Broadband Infrastructure Engineering Assessment Report

Door County, Wisconsin

November 5, 2021

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CCG Consulting

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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this Broadband Infrastructure Engineering Assessment that provides our findings and recommendations for bringing better broadband to Door County, Wisconsin. This project was enabled by the Door County Economic Development Corporation, which listed the goals of the assessment to:

- *Understand what is currently available, where does the infrastructure serve, capacity, and who owns the infrastructure.*
- *Voids or deficiencies in service.*
- *Options in providing service both in the short-term and long-term along with possible financing plans and strategies.*

This report documents how we undertook the investigation of broadband. There are hundreds of facts included in the report that document our findings, and the accumulation of these facts led us to reach four primary conclusions about the state of broadband in the county:

- There is almost no broadband competition in the county. Most residents and businesses told us that they felt the ISP they are using is their only realistic option.
- We also conclude that the state of broadband in the county is negatively affecting your economic prosperity. Examples of the negative impacts of poor broadband abound in the county. Many businesses don't have good enough broadband to support even basic business needs, and in the most extreme example, there are businesses that can't maintain good enough broadband to process credit cards. There are numerous inns, hotels, and condos in the county that don't have the broadband being expected by guests today, imperiling one of your primary industries. Business owners complain that they can't take work home due to inadequate home broadband. During the pandemic, businesses struggled with employees trying unsuccessfully to work from home. Many residents are unable to participate in the work-at-home economy, which is one of the fastest areas of economic growth in many rural communities.
- The quality of broadband is largely a matter of geographic happenstance – location dictates broadband availability:
  - The businesses and residents in towns where Charter/Spectrum provides broadband said that broadband is adequate. But we heard many stories about problems caused by inadequate upload speeds and recurring short outages.
  - The broadband in areas without Charter/Spectrum can best be described as dismal. We heard horror stories from residents and businesses about broadband that barely works in the winter and that largely disappears during peak tourist season. We heard from numerous residents who said they have no broadband options at home.
- We heard across the board that broadband performance by all ISPs degrades during the peak of the tourist season. Even large businesses served by fiber see a noticeable slowdown. While we would normally suspect this to indicate poor backhaul reaching the county, we think it's more likely that the last-mile networks of the ISPs are not robust enough to meet peak demand.

Our first phase of the investigation was market research to understand currently availability of broadband in the county today. We communicated with residents and businesses through surveys and interviews to understand the broadband needs throughout the county. We looked at publicly available data that documents prices and broadband availability in the county. Our engineers drove extensively through the county to identify the infrastructure used to provide existing broadband.

We also looked at the county from a wider perspective. For example, the FCC defines broadband as a customer connection that provides speeds of at least 25 Mbps download and 3 Mbps upload. We found that ISPs in the county have misrepresented the broadband they are providing in the county – the FCC believes that almost everybody in the county has access to 25/3 Mbps broadband. We find it likely that almost nobody outside of the towns can get broadband at that speed.

The report dives deeper into identifying the broadband gaps in the county. The most obvious gap is the broadband availability gap described above. We heard from residents who can't afford broadband, meaning the county, like most of the country, has a broadband affordability gap.

The next phase of the assessment quantified the cost of bringing better broadband to the county. Finley Engineering considered both wireless and fiber solutions for improving broadband.

- Finley quantified a cost of $4.5 million as the minimum amount needed to bring better fixed broadband to the county. We do not recommend this option for many reasons. First, a wireless solution is not scalable as the first step towards gigabit broadband and so fails one of your prime goals. We also don't see this as a workable broadband option. The terrain and heavy foliage in the county make it nearly impossible to deliver a high-quality wireless connection. Wireless technology will also likely not be eligible for grant funding.
- Finley then looked at fiber design options. They settled on a passive optical network (PON) design that could deliver gigabit broadband to every home and business in the county and which could easily be supplemented to offer 10-gigabit broadband. Finley designed a network consisting of 25 neighborhood cabinets that are interconnected in a mesh to provide redundancy. Finley determined that 1,574 miles of fiber are needed to serve the whole county, with 1,092 miles needed to serve the rural parts of the county. The cost of the assets needed to bring fiber to the whole county is over $130 million, with the costs for the rural areas at over $76 million.

We knew before we started that any fiber built in the rural areas would require grant funding. Our analysis shows that the amount of grant money required to build the rural areas is highly dependent upon the likely customer penetration rate on a new fiber network. Customer revenues help to pay for fiber, and the greater the customers, the smaller the needed grants. If an ISP expects to subscribe only 45% of the rural customers, the needed grants are over $39 million. The needed grants drop to $33 million for an expected 50% customer penetration. We may be entering a time when grants of that magnitude might become available. The largest source of major grant funding on the horizon is the infrastructure bill proposed by Congress.

