them all we have included them as start-up costs.

Sales and Marketing Expenses: Every scenario will require a significantly high customer penetration rate to be successful. We used the assumption that there would be a marketing effort to sign customers. We've assumed an average cost of $200 in sales and marketing costs for each new customer added. It is likely that well-known local ISPs could spend less on marketing. Some entities like cooperatives can sometimes avoid most traditional marketing costs.

Delivery of Products: The projections assume that the new business will not construct a headend to provide the services. The studies assume that a wholesale basic telephone line can be purchased wholesale at $6 per month. A line with unlimited long-distance is assumed to cost $9. It's possible to buy telephone lines for less than these estimates. The studies assume there is no cable TV product.

Maintenance Expenses: There are a number of routine maintenance expenses that the new business would incur on an incremental basis. These include:

- Vehicle expenses to maintain the vehicles required for the field technicians.
- Computer expenses to support the computers used by employees.
- Tools and equipment expenses.

- Power expenses to provide power to the network.
- General maintenance and repair of the outside plant network and the electronics to repair damaged or nonfunctional electronics.
- Internet Backbone. Since this is an incremental analysis, we have shown only incremental increases in the cost of Internet bandwidth.

Software Expense: ISPs typically maintain a complex software system called BSS/OSS (billing and operational support systems). This software provides a wide range of functions: order taking, provisioning new customers, tracking customer equipment, tracking inventory, creating customer bills, and tracking customer payments (or nonpayment). Since most such software is billed to providers on a per-customer basis, we have assumed an expense for this maintenance.

Billing: Billing costs are shown as the incremental cost used to bill customers. We assumed that there would be some mix of mailing paper bills, charging bills to credit cards, and charging bills directly as debits to bank accounts.

Taxes: The model assumes that if a commercial ISP operates the business, it will pay state and federal income taxes. These taxes would not apply to a municipal business or a non-profit.

We have assumed no property taxes on assets, but it's possible that some amount of this might apply. There are a few places in the country that charge property taxes on fiber networks, but most of the country doesn't.

The forecasts do not include any taxes assessed to customers. For example, this business would charge and collect various sales and telephone taxes. The models don't show these taxes, and the assumption is that the taxes would be collected and sent to the tax authorities on the customers' behalf. The expenses are a passthrough on the ISP books rather than a revenue or expense.

Overhead Expenses: The forecasts include minor overhead expenses. Since this is an incremental model, it does not include allocated expenses such as an allocation of the general manager's salary. However, there are incremental costs attributable directly to the new business. This would include things like legal expenses, accounting audit expenses, consulting expenses, business insurance, and other similar expenses that are related to entering a new market.

Depreciation and Amortization Expense: The forecasts include both depreciation and amortization expense. These are the expenses recognized by writing off assets over their expected accounting lives. For example, the depreciation rate for a vehicle is 20% per year (it is written off over five years). The cost of a new vehicle is depreciated monthly to write off the asset over five years or sixty months. All hard assets are depreciated except land. Depreciation rates are set according to the expected life of the assets—something that is usually determined to comply with IRS rules and accounting standard practices. Soft assets like software are amortized using the same process as depreciation.

B. Financial Results

We created the financial analysis for two purposes. First, this is the only way to understand the amount of grant funding that is needed for different scenarios. Second, the analysis provides an outside opinion showing ISPs the possibility of operating profitably in the unserved areas.

We always try to be conservative in creating financial forecasts. By conservative, we mean that an actual business plan ought to perform a little better than what we are projecting.

It is never easy to summarize the results of complicated business plans and make them understandable to the nonfinancial layperson. The following summary shows a few key results of each scenario that we think best allow a comparison of the numbers between scenarios. Note that a table of all the financial results is included in Exhibit II, which makes it easier to compare different scenarios.

There are a few key assumptions in the base analysis:

- We've assumed an all-fiber network using XGS-PON electronics capable of delivering 10 gigabit broadband.
- We've assumed that the network would be constructed and owned by existing ISPs.
- Construction costs reflect 100% aerial construction.
- We've assumed a 60% market penetration, meaning that 60% of customers would buy broadband on the new network.
- We use broadband rates that start at $65.
- We've assumed that non-grant funding would consist of 85% loans, financed at 7.5% for 25 years, and the remainder from equity.

All of these assumptions affect the amount of grant funding that is needed, and we went on to analyze numerous scenarios to understand the financial characteristics of operating an ISP in the county.

Results of the Forecasts

This scenario looks at the ability of an existing commercial ISP to bring fiber to every home and business in the area. This scenario assumes an ISP that is already operating nearby. An ISP that is already serving nearby can add on the county with the smallest amount of incremental new cost. The ISP might only have to add part-time staff to add this area to the existing business. A commercial ISP that is not nearby would incur additional staff and other costs needed to open a new market.

Two Scenarios. The following table shows the results of our analysis at both market wages and prevailing wages. As mentioned earlier, prevailing wages are often required for projects funded with grants. In rural Florida, the labor cost of prevailing wages is approximately 15% higher than market wages for construction. The following tables shows two results for each scenario. The Base column shows the project funded using a 75% broadband grant. The second column for each scenario shows a breakeven scenario.

In this case, breakeven is defined to show the as in the report as a scenario where the grant is set to a level that makes sure the project never runs out of cash, but no higher. ISPs would be reluctant to do a project at a breakeven amount of grant, so a typical ISP will expect more grant than is shown in the breakeven column.

	Market Wages		Prevailing Wage	
	Base	Breakeven	Base	Breakeven
Asset Costs	$ 16.7 M	$ 16.7 M	$ 19.3 M	$ 19.3 M
Grant	$ 11.5 M	$ 9.2 M	$ 13.4 M	$ 11.8 M
Equity	$ 1.0 M	$ 1.4 M	$ 1.1 M	$ 1.4 M
Debt	$ 5.7 M	$ 8.1 M	$ 6.4 M	$ 8.1 M
Total Financing	$ 18.2 M	$ 18.7 M	$ 20.9 M	$ 21.3 M
Cash after 5 Years	$ 0.46 M	$ 0.25 M	$ 0.40 M	$ 0.24 M
Cash after 10 Years	$ 1.47 M	$ 0.08 M	$ 1.00 M	$ 0.03 M
Cash after 15 Years	$ 3.05 M	$ 0.48 M	$ 2.13 M	$ 0.37 M
Cash after 20 Years	$ 5.63 M	$ 1.88 M	$ 4.27 M	$ 1.70 M

This shows that building fiber in the rural areas is only feasible with substantial grant funding.

- It's obvious that a substantial amount of grant funding is needed to support build fiber in the unserved parts of the county. This is not unexpected due to the cost per passing that that is over $6,200 for the market wage scenario and even higher with prevailing wages.
- This table shows that both scenarios can be profitable with a 75% broadband grant, but that an ISP could ask for less than 75% if needed to win a broadband grant.

Sensitivity Analysis

The sensitivity analyses looks at how the base cases shown above would change by varying key variables of the business plan.

Customer Penetration Rate

The most significant variable affecting the success of a fiber project is usually the customer penetration rate – the percentage of customers that buy broadband. The numbers below show a breakeven grant scenario for penetration rates between 50% and 70%.

Market Wages	50%	55%	60%	65%	70%
Asset Costs	$ 18.2 M	$ 16.5 M	$ 16.7 M	$ 17.0 M	$ 17.2 M
Grant	$ 11.3 M	$ 10.2 M	$ 9.2 M	$ 8.1 M	$ 8.1 M
Equity	$ 1.0 M	$ 1.2 M	$ 1.4 M	$ 2.1 M	$ 1.6 M
Debt	$ 5.8 M	$ 7.0 M	$ 8.1 M	$ 9.3 M	$ 9.3 M
Total Financing	$ 18.0 M	$ 18.4 M	$ 18.7 M	$ 19.1 M	$ 19.1 M
Cash after 5 Years	$ 0.25 M	$ 0.24 M	$ 0.25 M	$ 0.22 M	$ 0.23 M
Cash after 10 Years	$ 0.07 M	$ 0.05 M	$ 0.08 M	$ 0.04 M	$ 0.07 M
Cash after 15 Years	$ 0.31 M	$ 0.35 M	$ 0.48 M	$ 0.51 M	$ 0.65 M
Cash after 20 Years	$ 1.31 M	$ 1.54 M	$ 1.88 M	$ 2.10 M	$ 2.47 M

% Grant to Assets	70%	62%	55%	48%	41%
Prevailing Wages	50%	55%	60%	65%	70%
Asset Costs	$ 18.7 M	$ 19.0 M	$ 19.3 M	$ 19.6 M	$ 19.8 M
Grant	$ 13.8 M	$ 12.8 M	$ 11.8 M	$ 10.8 M	$ 9.8 M
Equity	$ 1.0 M	$ 1.2 M	$ 1.4 M	$ 1.6 M	$ 1.8 M
Debt	$ 5.7 M	$ 6.9 M	$ 8.1 M	$ 9.2 M	$ 10.4 M
Total Financing	$ 20.5 M	$ 20.9 M	$ 21.3 M	$ 21.6 M	$ 23.3 M
Cash after 5 Years	$ 0.25 M	$ 0.23 M	$ 0.24 M	$ 0.22 M	$ 0.23 M
Cash after 10 Years	$ 0.03 M	$ 0.02 M	$ 0.03 M	$ 0.04 M	$ 0.05 M
Cash after 15 Years	$ 0.20 M	$ 0.27 M	$ 0.37 M	$ 0.48 M	$ 0.57 M
Cash after 20 Years	$ 1.13 M	$ 1.41 M	$ 1.70 M	$ 2.02 M	$ 2.34 M
% Grant to Assets	74%	67%	61%	55%	52%

The above tables demonstrates the following:

- The higher the penetration rate, the higher the asset costs - it costs more to add additional customers.
- Even using the conservative assumptions in our analysis, BEAD grants will work to fund a penetration as low as 50%. With that said, the rest of the sensitivity analysis below shows there are ways to improve on the numbers in the above table.

We finally note that ISPs are unlikely to pursue a grant that only breaks even over twenty years, so ISPs would be asking for higher amounts of grant than shown in these tables.

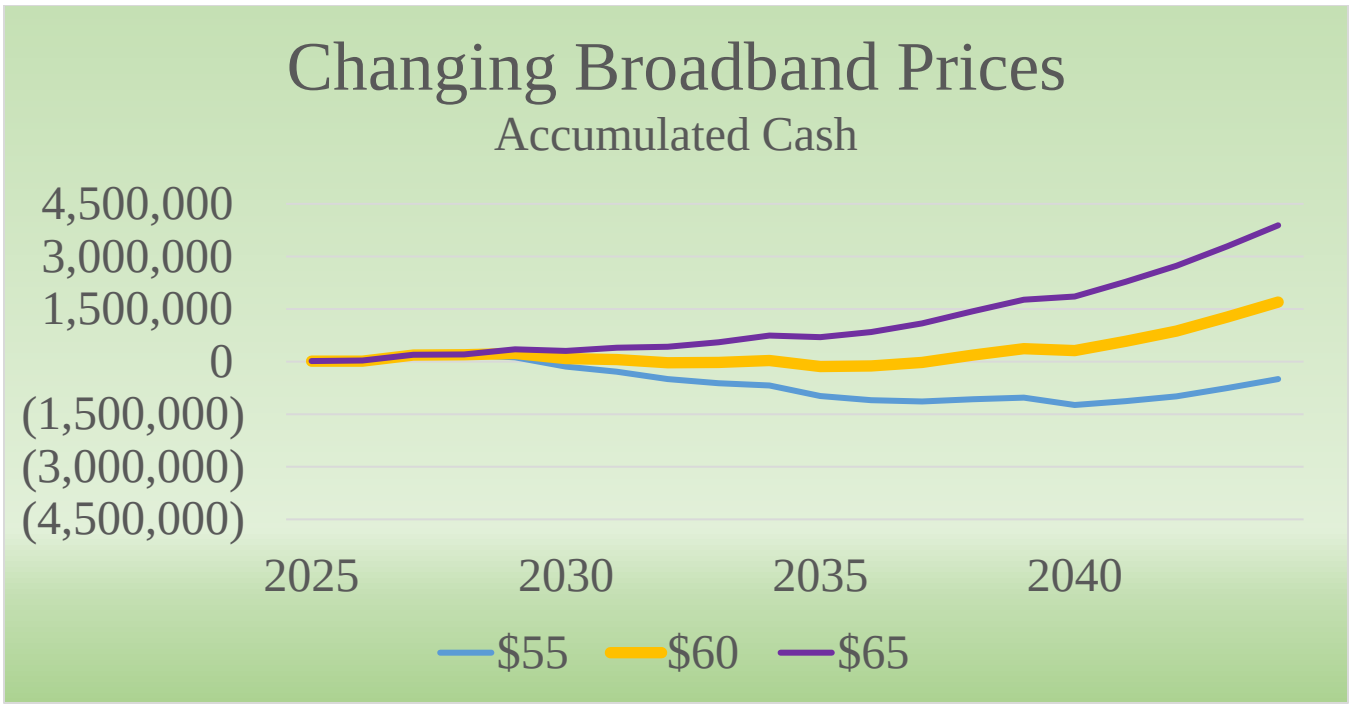
Changing Broadband Prices

We looked at the impact of changing broadband prices. Increasing broadband prices by $5 per month (changing the base rate from $60 to $65) increases cash flow over 20 years by almost $2.2 million. This means that a $1 change in broadband prices changes the 20-year cash flow by approximately $438,000. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by $2.2 million.

This high sensitivity to prices means several things for an ISP.

- An ISP should be careful about lowering rates in the future. For example, if a future marketing plan suggests cutting rates to gain customers, the long-term impact of lower rates could be devastating for cash generation.
- This sensitivity shows that an ISP can raise rates to cover expected cash shortfalls (to the extent that the market will accept higher prices.

The following graph shows the swing in financial performance due to changing prices upward or downward by $5. The yellow line represents the base case with broadband rates at $65.



Mix of Products

The forecasts make an assumption about the number of customers that will buy each product. The forecast takes a conservative approach and assumes that only 7% of customers that will buy gigabit broadband. We used the conservative assumption based upon the poverty level and the low incomes in the county. One sensitivity analysis looks at assuming a higher penetration of the more expensive broadband, as follows:

Residential Fiber Broadband	Price	Base Study	Sensitivity
100 Mbps	$60	60%	35%
250 Mbps	$75	33%	40%
Gigabit	$90	7%	25%
Business Fiber Broadband			
100 Mbps	$ 95	50%	40%
25- Mbps	$110	40%	35%
Gigabit	$125	10%	25%

Changing this assumptions has a significant impact on cashflow, and over twenty years adds almost $1.2 million in cash. Changing this assumptions in a feasibility study is different than achieving it in real life. We find it highly likely that an ISP will do better than the conservative assumptions used in the study – but it's hard to know how much better. We learned in the survey that 25% of respondents said they would be willing to pay at least $80 per month for fast broadband – but how many of them would do so if they were offered a fast product for less than that?

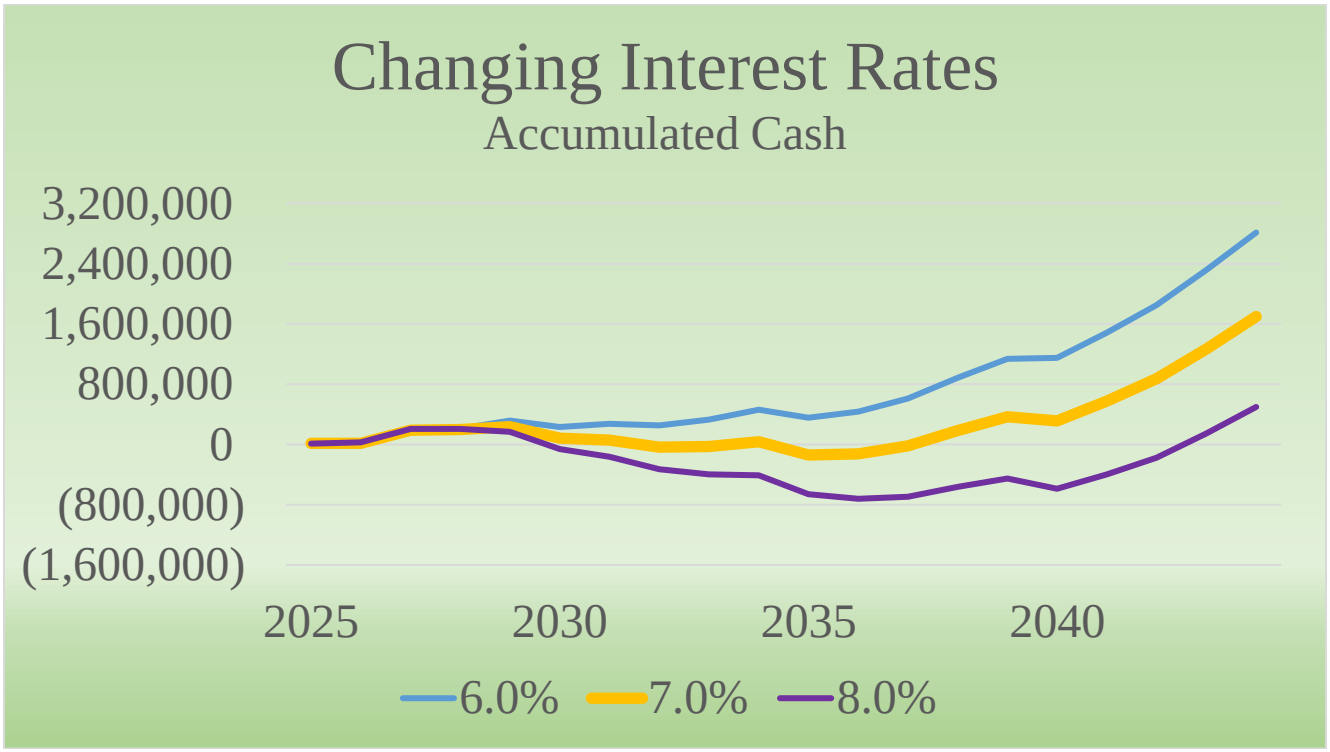
Changing Financing Terms

We looked at the impact of changing the various financing parameters.