The report concludes with specific recommendations on the next steps to take after receiving this report. The most important recommendation is to share this with the ISPs that could be your partners in bringing the needed broadband. We have done the engineering in such a way as to provide cost estimates for an ISP interested in building fiber to a portion of the rural area. An idea worth thoughtful consideration is to bring a collaborative approach to getting better broadband. There are separate amounts of funding available to local governments, ISPs, schools and libraries, rural health care, and others that would be most effective if pooled.

FINDINGS

Following are our primary findings:

Existing ISPs. The county has a wide array of ISPs today. There are three different incumbent telephone companies that serve portions of the county using DSL technology over telephone copper wires – AT&T, CenturyLink, and Frontier. Charter/Spectrum is the incumbent cable company in the county and provides broadband over HFC technology in Sturgeon Bay, Jacksonport, Egg Harbor, Fish Creek, Ephraim, Sister Bay, and Ellison Bay. There are several wireless ISPs serving parts of the county using fixed wireless broadband, including Door County Broadband, Mercury Network, Astrea, and SonicNet. There are two companies providing high-orbit satellite broadband - Viasat and HughesNet. There are residents of the county using the low-orbit satellite broadband being offered by Starlink in beta test mode. Some rural homes get home broadband using mobile broadband from AT&T, Verizon, U.S. Cellular, and Cellcom.

Existing Broadband Prices

As might be expected with so many different ISPs, broadband prices vary widely. Following is a summary of the prices for the predominantly used residential broadband products. Note that prices are not always directly comparable since ISPs differ on charges for things like modems. As will be discussed throughout the studies, many of the existing ISPs don't come close to achieving the advertised speeds.

- AT&T sells DSL for $60 per month plus $10 for the DSL modem.
- CenturyLink DSL starts with a list price of $47 for 7 Mbps DSL. The price for 12 Mbps DSL is $52, and 20 Mbps is $62. CenturyLink adds up to $6.95 per month for the DSL modem.
- Frontier charges $44.95 for 6/1 Mbps, $54.95 for 12/1 Mbps, and $59.95 for 18/1.5 Mbps. For all products, a modem is $10.
- Charter/Spectrum's basic broadband product is $69.99 per month for up to 200 Mbps, with an optional $9.99 for a WiFi router. Charter/Spectrum offers faster speed tiers.
- Door County Broadband prices start at $54.95 for 4/1 Mbps, $64.95 for 6/2 Mbps, $74.95 for 8/2.5 Mbps, and $84.95 for 10/2 Mbps.
- SonicNet charges $52.95 for 5 Mbps and $73.85 for 12 Mbps.
- Other wireless ISPs don't quote rates online.

The Study Areas. We studied two different geographic footprints. We looked at the cost of bringing broadband to the whole county. We also then looked at bringing broadband only to the rural areas. We defined rural areas as everywhere that doesn't isn't served by Charter/Spectrum, which serves Sturgeon Bay, Jacksonport, Egg Harbor, Fish Creek, Ephraim, Sister Bay, and Ellison Bay.

Market Demand Assessment

<u>Residential Survey</u>. We conducted an online residential survey that attracted 995 responses. This was one of the highest numbers of responses that we've gotten in an online survey. It's important to note that this is not a statistically valid sample, meaning that the results tell us a lot about how the public feels about broadband and the ISPs, but that the percentage derived for factual questions (such as the percentage of people that use a specific ISP) are not numerically reliable. Following are the key results of the survey:

- 85% of survey respondents use broadband at home.

- 15% don't have home broadband, and 71% of those say that broadband is not available at their home.
- For residents that claim a home broadband connection, 25% use Charter/Spectrum, 26% use DSL from the telephone companies, 21% use fixed wireless technology, and 18% use satellite broadband. 10% of respondents use their cellphones for home broadband.
- There is a high level of dissatisfaction with broadband. 51% of respondents are unhappy with download speeds. 39% are unhappy with ISP customer service. 61% of respondents are unhappy with the value received for the price paid for broadband.
- 73% of respondents said that somebody is working from home at least part-time. This includes 18% of households that have somebody working from home full-time. 54% of respondents said they would work from home more with better broadband.
- 18% of respondents have school-age children at home. 64% of these households said that home Internet was not good enough to support the students during the pandemic.
- 99% of respondents have a cellphone. 41% of respondents say that they don't have good cellular coverage at home.
- The average price being paid for broadband is $86 per month.
- 81% of respondents support the idea of funding a better broadband solution. Another 18% might support better broadband but need more information. Only 1% of respondents do not support the idea.
- 62% of respondents said they would buy broadband and pay the same price as today from a new network if it was faster. Another 23% said they would probably buy from a new network.

Business Survey and Interviews. We reached out to businesses through an online survey and also by interviewing some businesses in depth. Altogether we heard from 123 businesses.