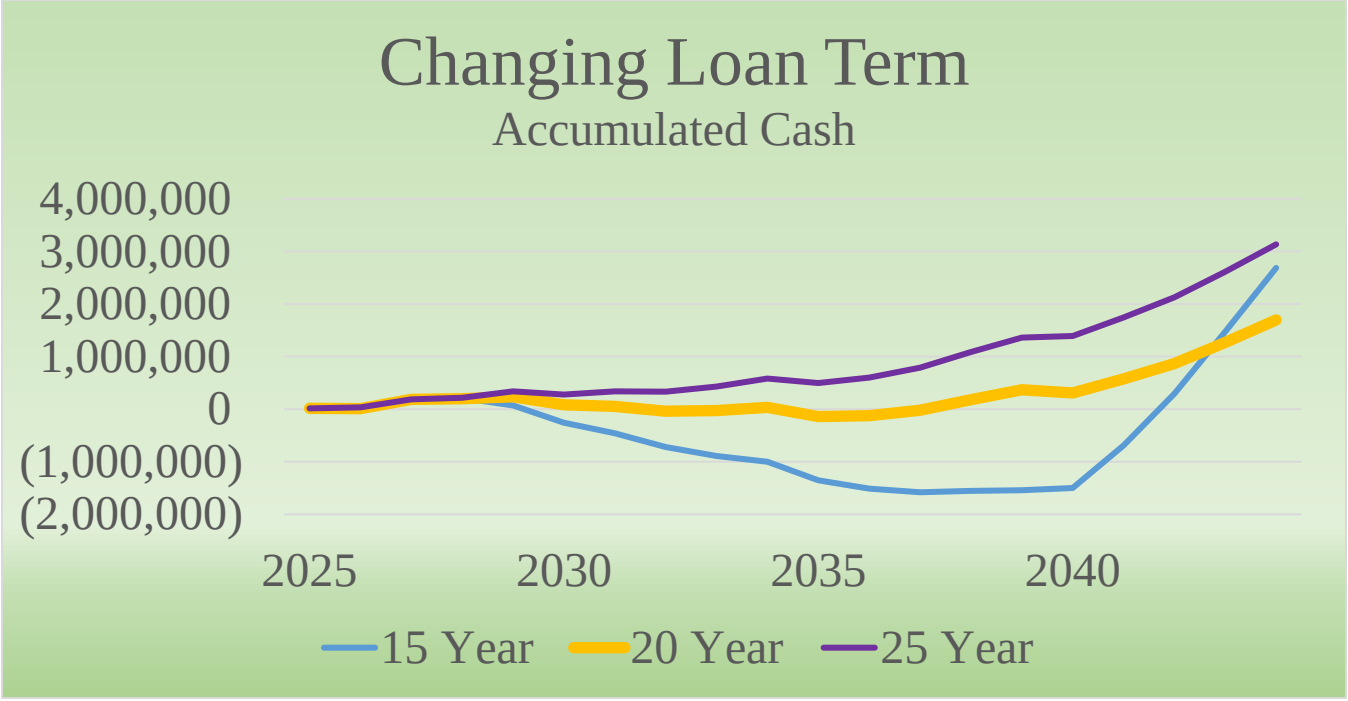
Interest Rate. Our base study assumed an interest rate of 7%. We looked at a scenario that lowered the interest rate by 100 basis points, or 1% (in this case, lowering the interest rate from 7% to 6%.). Lowering the interest rate by 100 basis points improves cash flow by more than $1.1 million over twenty years. The impact of increasing the interest rate to 7.5% was similar and decreased cash flow by $1.2 million over twenty years.

This result provides a warning that anybody planning a new fiber network during a time of financial uncertainty should keep a close eye on interest rates and not proceed if interest rates move too high. If an ISP must finance at a high interest rate, it should make sure that the loan can be refinanced in the future if interest rates drop. Interest rates have been low and stable for the last decade, but looking back over the last fifty years, it's more normal for interest rates to fluctuate.

The graph below is the prevailing wage scenario at 6%, 7%, and 8% interest rates.



Loan Term. Loan term refers to the number of years of payments on a loan. The base scenario assumed a 20-year loan term. Changing the loan term changes cash flow since it changes the annual debt payments - much like what happens with longer or shorter-term home mortgages. We looked at the impact of increasing the loan term to 25 years. This increased cash over 20 years by almost $1.5 million. We also looked at decreasing the loan term to 15 years. This scenario does not work since the business doesn't have enough cash to cover the higher debt payments. The following graph shows the impact of using a 15-year, 20-year, and 25 year loan term.



Refinancing the Loans. Any ISP borrowing money at today's high interest rates is likely counting on the possibility of someday refinancing the loan if interest rates drop. We looked at a scenario where the original loans are refinanced after five years to an interest rate of 4.5%. This is not a prediction that rates will be lower by then but is a way to quantify the impact if refinancing is possible.

Refinancing increased cash flow over 20 years by over $2 million. It's likely that any ISP that borrows at current interest rates will try to refinance loans at some future point.

$1 Million Cost Overrun. We looked at the impact of spending $1 million more on assets than is budgeted. We've assumed that a cost overrun would add $1 million to debt and $200,000 to equity. This reduces cash flow by almost $1.7 million over twenty years.

Funding With Equity Instead of Debt. Most small ISPs have no option other than using debt to finance the matching funds required to obtain a grant. Small ISPs rarely carry any substantial cash reserves. However, large ISPs like the big telcos and cable companies, or ISPs backed by investment bankers can fund most capital spending with equity.

Our analysis shows that adding $1 million extra in equity improves cash flow over 20 years by $2.2 million. The increase in cash is due to less borrowing. An ISP using more equity will see a big cash benefit by avoiding debt payments. The above is a good demonstration of the advantage that big ISPs have over small ones. Big ISPs can accept grants without incurring the burden of debt payments. That lets them accept smaller grants for the identical project compared to smaller ISPs.

A More Optimistic Scenario

The base scenario includes a number of conservative assumptions. In this scenario we looked at a more optimistic scenario that an ISP might contemplate when pursuing a grant.

- We increased the starting broadband price by $5 per month to $65.
- We assumed the ISP would be able to obtain a 25-year loan term.
- The ISP will assume that debt can be refinanced in the fifth year.

Making these three changes to the forecast would allow for an ISP to need less grant funding. Following is a comparison of the original conservative base study and the breakeven scenario for this more optimistic scenario:

Market Wages	Base	Optimistic
Asset Costs	$ 16.7 M	$ 16.7 M
Grant	$ 9.2 M	$ 11.6 M
Equity	$ 1.4 M	$ 2.1 M
Bank Debt / Bond	$ 8.1 M	$ 5.5 M
Total Financing	$ 18.7 M	$ 19.2 M
% Grant to Assets	55%	33%

This may be the most important result of the analysis because it shows that ISPs have options and ways to justify asking for less than the maximum of amount of grants available in a grant program. There are other assumptions that could improve the optimistic view even more, such as assuming a higher penetration rate or that more customers would buy gigabit broadband.

What Conclusions Can We Draw for a Commercial ISP?

There are a number of conclusions we can draw from the results of the business plan analysis:

It's Feasible for ISPs to Operate Successfully with Grants

Our analysis started with conservative assumptions – in particular, the assumption that an ISP would achieve a 60% penetration rate, would have broadband rates starting at $60, and would only convince 7% of customers to subscribe to gigabit speeds. Even with these conservative assumptions, it looks feasible for a commercial ISP to successfully pursue a BEAD grant at an amount less than the 75% maximum grant and still be profitable.

However, the sensitivity analysis shows that using more optimistic assumptions can make it easier to justify lowering the amount of grant requested. Obviously, an ISP has to believe the more optimistic assumptions. Many of the more optimistic assumptions are backed by our findings in the statistically valid customer survey.

The Forecasts are Sensitive to Changes in Other Key Variables

There are a few key assumptions that have the biggest impact on the forecasts and on operating the ISP business.

- Financing with equity instead of debt makes it easier to be successful since covering debt payments are a big burden on a rural business plan. But anybody financing with equity will have earnings expectations, and it's also a challenge to make a sufficient return on equity.
- The expected penetration rate is probably the most important variable. The analysis shows that it would be a lot harder to be successful if the eventual penetration rate doesn't climb over 50% of households. However, exceeding the 60% penetration rate significantly adds to future cash flow.
- The other penetration rate that matters is the percentage of customers that buy faster and more expensive products. In some markets a large majority of customers buy the lowest-price product, while in others, customers care more about speed than price.
- For ISPs using debt to finance grant matching funds, the interest rate is of key importance. But perhaps even more important in this environment of high interest rates is the hope that in a few years that interest rates will return to normal, and that a project financed today can be refinanced at a lower interest rate.
- The other key variable is price. Increasing the prices across the board for broadband products can significantly increase cash flow over time. There is always a concern that higher prices means fewer customers – but a price differential of $5 per month will probably not make a big difference.
- Finally, it's important for an ISP to not have cost overruns after winning a grant. Once a grant has been awarded, the amount of grant can't be modified if the ISP realizes higher than expected costs. As this report is being written, inflation has returned closer to historical levels. But just a year or two ago there was significant inflation that negatively impacted any ISP that won a grant before the inflationary period.

The Importance of the Breakeven Calculations - and the Important of Expected Returns

The numbers in the tables above were calculated based on the amount of grant funding needed to achieve financial breakeven. Breakeven is defined in our analysis as making a large enough initial investment so that the business always maintains a positive cash balance. The breakeven scenario is not a profitable scenario – just one that doesn't run out of cash.

Each ISP will have a different definition of profitability, and if you talk to a dozen ISPs, you might find a dozen different ways methods for calculating profitability.

Most commercial ISPs measure success by meeting some return goal, although some smaller ISPs only care about the amount of free cash spun off by a business at the end of the year. Every return calculation includes both a numerator and denominator, and commercial ISPs don't use the same numerators or denominators. As an example, one ISP may expect a certain return on equity, with the numerator being based on operating margin, while another ISP may expect a return on equity based on free cash flow. Other ISPs use a metric of return on assets. Other ISPs measure success based on the internal rate of return (IRR), which is the net present value in today's dollars for future expected earnings.

Calculating profits can get complicated, and so anytime an ISP talks about a desire to make a specific return, it's vital to see the formula the ISP is using to calculate its return. A return of 20% on equity expected by one ISP might turn out to be lower than an expected IRR of 6% for another ISP.

The expected return can be a huge factor for commercial ISPs, and many will only tackle new markets that meet their return goals. As can be seen by the above earnings discussions, it's difficult enough to get a rural business to the point of breakeven, let alone earn a commercially acceptable return.

C. Funding for Broadband Networks

For a large percentage of broadband projects, the biggest challenge is finding funding. This section of the report looks at the various ways that other communities have been able to fund broadband networks. The following discussion covers both commercial bank financing and bond financing. There are a number of different financing options to consider. The report examines the following:

- Federal and State Grants
- Private Financing (loans)
- Public Financing (bonds)
- Loan Guarantees
- Customer Financing
- Public-Private Partnerships

Federal Infrastructure Grants

There are several federal broadband grant programs that might benefit from this project.

Broadband Equity, Access, and Deployment Program (BEAD) Grants

This is the official name of the $42.5 billion grant program approved by Congress in November 2021. Florida will receive $1.17 billion in grants that can be used to build broadband networks.

This grant program was established by the Infrastructure Investment and Jobs Act. Congress established the following high-level requirements for this grant program. Detailed rules were defined by a Notice of Funding Opportunity.

- Every State Has a Separate Timeline. The money will go from NTIA to the states, and states will administer the grants. However, the grants must meet all of the NTIA rules. There is a detailed process for states to get access to the funding. States must allow for challenges to the maps used to define grant eligibility. After the NTIA approves a State's plan, the State will have to develop and announce the specific grant program and timing. There will not likely be any BEAD grant programs that start before the spring of 2024.
- The Grant Application is Complicated. This is the most intensive set of grant application rules ever for broadband grants.
- Definition of Broadband. Grants must adhere to two key definitions of broadband. Unserved locations are those that have no broadband options of at least 25/3 Mbps. Underserved are areas with speeds between 25/3 and 100/20 Mbps. Grants must first go to unserved areas before being used for underserved areas. Funding for anchor institutions is only allowed after serving underserved areas.

- Deployed Networks Must Deliver at least 100/100 Mbps. Technologies must be able to deliver speeds of at least 100/100 Mbps – but there are waivers to build infrastructure that meets 100/20 Mbps.
- Other Uses of the Grants. Grants don't have to all go for broadband to unserved and underserved areas. Grants can be made to connect eligible community anchor institutions. States can use the money for data collection, broadband mapping, and planning. Funding can go to serve qualifying multi-family apartments with WiFi or low-cost broadband.
- Eligible to All. BEAD doesn't give priority to any class of grant recipients. The grants can't exclude tribes, cooperatives, non-profit organizations, public-private partnerships, private companies, public or private utilities, public utility districts, or local governments from eligibility.
- Several Grant Priorities. States must give priority to grants that are deployed in counties with persistent poverty. Projects that will deliver more than the minimum speeds will be given priority. Projects that are shovel-ready will be given priority. Projects that pledge to pay prevailing wages will get priority.
- Challenge Process. Incumbent ISPs can challenge the validity of a grant area. Interestingly, the NTIA can override states in the challenges.
- Grants up to 75%. Grant applications must provide at least a 25% matching for the cost of the project. Matching may include CAREs funding and ARPA funding. Matching can also come from state grants. The NTIA rules suggest that grant applicants willing to take less than 75% will have an advantage.
- Requires Two 9's Reliability. Deployed technology must meet two 9's reliability – meaning that it can be out for two days per year and still be considered adequate.
- Construction Must be Completed in Four Years. A grant recipient must cover every home in a coverage area within four years of receiving the grant.
- Low-Price Option. Grant recipients must provide at least one low-cost broadband option for eligible households and must participate in the FCC's ACP program. Nobody is sure what this means if the ACP program ends. The NTIA is expressly forbidden from regulating rates in any manner.
- No Middle-Mile. Interestingly, any fiber built along highways must include access points at "regular and short intervals." This money is not intended for middle-mile fiber.
- Plenty of Paperwork. Grant recipients must file semiannual reports tracking the effectiveness of the grant funding.

BEAD Volume I

Florida Issued this report[21] which covers the following issues:

- Status of current grant funding that has already been used in a state to bring broadband to unserved and underserved locations.
- A list identifying the remaining unserved and underserved locations.
- A list of the community anchor institutions that don't yet have good broadband
- A description of the State's map challenge process where local governments and ISPs will be able to challenge the accuracy of the broadband maps to define areas eligible for BEAD grants.

BEAD Volume II

[21] https://www.floridajobs.org/docs/default-source/office-of-reemployment-assistance/initial-proposal---volume-i_public-comments.pdf?sfvrsn=abce5db0_2

Florida issued this report[22], which is a draft of the proposed BEAD grant rules. The report includes the following topics:

1. The Office of Broadband (OB) will determine the study areas. An applicant must file a separate application for each study area. ISPs will have to wait to see the study areas to understand how good or bad this is.
2. Grant winners are chosen purely based on grant points. This gives the State very little leeway to favor one ISP over another.
3. The State will determine high-cost areas after getting the grant applications.
4. The State is only going to disperse funds based upon completed milestones. This could mean waiting a long time to see reimbursement.
5. The State will start auditing once they've dispersed 15% of the funding. Any year that receives more than $750,000 is an automatic audit.
6. The grants give a huge priority to building fiber. It's not clear how they will do this.

Highlights of the Grant Scoring
Based on a maximum of 400 points

1. Matching – 190 points. The larger the percentage of matching funds, the more grant points. 25.1% matching gets 100 of 190 points. Matching of 55% or more gets the full 190 points.

2. Community Financial Contribution – 5 points. This can come from ISP cash or in-kind matching from communities.

3. Leverage Existing Infrastructure – 5 points. Points if the grant area connects to an existing network or there is existing infrastructure that can benefit the project.

4. Affordability – 30 Points. The ISP with the lowest cost for providing gigabit broadband gets 30 points. Other ISPs lose 1 point for every dollar higher for the gigabit rate.

5. Low-Income, Anchor Institution Rates – 15 points. ISPs must offer a low-income rate that is not dependent on ACP. ISPs must have a strategy to promote adoption.

6. Participates in ACP – 15 points.

7. Fair Labor Practices – 40 points. ISPs must meet a long list of labor requirements.

8. Speed of Deployment – 7 points. There are points for having a clear schedule. Extra points for building in less than 2 years.

9. Detailed Engineering Design and Map – 6 points.

10. Leverage Existing Resources – 7 points. ISPs get points for taking advantage of existing infrastructure like data centers, middle mile.

[22] https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=485024

11. RDOF Winners Only – 20 points. ISPs that have already completed the required RDOF deployments statewide can win up to 20 points. If they've built nothing, they lose 40 points.

12. Workforce Development – 20 points. Long list of requirements like hiring locally, apprenticeship programs, etc.

13. Community Support – 10 points. Personalized letters, a recent survey, or community feedback.

14. Support of Local Broadband Committee – 10 points. This means the local community would have undertaken this State-operated process.

15. Open-access – 20 points. Must have at least two other ISPs agreeing to serve on your network.

ReConnect Grants

In the 2017 Farm Bill, Congress created a grant program called ReConnect[23]. A new round of grants – ReConnect 5 - will open in March 2024. The new grants will include:

- $150 million in 100% grants for tribal areas or areas with persistent poverty.
- $200 million in 100% loans.
- $200 million as a combination of grants and loans.
- $150 of 100% grants for non-tribal areas.

The following is a highlight of the rules for the latest ReConnect grants.

- Speeds. The grants provide funding for areas with broadband speeds under 25/3 Mbps along with areas under 100/20 Mbps. The grants do not automatically adhere to FCC mapping data, but an applicant needs to be prepared to demonstrate why an area is eligible.
- Required Network Speeds. New networks must deliver speeds of at least 100 Mbps symmetrical.
- Eligible Entities. Almost anybody is eligible, but preference is given to tribes, local governments, non-profits, and cooperatives (including for projects involving partnerships that include those entities).
- Must be Rural. Grant-serving areas must be rural and remote. There is a ReConnect mapping tool[24] that defines if an area is eligible. To be eligible for funding, the grant area must be "15 minutes or more drive time from an urban area of 2,500-9,999 people; 30 minutes or more from an urban area of 10,000-24,999 people; 45 minutes or more from an urban area of 25,000-49,999 people; or 60 minutes or more from an urban area of 50,000 or more people." Additionally, there is a density test.
- Economic Need. The grants favor bringing broadband to Socially Vulnerable Communities.
- Prefers Open-access. Retail rates must be affordable and non-discriminatory. There are grant points awarded to those willing to offer "wholesale rates," which is another way of describing open-access.

[23] https://www.usda.gov/reconnect

[24] https://ruraldevelopment.maps.arcgis.com/apps/webappviewer/index.html?id=1e82a64056fc46e4a28361c5e9447246

- Strong Labor Standards. While the grant doesn't require Davis-Bacon prevailing wages, there are grant points awarded for agreeing to pay prevailing wages.
- Net Neutrality. Applicants must be willing to adhere to net neutrality.

HUD Community Development Block Grants (CDBG)

Grants under this program can be used to build fiber or wireless networks in areas lacking broadband access. Any grant application must meet all three of the following objectives:

- The project must benefit low- or moderate-income neighborhoods
- The project must eliminate slums/blight.
- The project must demonstrate urgent need.

The last criterion is fairly easy to demonstrate in any community without adequate broadband. The big hurdle for many grant applicants is the second objective of eliminating blight. We've seen an argument made that improving broadband improves incomes, which ultimately improves impoverished communities. For example, luring tenants to closed storefronts with good broadband meets this test.

The CDBG grants have wide latitude in considering grant applications and can be used in the following ways that benefit broadband:

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes the placing underground of new or existing distribution facilities and lines.
- Digital literacy classes as a public service.
- Economic development – grants/loans to for-profit businesses, particularly businesses that focus on broadband/Internet access and technology.

The CDBG program also makes block grants to states, which then administer state grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

It's hard to use this money to support a widespread network that serves different neighborhoods, but it can be useful to supplement other grants by using this money for low-income areas.

Smart Grid Grants

There is a lot of grant funding that will be awarded through the federal Department of Energy (DOE) related to smart grid infrastructure. This funding comes from the same Infrastructure, Investment, and Jobs Act that created the BEAD grants.