We found two distinct sets of businesses in the county when it comes to broadband service – those located in towns or close to several major highways can get decent broadband, while everybody else has poor broadband. Businesses that are able to subscribe to Charter/Spectrum broadband are far happier, and twenty-one Charter/Spectrum customers were happy with existing broadband. It's a different story for businesses that can't get Charter/Spectrum. Some of them have the worst broadband stories imaginable, where they have trouble doing even low bandwidth functions like taking credit card payments. Many of these businesses describe a broadband nightmare, and poor broadband is clearly hurting their businesses. One restaurant went so far as to relocate to get close to the highway to get better broadband.

We also identified what we could best describe as a seasonal broadband problem. Businesses and residents complained about how broadband bogs down during the tourist season. When the county needs broadband the most, it slows down, and service is degraded across the board. This most likely means that the ISPs have not upgraded networks to keep up with demand. Since broadband usage continues to increase at an exponential rate, this problem is likely to get worse every year.

As might be expected, a lot of the businesses we heard from are hotels, motels, inns, and bed & breakfasts. They universally said that there was not enough broadband to keep guests happy. Guests show up expecting to keep in touch with the office and to stream videos in the evening. Many of these establishments said that guests were quite unhappy with the broadband. We heard a lot of conjecture from businesses that the lack of broadband is a leading reason that the county is mostly seeing older visitors, and many businesses worry about the future of tourism in the county.

We heard horror stories from retail stores. Many struggled with taking credit cards, which can be particularly devasting to stores that take a lot of payments to sell basics. Even stores like galleries that make fewer sales have to take credit card payments manually and send them in later when broadband is working. That means they're taking a chance on having transactions that are not accepted or even fraudulent.

There are a number of businesses in the county that sell online, and the lack of broadband really hurts their businesses. They can't host retail websites locally, they have trouble taking credit card payments, and they have trouble working with shipping information that is in the cloud.

Perhaps the most common complaint we heard was from business owners who have even worse broadband at home than at the businesses. They are unable to take work home and end up bringing home broadband needs to the office.

The schools have adequate broadband on fiber. But the school system was badly impacted by the pandemic. A significant percentage of students were unable to connect to the schools from home. The school system solved some of this problem by distributing cellular hotspots – but then found that cellular coverage was so poor in parts of the county that the hotspots didn't function.

Speed Tests. The Wisconsin Department of Public Information (DPI) offers a speed test to anybody living in Wisconsin. DPI uses the MLabs speed test, which is one of the most common and popular speed tests in the country. We got access to 19,712 speed tests results. Following is a summary of the DPI speed tests.

	Technology	Tests	Download (Mbps)	Upload (Mbps)
Charter	Cable Modem	11,844	67.06	9.82
AT&T	DSL	84	11.37	5.16
CenturyLink	DSL	472	12.14	2.47
Frontier	DSL	1,193	7.25	0.93
Door County Broadband	Fixed Wireless	5,493	4.61	1.99
Satellite	Satellite	515	12.60	1.53
Cellcom	Cellular	106	18.32	2.28
US Cellular	Cellular	5	0.77	0.27

Broadband Gaps. Door County has a significant broadband availability gap, and the county is a story of broadband haves and have-nots – there is almost nobody in the middle. A handful of anchor institutions and large businesses have broadband provided by fiber. Fiber broadband is expensive and is only available in limited circumstances.

Charter/Spectrum offers broadband speeds in the towns that most customers find adequate. The biggest complaint about Charter/Spectrum was problems working and schooling at home during the pandemic. This is due to sluggish upload speeds.

The rural homes and businesses in the county have poor broadband and virtually nobody has broadband that meets (or even comes close) to the FCC-defined broadband definition of broadband at 25/3 Mbps. It's worth noting that the poor quality of rural broadband was magnified during the COVID-19 crisis as employees and students tried to function from home.

We note in our analysis that ISPs, including Frontier, CenturyLink, and Door County Broadband overstate broadband capabilities when reporting to the FCC. The FCC believes that most of the residents in the county, including the rural ones, can buy 25/3 or faster broadband. In the past, this has diverted broadband grant money from the county. Hopefully, this won't make a difference with new federal grants, but it's an issue worth keeping an eye on.

Like most places, there are also other broadband gaps such as an affordability gap, a computer gap, and a computer training gap. The report discusses ways that the County might want to tackle these issues as you also tackle the more important availability gap.

Summary of Broadband Issues

The study highlighted the following broadband issues:

- Rural Broadband speeds are far below the FCC 25/3 Mbps definition of broadband. The average MLab speed tests for every ISP other than Charter/.Spectrum showed average broadband speeds of 6/2 Mbps.
- The pandemic highlighted an upload broadband crisis. There are problems connecting to schools, working from home, using video calling services, or using cloud software. Even Charter/Spectrum upload speeds less than 10 Mbps. Every other ISP was slow.
- 11% of homes said they had no reasonable broadband option.
- We heard across-the-board that speeds on all of the broadband networks in the county bog down during tourist season, to the point in many cases where broadband is unusable.
- 87% of residents want faster speed. 83% of residents and most businesses want more choice of broadband provider. 76% want better reliability.