These grants will be awarded from the DOE to states, and the states will then award grants. The grants will stress electric grid resiliency. One of the best ways to gain resiliency and smart grid technologies is by deploying fiber to provide 2-way communication with network electronics and devices. Any fiber that is built for smart grid purposes could also double to bring last-mile broadband.

These grants would require partnering with a local electric utility.

The Department of Energy announced $13 billion in grants, with 30% of the funding going to small utilities selling no more than 4 million MWh of electricity annually. There will be $10.5 billion in grants from the Grid Resilience and Innovation Partnership (GRIP). Within the GRIP program, there are three separate programs:

- $2.5 billion will go to grid resiliency grants to provide infrastructure to improve the survivability of the electric grid from weather-related and other events.
- There is $3 billion for smart grid grants that can be used for projects that add intelligence to the electric grid.
- Finally, $5 billion in grants is aimed at grid innovation. This grant is looking for creative ideas for improving the electric grid.

The other grant program is the Transmission Facilitation Program, which will provide $2.5 billion to improve the long-haul electric grid between communities.

The first and immediate round of funding for the GRIP program will be $3.9 billion, with additional rounds of funding announced next year. The first round of GRIP grants was on a rapid timeline; the White House wanted to see more infrastructure spending being used. Grants will be made later this year.

- Applicants were required to submit a concept paper, which the DOE must approve before the applicant can submit for the grant. The smart grid and resiliency grants concept paper was due December 16, the Innovation grant concept paper was due January 13, and the Transmission grants were due February 1.
- The full grant applicants are due in March, April, and May.

Broadband Adoption Grants

The Infrastructure Investment and Jobs Act (IIJA) created two new grant programs to address digital equity and inclusion. This section of the IIJA recognizes that providing broadband access alone will not close the digital divide. There are millions of homes that lack computers and the digital skills needed to use broadband. The grant programs take two different approaches to try to close the digital divide.

The State Digital Equity Capacity Grant Program will give money to States to then distribute through grants. The stated goal of this grant program is to promote the achievement of digital equity, support digital inclusion activities, and build capacity for efforts by States relating to the adoption of broadband.

The Act allocates $1.5 billion to the States for this program – that's $300 million per year from 2022 through 2026. Before getting any funding, each State must submit a plan to the NTIA on how it plans to use the funding. States will have to name the entity that will operate the program, and interestingly, it doesn't have to be a branch of government. States could assign the role to non-profits or others.

The amount of funding that will go to each state is formulaic. 50% will be awarded based on the population of each state, according to the 2020 Census. 25% will be awarded based on the number of homes that have household incomes that are less than 150% of the poverty level, as defined by the U.S. Census. The final

25% will come from the comparative lack of broadband adoption as measured by the FCC 477 process, the American Community Survey conducted by the U.S. Census, and the NTIA Internet Use Survey.

The second new grant program is called the Digital Equity Competitive Grant Program. These are grants that will be administered by the NTIA and awarded directly to grant recipients. The budget for this grant program is $1.25 billion, with $250 million per year to be awarded from 2022 until 2026.

These grants can be awarded to a wide range of entities, including government entities, Indian Tribes, non-profit foundations and corporations, community anchor institutions, education agencies, entities that engage in workforce development, or a partnership between any of the above entities.

This will be a competitive grant program, with the rules to be developed by the NTIA. While the broadband infrastructure grant in the Act includes a long list of proscribed rules, Congress is letting the NTIA determine how to structure this grant program.

The two grant programs create an interesting choice for entities involved in digital inclusion. They can pursue funding through the State or compete nationwide for grants.

State Infrastructure Grants

The State of Florida has been operating the Florida Broadband Program.[25] For the last year. This was funded from the State's share of ARPA funding. The State recently announced the winners of round 2 of these grant program, and as far as we can tell, the State has spent all of the grant funding. The grant program was operated by the Office of Broadband is part of the Florida Commerce Department – the same group that will administer the BEAD grants.

Private Financing Options

Most commercial ISPs rely on traditional private financing, meaning loans. Some of the largest, publicly traded ISPs raise money through corporate bonds or use equity. Following are some key challenges that ISPs must navigate to get bank financing:

Equity: Most forms of private financing require some equity. Equity means that the borrower brings some sort of cash or cash equivalent to the business as part of the financing package. The amount of equity required will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity is required.

Equity can take a number of different forms:

- Cash: Cash is the preferred kind of equity, and lenders like to see cash infused into a new business – cash that can't be pulled out of the business and that doesn't earn interest.
- Preferred Equity: A stock corporation (like an LLC or C Corp) can raise equity by selling some form of preferred stock that acts as equity. A buyer of preferred equity usually earns some guaranteed interest rate on the equity investment, but the payments are not usually guaranteed like

[25] https://ded.mo.gov/content/broadband-development

they are for bank loans. If the business gets into a cash crunch, it must pay bank loans and other forms of debt before paying preferred equity interest.

- Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or another valuable asset to the business. In such a case, the contributed asset often must be assigned a market value, often appraised by an independent appraiser.

Bank Loan Basics: The banking industry does not like to finance long-term infrastructure projects. This is one of the primary reasons why the country has had such an infrastructure deficit. Until about the 1960s, banks would fund things like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. Various changes in banking laws require banks to maintain larger cash reserves, which makes them less willing to make long-term loans. Banks have also increased their expectations over time to favor loans with a higher interest rate. Many attribute this to the fact that giant publicly traded banks have captured most of the banking market. Banks don't like long-term loans since the interest rates get locked in for many years, possibly depriving the banks of earning more on their own equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and a broadband project might not generate enough cash in that time period to repay the loans.

Banks are also averse to start-ups and prefer to make loans to existing businesses that already have a proven revenue stream. It's extremely hard for a first-time borrower to be able to borrow the kind of money needed to build a broadband network.

Collateral. The biggest issue that borrowers have in getting a bank loan is the requirement for collateral, which is the assets a borrower pledges to a bank if the project fails. Banks like hard collateral like buildings, vehicles, shares of stock, and things they know they can readily sell for a reasonable price. Banks don't like broadband networks as collateral because even a little bit of web searching shows them that failed fiber networks are sometimes sold for pennies on the dollar. Fiber networks have little intrinsic value – all of the value of an ISP comes from the paying customers on a network.

It's important to understand the implications of collateral. Communities often ask an ISP operating nearby to build fiber in their town. What they fail to realize is that the ISP might have to pledge the entire business as collateral in order to secure the loan – meaning that if the new venture fails, the ISP could lose the whole existing business.

Return on Bank Equity. Banks don't only consider the interest rate when making loans. A bank concentrates on its return on equity and will consider a combination of factors like interest rates, upfront and monthly loan fees, the likelihood that a borrower will pay a loan off early, or borrower default. A bank will look at a dozen financial parameters before making an offer of interest rate and term – based on meeting the bank's targeted return on bank equity. There is a misperception that interest rates are negotiable, but the same project offered to multiple banks is likely to get a nearly identical financing package offered by all banks.

Federal Loans

Rural Utility Service (RUS): This is a part of the Department of Agriculture and is the only federal agency that makes direct loans for broadband projects. The Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program) furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband in eligible rural areas. These loans can't be used for any town with a population of over 20,000. The RUS acts much like a bank and follows similar lending practices. I like to describe the RUS as a bank from the 1950s because its lending rules were set by Congress to loan money for rural electrification and have never been modernized.

RUS makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband, including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan, excluding any amount requested to refinance outstanding telecommunication loans.

RUS is allowed to make loans to a wide range of entities. Borrowers can be either non-profit or for-profit and can be one of the following: corporation, limited liability company (LLC), cooperative or mutual organization, Indian tribe or tribal organization as defined in 25 U.S.C. 450b, or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

To be eligible to receive a loan under this program, the entity must:

- Submit a loan application. The loan application requires a lot of work, including pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things, which make the application expensive to prepare externally.
- Agree to complete the build-out of the broadband system described in the loan application within three years from the date the borrower is notified that loan funds are available.
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas.
- Demonstrate an equity position equal to at least 10% of the amount of the loan requested in the application; and
- Provide additional security if it is necessary to ensure financial feasibility as determined by the administrator. (For anyone other than large borrowers, this means pledging the whole existing business as collateral).

In practical terms, RUS loans are administered as follows:

- The rules say that a project needs at least 10% equity, but this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS acts as a bank, and it will require enough equity so that the projected revenues can cover debt payments.
- The loan terms are generally in the range of 12 years, but the RUS can choose to extend to 20 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under an RUS loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. The RUS typically wants the whole company of the borrower pledged as collateral. Thus, the bigger and more successful the existing company, the easier it is to meet the RUS loan requirements.
- Their collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if the project is going to share fiber with some existing network, such as one built by a school system, they would want that asset as collateral. Many borrowers find the RUS collateral demands to be impossible to meet.

The RUS loan fund is often large, and there have been many times over the last decade when the balance to be lent sat at more than $1 billion. Congress generally adds additional funds to the RUS pot each year. The RUS also has some discretion, and it has the power to include some portion of a loan as a grant that doesn't have to be repaid. This is something that can't be counted on, but we know of projects where the borrower only had to pay back 80% of what they borrowed. The RUS interest rate tends to be lower than bank rates during periods when bank interest rates move higher.

Servicing an RUS loan requires significant paperwork for drawing down funds along with significant annual reporting requirements.

Other Bank Loans

There are two specialty banks that specialize in making broadband loans that should be mentioned. The first is CoBank. This is a boutique bank that is owned collectively by telephone cooperatives. CoBank historically made loans to cooperatives but has branched out to the other parts of the industry.

CoBank is cautious and only takes on loans that look to have a high chance of success. This means it rarely loans to a start-up and prefers existing ISPs with a long history and a strong balance sheet. CoBank loans are generally at market interest rates, similar to bank rates. CoBank also wants significant collateral. Finally, CoBank loans are rarely longer than 15 years and often for shorter terms.