Engineering Analysis.

The telecom industry uses the term passing to mean any home or business that is near enough to a network to be considered as a potential customer. Finley Engineering primarily used the county's GIS database to count passings. We refined business passing using tools like Google Maps. In the assessment, we settled on the following as the count of potential passings.

Passings	Rural	Total County
Residential	11,685	25,086
Business Customers	1,031	2,599
Total	12,716	27,685

The report considered both wireless and fiber broadband as ways to bring better broadband to the county. In many places, we've recommended fixed wireless broadband as a first step towards getting fiber everywhere.

Wireless Design. We quantified the cost of building a state-of-the-art fixed wireless network at $4.5 million. We did not explore this option further for several reasons. First, because of the terrain and heavy foliage in the county, there are rural customers that likely can't be reached with fixed wireless. The capacity of the network would not enable serving all of the likely customers. More importantly, the average broadband speed delivered to homes would likely be around 50 Mbps, with some locations getting as much as 100 Mbps. Wireless technology is currently not eligible for funding by most grants.

Fiber Design. We then turned our attention to fiber technology. We considered both common fiber technologies and selected Passive Optic Network (PON) technology as the best solution for the county. This can deliver gigabit fiber to everybody today and is easily upgraded to offer 10-gigabit broadband by adding circuit cards.

The network was designed using the following primary assumptions:

- The network was designed to pass every home and business in each scenario.
- The fiber would be on poles or buried in the same manner as existing utilities.
- The network is designed to accommodate future growth.
- We sized the fiber to fit the needs of each route using industry-standard fiber sizes of 12, 24, 48, 72, 144, and 288 fibers.
- The total county design places 25 large cabinets around the county to act as neighborhood hubs.
- When possible, we try to design redundancy into a network to provide fiber route diversity so that if a main fiber is cut, a neighborhood node will continue to operate. The layout of the county did not lend itself to a logical fiber ring, so the network is designed in a mesh such that every neighborhood hut is connected to two other neighboring huts. Under this configuration, a neighborhood node can't be taken out of service by a single fiber cut.
- The county was separated into 61 neighborhood passive optical nodes (PONs) that are each connected to one of the 25 regional cabinets.

Finley Engineering identified the following required miles of fiber construction for the two scenarios:

	Miles	Cost	Cost / Mile
Total County	1,574 miles	$99,571,592	$63,260
Rural Study Area	1,092 miles	$60,298,125	$55,218

This highlights that fiber construction is generally more expensive, on a per-mile basis, in towns compared to rural areas. This is due to several reasons. It's typically more expensive to build fiber in a city when construction involves cutting into paved streets – that's something that can usually be avoided in rural construction. The cost of fiber is also a lot higher due to the density of homes, which means tightly packed access points into the fiber network. That means a lot more labor-intensive splicing for both buried and aerial fiber.

Note that Finley Engineering has designed the most efficient network possible for the county. For instance, the mesh that connects neighborhood huts is highly efficient since all service areas have been designed at an ideal size. If communities tackle building individual local fiber solutions, the network will be less efficient, and the overall cost of building the network on a piecemeal basis would be higher than the design in this study.

Asset Costs. Below is a summary of the cost of the needed assets to support the two fiber options we studied. It's worth noting that these costs represent connecting 50% of the households and businesses in the county. The investments will vary from these numbers if a different number of customers are added to the network.

	Whole County	Rural Only
Fiber	$ 99,571,592	$60,298,125
Drops	$ 15,476,075	$ 7,435,255
Electronics	$ 12,360,410	$ 5,889,393
Huts	$ 1,248,328	$ 1,191,328
Operational Assets	$ 1,816,915	$ 1,330,596
Total	$130,473,319	$76,144,696
Passings	27,685	12,716
Cost per Passing	$ 4,713	$5,988

We must caution that the supply chain in the telecom industry is under extreme stress. There have been substantial price increases for fiber and fiber materials over the last year, and it seems that costs for fiber components are still rising. The above numbers are conservatively high and include a boost of 20% for material costs compared to the prices in the market at the time that we began this report. Some economists think the country is experiencing a price bubble and that costs will eventually return to normal. We felt obligated for the purposes of this assessment to be conservative. We think it's important to plan for high costs in this economy – if costs start to return to normal, it will be easier to fund a network than is predicted by our projections.