The other industry bank is RTFC, which is a bank owned by electric cooperatives. RTFC rarely lends to anyone other than a cooperative but could be the source of funding if a local government is partnering with a cooperative. Borrowers must typically join the cooperative as a condition of borrowing.

Loan Guarantees

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of

a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks are required to offer a significantly lower interest rate.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, which means a lot of paperwork. The agency making the guarantee will want a fee equal to several interest "points" upfront. To some extent, this process works like insurance, and the agency keeps these fees to cover some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

There are several federal agencies that might be willing to make loan guarantees for telecom projects. The following agencies are worth considering:

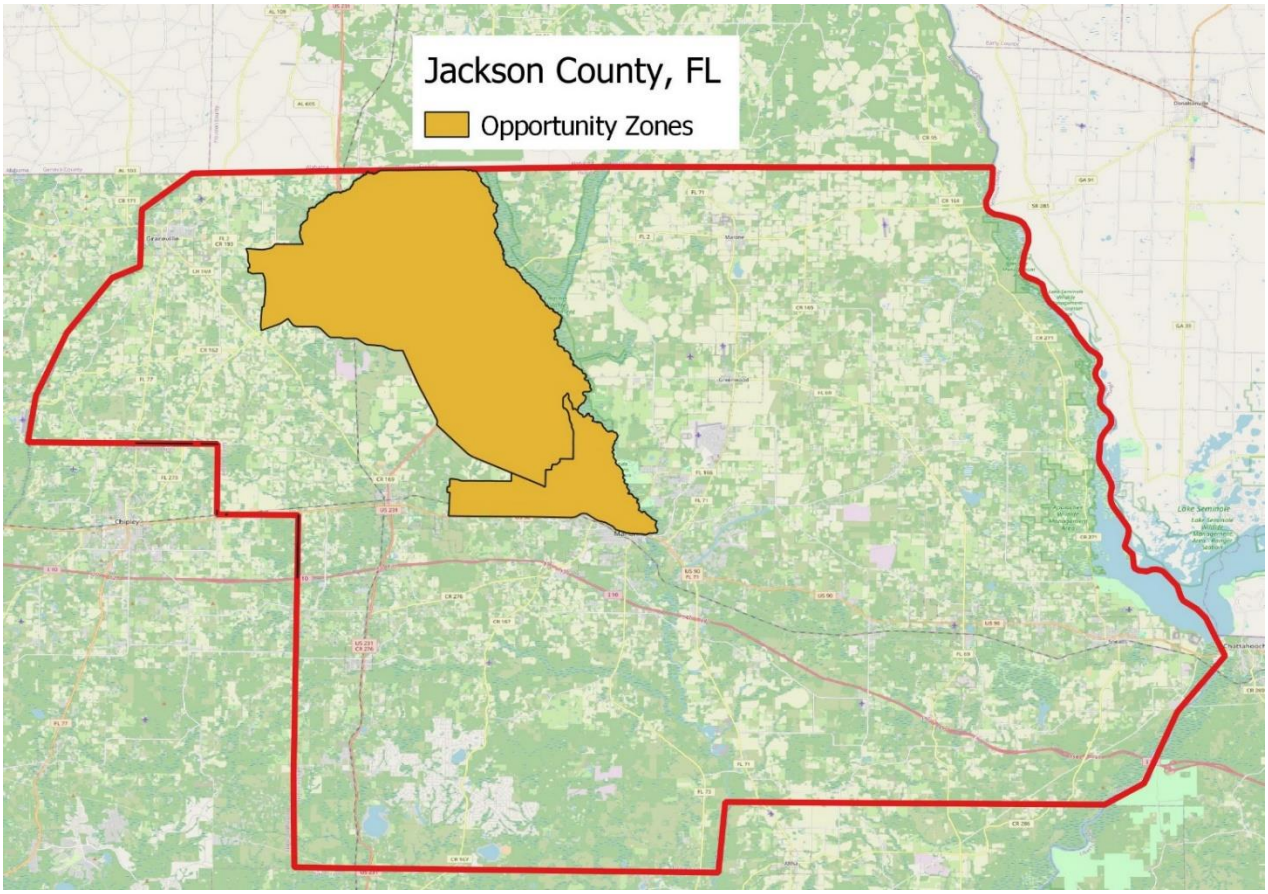
HUD 108 Program: The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the State to administer. While these loans and loan guarantees generally are housing-related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project.

Small Business Administration 504 Loan Program: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.

USDA Business and Industry Guaranteed Loans (B&I): The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

Opportunity Zones. Congress created a new investment opportunity as part of the 2017 Tax Cuts and Jobs Act. The Act created Opportunity Zones in which investors can get special capital gains treatment and other tax breaks for investing in qualified infrastructure within an opportunity zone. Each state governor designated specific opportunity zones. There are two Opportunity Zones in the northwestern part of Jackson County, shown on the map below.

Qualified investments made inside an Opportunity Zone can get special tax treatment. The first benefit is that capital gains tax can be deferred from past investments if the gains are reinvested inside of an opportunity zone. For example, if an investor had a capital gain from the sale of a property, they could invest those gains in an Opportunity Zone project and defer the original capital gains taxes until as long as 2047. Investors have until 2026 to make such investments.



An investor also gets capital gains tax forgiveness on new investments made inside an opportunity zone if that investment is held for at least ten years. Most of the opportunity zones include sizable areas of low-income residents, and a qualified investment must meet a test of benefiting that community in some significant way. A fiber network that will bring broadband to all the homes in an opportunity zone would meet that test since there are many demonstrable benefits of fiber.

The other benefit of using opportunity zone financing is that the interest rates can be favorable. Interest might be set far below market rates and some principal might be forgiven if there is enough benefit accruing to the lender.

An ISP building a network in the applicable locations could get at least part of the funding from one of the many Opportunity Zone funds that have been created to invest in qualified investments. This portion of the financing portfolio would have a lower interest rate and might not have to pay back the full cost of the investment.

New Market Tax Credits.

The New Markets Tax Credit (NMTC) Program was established in 2000 as part of the Community Tax Relief Act of 2000. The goal of the program was to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Most of rural America qualifies for new market tax credit financing. New market tax credits are normally used to fund only a small portion of a project.

The NMTC Program works by giving big tax credits to investors who are willing to invest in infrastructure projects in qualifying communities. The tax credits are so lucrative that often, the other terms for accepting the funding are modest. The tax credit equals 39% of the investment paid out—5% in each of the first three years, then 6% in the next four years, for a total of 39%.

The Community Development Financial Institutions (CDFI) Fund and the Department of the Treasury administer the program. Treasury allots credits each year in a complicated way, with the simplest explanation being that there are entities around the country each year which are awarded tax credits, and these entities work as brokers to allot the credits to specific projects. The credits are often purchased by large banks or other firms that invest in infrastructure.

In practice, these funds act like a mix of loans and credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the seven years of the tax credit and then have a balloon payment for the principal. However, some, or even all of the principal might be excused, making this look like a grant.

Public Financing Options

The two primary mechanisms used for the public financing of broadband are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. First, the term of the bond can match the expected life of the assets, and it is not unusual to find bonds for fiber projects that stretch to 25 or 30 years. It's also possible to finance a project completely with bonds, meaning that no cash or equity is needed.

Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the creditworthiness (bond rating) of the borrower as well as the perceived risk of the project. In recent years, when commercial interest rates were low, the rates for municipal bonds were similar to bank loans. But there have been times when bond rates are higher than bank rates.

For municipal entities with a good credit rating, it is easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved, there is a ready market for selling the bonds. The traditional source of public money used to finance telecom projects is through the issuance of tax-exempt municipal bonds, meaning the buyers of the bonds don't have to pay federal and/or state income taxes on the revenue from the bonds.

Customer Financing

We know of broadband projects where customers contributed some of the funding.

Property (or Other Kind of Tax) Revenues. It is possible to obtain some or all of the cost of a broadband network through a pledge of future tax revenues. That pledge can then support a bond. This is different than most bonds for a broadband network, where the network would be secured by revenues of the broadband venture. But a pledge of some other kind of tax revenue is one of the easiest ways to get a bond. Following are a few examples of this kind of financing:

- Lyndon Township, Florida: This is a township of about 1,000 homes that voted to raise property taxes to fund a fiber network. The township then partnered with a local broadband cooperative to provide services. The project is a win/win for citizens. Property taxes increased by about $25 per

month per household. The township provides inexpensive access to the cooperative, which offers attractive customer rates. This area had no broadband before the project.

- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Many of the member towns have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of its fiber network using a federal grant awarded from the Stimulus funding program in 2008. The County held a referendum and used a sales tax increase to finance bonds to pay for the remaining matching funds needed to build the project.

Direct Customer Contributions: It's also possible to fund some project costs through direct contributions from potential customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware of numerous cases where small pockets of rural homes raised the needed money to get connected to a nearby broadband network.
- Ammon, Idaho: This is the only municipal attempt at funding a network in this way. The City of Ammon will connect customers to a fiber network if they contribute $3,500 up-front to cover the cost of construction.

Public-Private Partnership (PPP). One last way that broadband projects get funded is through public-private partnerships. There is a wide variety of public-private partnerships that can be created between a local government entity and an ISP. There are many ways that revenues, profits, and risks can be shared between partners. The following discussion examines the most common forms of PPPs.

PPPs initially arose internationally as a way to finance infrastructure needs that local, regional, or national governments could not pay for upfront or finance from taxes, bonds, or other methods of raising government money. Over the last fifty years, governments collectively in the U.S. have been unable to fund the needed level of infrastructure - and PPPs were often formed to help finance the infrastructure deficit.

There are three major ways that a fiber PPP can be structured depending on who pays for the network. A fiber network could be mostly funded by the government, mostly funded by a commercial entity, or funded jointly by both.