Our Approach to the Financial Analysis. Our next task was to create financial projections showing how an ISP might fare if they financed and built the fiber solutions. The purpose of this analysis was twofold. First, we wanted to quantify the amount of grant funding that might be needed to get a network funded. Next, we wanted to show that an ISP could be reasonably profitable if they can attract the needed grant funding. We used the following approach in estimating the revenues and costs for operating a new fiber network for each of the three scenarios:

- The financial projections were made on an incremental basis, meaning we only considered new network costs, new operating expenses, and new revenues.
- A base model was created for each operating model. The models assume that a commercial ISP would offer broadband over a new network.
- We arbitrarily chose a market penetration rate of 50% for all residential and business customers. We don't know how many customers a new fiber business might attract and picked this penetration rate as conservative but typical of similar fiber markets. Note that in the whole county study that this is a composite penetration rate, assuming that the penetration rate would be lower in areas that compete against Charter/Spectrum and higher in the rural areas.
- The base models assumed financing with loans with a 25-year term.
- We included the engineering cost estimates provided by Finley Engineering, which we believe to be conservatively high.
- All studies include an estimate of future asset costs that are needed to maintain and upgrade the network over time. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.

- Broadband was priced at a modest discount from the existing market prices. The base fiber product was set at $60. The expectation is that the Internet speeds offered on the network will be significantly faster than the speeds available in the county today.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Most operating expenses are adjusted for inflation at 2.5% per year.

Key Financial Results. The assumptions used in creating the various financial forecasts are included in Section III.C of the report. The results of the financial analysis are included in Section III.D of the report. A summary of the financial results is included in Exhibit II. Following are the key financial findings of our analysis.

- <u>Building Fiber to Only the Rural Areas Requires Substantial Grant Funding</u>. We expected when we started the assessment that grant funding would be required to help fund broadband in the rural parts of the county. Grants are almost always needed to fund broadband to rural areas with low housing density. The analysis allowed us to quantify the amount of grants that are needed. It turns out that the amount of grant required varies significantly depending upon the expected customer penetration rate. Following are the grants required for the fiber business to break even. In this case, breakeven is defined as a business that always maintains positive cash flow after the initial financing.

Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
45%	$68.9 M	$40.9 M	59%
50%	$70.1 M	$33.7 M	48%
55%	$71.3 M	$26.4 M	37%
60%	$72.5 M	$19.2 M	26%
65%	$73.7 M	$11.8 M	16%

  A commercial ISP will want to do better than breakeven and would to make a return on any investment made into the business. Some municipalities also expect a return. ISPs calculate returns in a myriad of ways, so we didn't try to layer a return expectation across our models. But a commercial ISP will expect more grants than shown above (or might expect local grants over and above the amounts above if those represent state and federal grants).

  Since the ultimate customer penetration rate has such a significant impact on the amount of grants needed to fund broadband, we think that it's vital for anybody thinking of pursuing a grant to pin down broadband demand. The two ways this can be done are a statistically valid survey or a canvass.

- <u>Grants Would be Smaller for an ISP Building the Whole County</u>. Consider the following table that shows the amount of breakeven grant required for somebody willing to build fiber to the whole county.

Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
45%	$127.9 M	$29.0 M	23%
50%	$130.5 M	$14.0 M	11%
55%	$133.3 M	$ 0.0 M	0%

The levels of required grants are smaller for two reasons. First, there is an economy-of-scale benefit from more customers - there is more revenue and margin driven from customer revenues. But more importantly, the lower housing density in the towns results in a lower investment per customer, and it is more profitable to serve the towns. The lower grants shown in the second table are mostly due to profits from the towns being used to subsidize the rural areas.

- Seasonality**.** One of the biggest challenges in bringing broadband to the county is figuring out how to deal with seasonality. The report shows that there is a significant impact of providing a seasonal discount. The fear is that there are a lot of part-time visitors to the county that will not want broadband if they have to pay for it all year. But the cost of connecting and serving a part-time resident is almost the same as a full-time resident, and so providing discounts end up creating a subsidy of full-time residents propping up part-time residents. The report discusses the many ways that other communities have dealt with the issue, which range from only charging customers for the months they are in the market to the other extreme where some communities provide no seasonal discounts. There is also a risk of becoming unprofitable if too many part-time people want fiber but only pay for part of a year. This question requires a policy decision, and there is no easy answer.

- The Fiber Business is Sensitive to Other Key Variables. While customer penetration rate seems to be the most important variable, all scenarios are sensitive to variations in other key variables. This would include changes to variables like interest rates, loan terms, prices, and the cost of building the network. The report quantifies and describes these impacts for both the whole county and rural area scenarios.

  It’s important to note that changes to most variables are additive. If there is an improvement from getting more customers than expected and also for getting a lower interest rate than expected, the impacts of these changes can roughly be estimated by adding together the impact of each change. An actual fiber business is rarely going to exactly perform like any of the key variables included in the projected forecasts for the business – so ISPs must be diligent in keeping track of changes to key variables.

Funding Options. As mentioned above, any broadband expansion into rural areas will require substantial grant funding. The most likely grant funding is going to come from various federal broadband grants. There are several substantial grant programs already underway, with a few more opportunities coming at the end of this year with a new round of ReConnect grants and a big EDA grant program. But the only funding source that is probably large enough to tackle bringing broadband to most of the county will likely be from an infrastructure stimulus bill from Congress.