PPP Funded Mostly by a Government. This scenario means that a government takes all of the financial risks of building a network and then hands the operations to somebody else.

PPP Funded Mostly by the Commercial Provider. There are many examples where a commercial provider has built a fiber network with some upfront assistance from a community. In most cases, the parties don't think of these arrangements as a partnership. For example, ISPs often ask for some concessions when building a fiber network.

Another common form of this kind of partnership has been happening over the last year as local governments are providing grants to ISPs using the American Rescue Plan Act funding. For this kind of arrangement to be considered a traditional PPP, the local government would have to get something in return for the concessions they make to an ISP. This could be almost anything that is perceived to be of value. It might be free or reduced telecom prices provided to government buildings or fibers connecting government locations together. It could also be the ISP agreeing to meet some social goal, such as constructing in low-income neighborhoods that a commercial ISP might otherwise not have considered.

There are several kinds of contributions that a government can make to somebody else's fiber network. This could include cash, real estate, excused fees, or sweat equity. Governments can allow a commercial provider to use parcels of land or give them an existing building. Excused fees might mean not charging for something that would normally be paid, such as permitting fees or property taxes. The government could excuse payments for poles, conduits, existing fiber, or towers. The commercial provider might not need to pay taxes or fees for some period of time, as is often done in many economic development projects. Sweat equity involves assigning value to the time contributed by the local government. For example, the local government could assign employees for free for tasks like the permitting process during a major fiber construction project.

PPP Funded Jointly. When a local government and an ISP both contribute significant cash or hard assets to a venture, it's clearly a PPP.

Examples of PPPs. There are hundreds of examples of PPPs. The ones that get the big press are when Google Fiber or other large ISPs create a partnership with a city to bring fiber. But there are myriad smaller partnerships. Perhaps the easiest way to demonstrate the different kind of PPPs is to take a look at a number of PPPs that have been formed in northwest Colorado. We chose this region because there are numerous different PPPs that have been created within a relatively small geographic area.

PPPs in Northwest Colorado

We are highlighting a cluster of counties in northwest Colorado since there are numerous PPPs in the area operating using a wide range of partnership models. Many of the partnerships in this part of the state are partially the result of middle-mile network called Project THOR that was created from a partnership between three counties, four municipalities, a local consortium of anchor institutions, a health care district, and NWCCOG – the regional economic development agency.

The original purpose of the network was to provide reliable middle-mile fiber. The entire region had been plagued by multi-day outages of the CenturyLink network – the local incumbent telephone company in the region. The outages were devastating and knocked out 911 service, hospitals, public service networks, cellular service, and many large businesses across the region.

The THOR consortium created a PPP partnership with Mammoth Networks, a regional commercial ISP, to build and operate the network. Project THOR brings two advantages to the region. First, the network is designed to carry up to 400 Gbps – much more capacity than any existing fiber in the region. Mammoth Networks was also able to string together routes that provide diversity for each city to protect against fiber

cuts. A single fiber cut on the Project THOR routes won't interrupt service to any of the member communities.

The initial network was put together with some constructed fiber, dark fiber leases from the Colorado Department of Transportation, and lit fiber routes from Strata, Comcast, and Zayo. The THOR consortium is in the process of replacing all lit fiber with its own constructed fiber. The State of Colorado Department of Local Affairs funded the construction of fiber within each member community that was used to reach key anchor institutions like hospitals, 911 centers, and public safety. The State also funded half of the electronics for the network.

The communities are free to use the THOR network in any way they see fit. The network terminates at a meet-me center created in each community. Following are a few examples of public-private partnerships that have been created to take advantage of the THOR network.

- In Moffat County, the City of Craig, population 9,000, created a partnership with Mammoth Networks to extend fiber to reach the major anchor institutions in the City.
- In Moffatt County, the Yampa Valley Electric Cooperative partnered with THOR in order to win a ReConnect grant to extend rural fiber-to-the-home.
- In Rio Blanco County, the County pursued grants to build last-mile fiber networks. The County formed a partnership with THOR and Mammoth Networks to build last-mile fiber in the Towns of Meeker and Rangely, each with a population of around 2,500. The towns had almost no broadband options before the project. The County owns the network and has a concessionaire relationship with two ISPs to serve the residents and businesses in the towns.
- In Summit County, the City of Breckenridge formed a PPP partnership with ALLO, a large ISP from Nebraska. In this partnership, the City and ALLO each paid for a part of the fiber network, which is now operated by ALLO.
- In Eagle County, the City of Glenwood Springs, population 10,300, has operated a municipal fiber network since 2002 that served businesses and anchor institutions. In conjunction with the completion of the THOR network, the City invested in last-mile fiber for the whole City. The City also formed a partnership with nearby Eagle, Colorado (population 7,500), where Eagle funded a fiber network and Glenwood Springs will operate it. This is an example of a public-public-partnership.
- In Eagle County, THOR partnered with Forethought, a local ISP, to build a series of microwave towers to cross the mountains to bring the first broadband ever to the tiny town of Red Cliff, population 279.
- In Pitkin County, the County is using the THOR backbone network to support a new network of wireless towers throughout the county. These were funded with public safety grants. Much of the County had zero cellular coverage, and these towers are being used to bring both wireless broadband and cellular service to rural areas.
- In Pitkin County, the City of Aspen partnered with THOR and Mammoth networks to build fiber to reach sixteen anchor institutions that includes public safety and the hospital. The effectiveness of the THOR network was demonstrated a few days after this anchor institution network was activated. There was a major outage on the CenturyLink fiber in the region, but the 911 Center in Aspen, as well as hospitals in Granby and Kremmling stayed connected while the rest of the area lost broadband.
- In Routt County, the City of Steamboat Springs partnered with Thor and Mammoth network to build a fiber network to anchor institutions and to also lease out to local ISPs to reach businesses.

EXHIBIT I: RESIDENTIAL SURVEY SUMMARY

Jackson County Residential Survey
95% Accuracy ± 5%
January 2023

Total Surveys - 377

1. Who provides internet services to your home now?

	Number	Percent
AT&T	27	7%
Century Link	123	33%
Consolidated Communications	4	1%
Comcast	57	15%
T-Mobile	8	2%
Verizon	21	6%
Satellite	74	20%
Only use my cellphone	15	4%
Do not have internet	48	12%

2. What is the primary reason you don't have home Internet service today?

	Number	Percent
It's too expensive	7	14%
I'm uncomfortable using broadband	2	4%
I get access outside of my home	10	21%
Not interested in the Internet	21	44%
Not available	8	17%

3. Who is your current cell phone provider?

	Number	Percent
AT&T	72	19%
T-Mobile	28	7%
Verizon	200	53%
Other Trac Phone, Straight Talk, etc.	65	17%
Don't have a cell phone	12	4%

4. Is the cell coverage good enough at your home?

	Number	Percent
Yes	246	67%
No	114	31%
Sometimes	5	2%

5. What do you pay for Bundled services?

	Number	Percent
Under $41	4	3%
$41 - $80	17	12%
$81 - $120	13	10%
$121 - $160	12	9%
$161 - $200	31	22%
$201 - $240	15	11%
$241 - $280	19	14%
$300 or more	10	7%
Not Sure	16	12%

6. What do you pay for Standalone Cable?

	Number	Percent
$60 - $80	10	9%
$81 - $120	28	26%
$121 - $160	25	23%
$161 - $200	22	20%
$201 - $240	10	9%
$241 - $280	8	8%
$300 or more	1	1%
Not Sure	4	4%

7. What do you pay for Standalone Telephone?

	Number	Percent
$20- $40	26	22%
$41 - $60	32	27%
$61 - $80	12	10%
$81 - $100	7	6%
$101 - $120	5	4%
$121 - $150	10	8%
$151 - $200	9	7%
$280 - $325	6	5%
$326 or more	7	6%
Not Sure	6	5%

8. What do you pay for Standalone Internet?

	Number	Percent
$20- $40	13	8%
$41 - $60	33	20%
$61 - $80	23	14%
$81 - $100	42	25%
$101 - $120	25	15%
$121 - $150	14	8%
$151 - $200	7	4%
Not Sure	10	6%

9. What do you think is a reasonable price for broadband?

	Number	Percent
$0 - $20	9	3%
$21 - $40	29	8%
$41 - $60	110	32%
$61 - $80	58	16.5%
$81 - $100	58	16.5%
$101 - $125	11	3%
$126 - $150	14	4%
Over $150	6	2%
Fine with current Price	7	2%
Not Sure	26	7%
Less than I'm paying now	21	6%

10. Does anybody in your household use the Internet connection for work or school?

	Number	Percent
Full time	32	8%
Several Days per week	68	18%
Occasionally	63	17%
No	214	57%

11. Is your current broadband connection adequate for work/school from home?

	Number	Percent
Yes	89	54%
No	74	46%

10. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Service Provider on the following?

Download Speeds	**Number**	**Percent**
1 Very Dissatisfied	33	10%
2 Dissatisfied	81	25%
3 Neutral	119	36%
4 Satisfied	65	20%
5 Very Satisfied	31	9%

12. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Service Provider on the following?

Customer Service	**Number**	**Percent**
1 Very Dissatisfied	30	9%
2 Dissatisfied	58	18%
3 Neutral	132	40%
4 Satisfied	71	22%
5 Very Satisfied	38	11%

13. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Service Provider on the following?

Reliability	**Number**	**Percent**
1 Very Dissatisfied	39	12%
2 Dissatisfied	59	18%
3 Neutral	121	37%
4 Satisfied	77	23%
5 Very Satisfied	33	10%

14. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Service Provider on the following?

Value I Get for the Price I Pay	**Number**	**Percent**
1 Very Dissatisfied	56	17%
2 Dissatisfied	84	26%
3 Neutral	108	33%
4 Satisfied	57	17%
5 Very Satisfied	24	7%

15. Would you buy internet service from a new Internet Service Provider if they bring faster speeds than you have today at a similar rate?