There also will hopefully continue to be some substantial state broadband grants. For example, the state is getting a substantial cash infusion from the $1.9 trillion American Rescue Plan Act that can be used to improve broadband. The legislature has already approved a $125 million broadband grant program for early 2022, but this is likely to be increased from additional inflows of federal funding.

Finding an ISP Partner. The report discusses the ways that other local governments have used to attract an ISP partner or partners to bring better broadband.

Regulatory Hurdles. The RFP asked us to look at regulatory hurdles in Wisconsin that might make it harder to find a broadband solution. The good news is that broadband is lightly regulated both at the federal level and in Wisconsin. There are no hurdles we can see that would hinder a commercial ISP from bringing better broadband. However, there are restrictions on municipal broadband providers. Local governments have to jump through several regulatory hoops to be able to provide broadband. Our advice is that the county should be careful to follow the rules if any broadband solution includes local governments having any say in how an ISP operates in the county.

RECOMMENDATIONS / NEXT STEPS

We recommend the following next steps after this report is delivered.

Consider a Collaborative Effort to Get Better Broadband

All parts of the county want better broadband. The rural areas need better broadband desperately, but there is also unhappiness with broadband in the towns. Since the broadband business has significant economy-of-scale (meaning the more customers, the more efficient), then finding a whole-county solution is the lowest cost way to move forward. That doesn't mean that finding a whole-county solution is the only path forward – but it's the lowest cost long-term solution.

There are a lot of stakeholders in the county that can contribute towards a solution. There has already been grant funding made that can be used for broadband to the towns and the County. The state broadband office will be offering substantial grants to build broadband – mostly in rural areas. There should be huge grant funding coming from the federal government. But there are other stakeholders that could contribute. The federal infrastructure bill will allow for some funding for electric smart grid. There is grant funding currently available for school, libraries, and rural health care facilities. If sufficient grant funding is available, there are likely ISPs willing to invest in the county. Pooling all possible sources of funding from all stakeholders is the most efficient funding approach.

The first step should be for the primary stakeholders in the county to meet to determine the best path forward. There is no single best path forward, but a disjointed approach could leave some part of the county still unserved.

For example, there is a collaboration formed in the Upper Peninsula of Michigan for this exact purpose. The coalition there has been created to include the schools, libraries, local towns and townships, the county governments, and rural healthcare facilities. This collaboration is also working closely with the electric cooperative and the area tribes. The members of the collaboration in Michigan have access to funding of some sort that can be used for broadband. The towns, townships, and counties all have ARPA funding. The schools have access for the first time to use E-Rate Funds to build or lease infrastructure (in the past was mostly used to buy broadband capacity). The libraries have access to a range of funding opportunities. Rural healthcare facilities have a situation similar to the schools with the Universal Rural Healthcare Fund. None of these funding sources is enough to build broadband – and it's not even enough when added together to build the last mile fiber the community wants. But the coalition understands that they can help influence ISPs to build what is needed by providing local matching grants and by agreeing to be long-term customers for an ISP or ISPs that will work with them. The county and local governments within the county also have funding from the ARPA legislation that could be used to help provide matching grants for any ISP.

The funding opportunities for the next several years are unprecedented and offer a once-in-a-lifetime opportunity to get better broadband to all parts of Door County. Each of your group of stakeholders can contribute something towards the ultimate goal – and the accumulation of those amounts can make a difference in getting fiber built everywhere in the county.

It's not easy to form such a coalition. I recommend that you talk to the folks in Michigan to hear the effort they've undertaken to make this work. This means getting as many of the community stakeholders on board before they spend money elsewhere that would have been better used for fiber. In the case of Michigan, an actual consortium has been created to formalize the effort – and that takes a lot of local work. The consequence of not considering this might be the difference between getting fiber everywhere and not. No one stakeholder in the county can make this happen, but there is huge power in working collectively so that all of the stakeholders in the county are working towards the same goal.

Reach out to Potential ISP Partners

One of the primary purposes of this assessment was to quantify the cost of building broadband in the county for the benefit of any ISPs that might consider building broadband in the rural parts of the county. We think your immediate first step should be to reach out to potential ISP partners. That begins by sharing the results of this report. ISPs will be interested in much of the research we've done. ISPs likely have not made the kind of detailed cost estimates that were done for this assessment. The assessment also includes financial projections that will help an ISP better understand potential profitability.

It might be difficult to find a single ISP willing or able to serve all of Door County. Even with grant funding, the amount of money that will be required by an ISP to build fiber everywhere in the county is substantial and beyond the means of many small ISPs. It's not unusual in large counties for multiple ISPs to serve different parts of the county.

Sometimes the potential ISPs that are interested in a given county are obvious, and most broadband solutions come from local ISPs. However, we have been surprised at times when an ISP comes to a county that is not local, so the County might want to consider a wider search for ISPs. There is a more thorough discussion of this process in Section IV.B. of this report.

Identify Staffing Resources

The various recommendations made in this report require somebody to tackle the work and spearhead the effort. Finding a broadband solution takes a focused and persistent effort, so it's important to identify staffing. We've seen many efforts to get broadband fizzle when nobody was dedicated to the community engagement tasks. We've seen the following ways that communities have done this well.

- <u>Dedicate Staff</u>. The communities that have done this the best have dedicated at least one staff person to concentrate on community engagement. The biggest challenge in doing this is usually finding the funding. The person undertaking this task needs to be a big believer and advocate of broadband for it to be successful. This is not a permanent position, but rather somebody dedicated to this effort for some fixed time. This is also not a 9 to 5 job with a lot of demands placed on evenings and weekends.

  A county in Minnesota found a broadband solution because the mayor of one of the smallest towns in the county told his economic development director that getting broadband was his only priority. This one person met with everybody imaginable in the county, including city governments, county governments, state representatives, and every civic and social group imaginable. After two years of tireless effort, the county found a broadband solution. This would never have happened without this one dedicated staff position.

- Volunteers. Volunteers are also an important part of this effort. There are typically people living in areas with no broadband who are willing to volunteer to help find a solution. In the example given above of the Minnesota county, the one staffer assembled a group of active volunteers who helped with the effort to engage the public. These folks created email lists, went canvassing door-to-door talking about the need for broadband, and showed up at every government meeting to stress that they wanted a broadband solution. It's important that any volunteer effort has some structure and working with a staff person can make sure such a group stays focused. The County needs to be prepared to fund efforts that the volunteers think are needed. In the case of the Minnesota county, the volunteers engaged in several rounds of postcard mailings asking homeowners to pledge support for broadband.
- Broadband Task Force. A more formal solution is to create a committee of citizens who are willing to work to get better broadband. A Broadband Task Force generally is composed of citizen volunteers and a few elected officials. These groups meet regularly and work towards finding a broadband solution. It's normal that such a group would report back regularly to the County government about their progress. Such a group can collectively take on the needed community engagement tasks, and we've seen effective committees do this well. It's not unusual for a Broadband Task Force to solicit help from volunteers.

  Such groups are usually given a budget but also restrained by needing to have expenditure pre-approved. A Task Force might use funds to collect data needed to advance broadband. I've seen funding approved for such things as statistically valid surveys, for pledge card drives, and for hiring a consultant to answer their questions.

  We could write pages on the dos and don'ts of operating a successful citizen's advisory group. The one issue I've seen with a Task Force is if the citizen group has a different vision of the right broadband solution than the government – they are often impatient and want to see results. Most governments have already experienced this in working with citizen groups on other topics. The main keys for success are to make sure that the group has a specific agenda, a specified budget, and the specific authority to meet their goals. Citizen groups can accomplish great things if they are directed to do so – but can stray if not given good direction.

  As a final note, many communities are using the federal ARPA funding to pay for staffing to investigate broadband and other eligible infrastructure issues.

Get Creative in Finding Grants

This report mostly alludes to grants that can help to directly build broadband infrastructure. But there is a lot of additional grant monies available that can help in the broadband effort.

As an example of how we are currently flooded with grant opportunities, there are nearly a dozen grants that can be used to assist libraries. The biggest is a $200 million grant to the Institute of Museum and Library Services. This is an independent federal agency that provides grant funding for libraries and museums. $178 million of the $200 million will be distributed through the states to libraries. The Wisconsin share of this grant is $3.3 million. This is by far the largest federal grant ever made directly for libraries. There are other grants that can be used to pay for hotspots, modems, routers, and laptops.

There are currently federal grants aimed at issues like broadband adoption and training, which can be used to buy computers for homes without them and which can be used to create basic computer literacy training.

If Congress passes a broadband infrastructure bill, there will be numerous additional grant opportunities. For example, the current draft infrastructure bill includes funding to improve the electric grid – and part of that money could be used to build fiber to substations. The federal grants also include money for smart city and smart government initiatives. We suspect that an infrastructure bill will spawn dozens of one-time grant programs that could be helped to provide a broadband solution with enough creativity in putting grants together.

Consider a Statistically Valid Survey

One of the most important ways that a community can help attract ISPs is to help them understand the potential for operating a successful broadband business in the area. The biggest concern that every ISP has about a new market is knowing if they can get enough customers to be successful. Rural areas differ widely in the willingness of people to subscribe to broadband. We've worked in rural communities in just the last few years where the demand for broadband varied between 60% and nearly 90% - and it's vital for an ISP to understand where your communities fall within that wide range.

We've seen local governments undertake research to help ISPs understand the market better. This assessment included an extensive online survey, which will help an ISP understand the powerful desire in the county for better broadband. We got almost 1,000 responses to that survey.