	Number	Percent
Yes	193	51%
Probably	71	19%
Maybe	71	19%
Probably Not	22	6%
Definitely Not	20	5%

EXHIBIT II SUMMARY OF FINANCIAL RESULTS

		Year 4 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 5 Cash	Year 10 Cash	Year 15 Cash	Year 20 Cash
	Market Wages										
1	**60% Penetration 75% Grant**	$16.7 M	60%	$ 5.7 M	$1.0 M	$11.5 M	$18.2 M	$0.46 M	$1.47 M	$3.05 M	$5.63 M
2	**60% Penetration Breakeven**	$16.7 M	60%	$ 8.1 M	$1.4 M	$ 9.2 M	$18.7 M	$0.25 M	$0.08 M	$0.48 M	$1.88 M
3	**50% Penetration 75% Grant**	$16.2 M	50%	$ 5.8 M	$1.0 M	$11.3 M	$18.0 M	$0.25 M	$0.07 M	$0.31 M	$1.31 M
4	**50% Penetration Breakeven**	$16.2 M	50%	$ 5.8 M	$1.0 M	$11.3 M	$18.0 M	$0.25 M	$0.07 M	$0.31 M	$1.31 M
5	**55% Penetration 75% Grant**	$16.5 M	55%	$ 5.7 M	$1.0 M	$11.4 M	$18.1 M	$0.37 M	$0.77 M	$1.66 M	$3.45 M
6	**55% Penetration Breakeven**	$16.5 M	55%	$ 7.0 M	$1.2 M	$10.2 M	$18.4 M	$0.24 M	$0.05 M	$0.35 M	$1.54 M
7	**65% Penetration 75% Grant**	$17.0 M	65%	$ 5.7 M	$1.0 M	$11.6 M	$18.3 M	$0.58 M	$2.19 M	$4.44 M	$7.81 M
8	**65% Penetration Breakeven**	$17.0 M	65%	$ 9.3 M	$1.6 M	$ 8.1 M	$19.1 M	$0.22 M	$0.04 M	$0.51 M	$2.10 M
9	**70% Penetration 75% Grant**	$17.2 M	70%	$ 5.6 M	$1.0 M	$11.7 M	$18.3 M	$0.68 M	$2.88 M	$5.82 M	$10.01 M
10	**70% Penetration Breakeven**	$17.2 M	70%	$10.5 M	$1.8 M	$ 7.1 M	$19.4 M	$0.23 M	$0.07 M	$0.65 M	$2.47 M
	Based on Line 2										
11	**More Gigabit Customers**	$16.7 M	60%	$ 8.0 M	$1.4 M	$ 9.2 M	$18.6 M	$0.30 M	$0.45 M	$1.23 M	$3.06 M
12	**Higher Prices**	$16.7 M	60%	$ 8.0 M	$1.4 M	$ 9.2 M	$18.6 M	$0.36 M	$0.79 M	$1.87 M	$4.07 M
13	**Lower Prices**	$16.7 M	60%	$ 8.2 M	$1.5 M	$ 9.2 M	$18.9 M	$0.13 M	($0.63 M)	($0.92 M)	($0.31 M)
14	**Higher Interest Rate**	$16.7 M	60%	$ 8.3 M	$1.5 M	$ 9.2 M	$18.9 M	$0.17 M	($0.37 M)	($0.35 M)	$0.68 M
15	**Lower Interest Rate**	$16.7 M	60%	$ 8.0 M	$1.4 M	$ 9.2 M	$18.6 M	$0.30 M	$0.49 M	$1.25 M	$3.01 M
16	**15-Year Term**	$16.7 M	60%	$ 8.4 M	$1.5 M	$ 9.2 M	$19.0 M	$0.05 M	($0.98 M)	($1.44 M)	$2.90 M
17	**25-Year Term**	$16.7 M	60%	$ 8.0 M	$1.4 M	$ 9.2 M	$18.6 M	$0.33 M	$0.62 M	$1.47 M	$3.34 M
18	**Refinance**	$16.7 M	60%	$ 8.1 M	$1.4 M	$ 9.2 M	$18.7 M	$0.36 M	$0.84 M	$1.90 M	$3.96 M
19	**Add $1M Equity**	$16.7 M	60%	$ 6.7 M	$2.5 M	$ 9.2 M	$18.4 M	$0.36 M	$0.89 M	$1.80 M	$4.08 M
20	**$1M Cost Overrrun**	$17.7 M	60%	$ 9.2 M	$1.6 M	$ 9.2 M	$20.0 M	$0.15 M	($0.54 M)	($0.66 M)	$0.22 M
21	**Lines 12 + 17 + 18**	$16.7 M	60%	$ 7.8 M	$1.4 M	$ 9.2 M	$18.4 M	$0.56 M	$2.11 M	$4.32 M	$7.65 M
22	**Lines 12 + 17 + 18 Breakeven**	$16.7 M	60%	$11.6 M	$2.1 M	$ 5.5 M	$19.2 M	$0.29 M	$0.51 M	$1.39 M	$3.38 M

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		Year 4 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 5 Cash	Year 10 Cash	Year 15 Cash	Year 20 Cash
	Prevailing Wage										
23	**60% Penetration 75% Grant**	$19.3 M	60%	$ 6.4 M	$1.1 M	$13.4 M	$20.9 M	$0.40 M	$1.00 M	$2.13 M	$4.27 M
24	**60% Penetration Breakeven**	$19.3 M	60%	$ 8.1 M	$1.4 M	$11.8 M	$21.3 M	$0.24 M	$0.03 M	$0.37 M	$1.70 M
25	**50% Penetration 75% Grant**	$18.7 M	50%	$ 6.5 M	$1.1 M	$13.1 M	$20.7 M	$0.18 M	($0.39 M)	($0.58 M)	$0.00 M
26	**50% Penetration Breakeven**	$18.7 M	50%	$ 5.7 M	$1.0 M	$13.8 M	$20.5 M	$0.25 M	$0.03 M	$0.20 M	$1.13 M
27	**55% Penetration 75% Grant**	$19.0 M	55%	$ 6.4 M	$1.1 M	$13.2 M	$20.8 M	$0.29 M	$0.30 M	$0.77 M	$2.12 M
28	**55% Penetration Breakeven**	$19.0 M	55%	$ 6.9 M	$1.2 M	$12.8 M	$20.9 M	$0.23 M	$0.02 M	$0.27 M	$1.41 M
29	**65% Penetration 75% Grant**	$19.6 M	65%	$ 6.4 M	$1.1 M	$13.5 M	$21.0 M	$0.51 M	$1.70 M	$3.51 M	$6.42 M
30	**65% Penetration Breakeven**	$19.6 M	65%	$ 9.2 M	$1.6 M	$10.8 M	$21.6 M	$0.22 M	$0.04 M	$0.48 M	$2.02 M
31	**70% Penetration 75% Grant**	$19.8 M	70%	$ 6.4 M	$1.1 M	$13.7 M	$21.1 M	$0.62 M	$2.39 M	$4.87 M	$8.58 M
32	**70% Penetration Breakeven**	$19.8 M	70%	$10.4 M	$1.8 M	$ 9.8 M	$23.3 M	$0.23 M	$0.05 M	$0.57 M	$2.34 M
	Based on Line 24										
33	**More Gigabit Customers**	$19.3 M	60%	$ 8.0 M	$1.4 M	$11.8 M	$21.2 M	$0.29 M	$0.41 M	$1.12 M	$2.88 M
34	**Higher Prices**	$19.3 M	60%	$ 8.0 M	$1.4 M	$11.8 M	$21.1 M	$0.35 M	$0.74 M	$1.76 M	$3.89 M
35	**Lower Prices**	$19.3 M	60%	$ 8.2 M	$1.4 M	$11.8 M	$21.4 M	$0.12 M	($0.68 M)	($1.03 M)	($0.50 M)
36	**Higher Interest Rate**	$19.3 M	60%	$ 8.2 M	$1.5 M	$11.8 M	$21.4 M	$0.17 M	($0.41 M)	($0.45 M)	$0.50 M
37	**Lower Interest Rate**	$19.3 M	60%	$ 7.9 M	$1.4 M	$11.8 M	$21.1 M	$0.32 M	$0.46 M	$1.14 M	$2.81 M
38	**15-Year Term**	$19.3 M	60%	$ 8.3 M	$1.5 M	$11.8 M	$21.6 M	$0.07 M	($1.00 M)	($1.54 M)	$2.69 M
39	**25-Year Term**	$19.3 M	60%	$ 7.9 M	$1.4 M	$11.8 M	$21.1 M	$0.34 M	$0.58 M	$1.36 M	$3.13 M
40	**Refinance**	$19.3 M	60%	$ 8.1 M	$1.4 M	$11.8 M	$21.3 M	$0.35 M	$0.80 M	$1.78 M	$3.76 M
41	**Add $1M Equity**	$19.3 M	60%	$ 6.8 M	$2.4 M	$11.8 M	$21.0 M	$0.37 M	$0.78 M	$1.74 M	$3.69 M
42	**$1M Cost Overrrun**	$20.3 M	60%	$ 9.1 M	$1.6 M	$11.8 M	$22.5 M	$0.26 M	$0.27 M	$0.82 M	$2.36 M
43	**Lines 34 + 39 + 40**	$19.3 M	60%	$ 7.8 M	$1.4 M	$11.8 M	$21.0 M	$0.55 M	$2.06 M	$4.20 M	$7.44 M
44	**Lines 34 + 39 + 40 Breakeven**	$19.3 M	60%	$12.5 M	$2.2 M	$ 7.2 M	$21.9 M	$0.20 M	$0.06 M	$0.54 M	$2.13 M