A useful next step might be to conduct a statistically valid survey. Such a survey can be used to predict the most likely range of customer broadband penetration should somebody build a broadband network. We've found over the years that if a survey is conducted in a way to be statistically valid that the results provide a good prediction of the likely customer penetration rates.

There are a few factors that are vital for getting an accurate and believable survey. First, the questions asked must be unbiased and can't lead respondents into answering in a given way. It's also important for a survey to be random if you want the results to represent the whole County. For example, since the goal is to predict broadband penetration rates, it's just as important to hear from those who don't want broadband as it is to hear from those who do.

It's also essential to have confidence in the survey results, and this speaks to the accuracy of the answers obtained in the survey. Most business and political surveys are designed to provide an accuracy of 95% plus or minus 5%. That accuracy would mean that if you were to ask the same questions to 100% of the people in the area that the results should not vary by more than 5% from what was obtained in the survey. That is a high level of accuracy, but other levels of accuracy are possible by varying the number of completed surveys. For most communities, a survey with between 365 and 380 completed surveys will produce this desired accuracy.

Surveys have gotten a bad name due to political surveys. There are several reasons that a political survey can produce different results than what is seen in an election. The primary reason is that respondents might not truthfully answer all of the questions for many different reasons. We've found that we don't see this kind of bias in broadband surveys because the topic doesn't trigger emotional responses – folks generally tell the truth about the topic.

The last factor to consider is a phenomenon called survey fatigue. If the survey asks too many questions or takes too long, then a lot of people will hang up in the middle of the survey. An ideal survey is done in 5 minutes and no longer than 10 minutes.

There are two usual methods used to conduct a statistically valid survey of a whole community – either by knocking on doors or by telephone. The effort required to knock on doors is massive, especially in a rural area. You'd have to go to homes randomly, meaning hitting all corners of the rural county. You'd have to knock on doors of all types, from the smallest to the largest homes.

It's far easier to administer the survey by telephone, but it makes no sense these days to do a telephone survey using the white pages and calling just landlines. We know that the households keeping landlines are older and more conservative, and their responses on a survey probably don't represent all households in an area. A valid telephone survey needs a list of telephone numbers that include cellphone numbers.

We must caution, though, that undertaking a statistically valid survey in Door County might not be easy. If an ISP wants to consider bringing broadband to rural parts of the county, then a survey should only be given to people in rural areas. That's a lot harder to undertake than you might think because if the survey is to be conducted by telephone, then you'd somehow need to gather a large number of telephone numbers from rural residents.

Pledge-Card Drives. An alternative to a survey would be to conduct a pledge card drive. This would be some sort of system where customers could pledge to buy service if an ISP were to build a new network. A pledge card drive works best when you can cite specific products and prices. For instance, if an ISP was partnering with a county to come to a certain area, then naming that ISP and disclosing their products and prices provide a more believable response. We've seen communities do pledge card drives and then see more than 95% of homes that said they would buy broadband actually buy it when it became available.

Be Prepared to Challenge the FCC Broadband Maps.

Many federal grant programs rely on the FCC "maps" that are derived from the Form 477 data that the FCC gathers from ISPs. We've shown in this report that the FCC broadband maps are badly overstated in nearly the entire rural areas of the county. Several ISPs are claiming broadband speeds that look to be much faster than what has been reported in the Wisconsin state-sponsored speed tests.

There is a significant and negative consequence to poor FCC mapping. In the past, this mapping has diverted potential broadband grants away from the county. A good example of this is when Door County Broadband challenged the maps for the FCC's RDOF awards in 2020 and successfully kept that funding away from 516 Census blocks in the county. From what we can see, the Door County Broadband challenge does not look valid. There are nearly 5,500 speed tests for Door County Broadband in the state speed test database. Door Counties speeds look to about the same speed as DSL, at around 5 Mbps download and 2 Mbps upload – far below the RDOF challenge threshold of 25/3 Mbps.

Some current federal grants still start with the assumption that grant funding should go first to areas with speeds under 25/3 Mbps. According to the FCC database, much of the rural county has speeds greater than 25/3 Mbps - in reality, there are likely few if any rural customers in the county receiving speeds greater than 25/3 Mbps.

The county needs to get proactive with the FCC and the ISPs to try to fix this issue. The FCC has promised new mapping, and that mapping will include a challenge process. The county should get prepared to challenge the maps vigorously if currently overstated broadband speeds carry into the new maps. Meanwhile, the county might want to get as many people in the rural areas as possible to take the Wisconsin speed tests. It would also be hugely beneficial if you could get the raw speed test data from the state, which would allow seeing the high and low speeds from each ISP in various portions of the county.

Review Local Policies Related to Fiber Construction.

One factor that always worries ISPs is that there will be local rules, ordinances, and processes that will slow down the construction process and add cost to the fiber construction process.

Door County should coordinate a review of the following kinds of policies to see if there are ways to be friendlier to ISPs. Changing these processes might require new ordinances or new internal procedures. Local governments need to remember that any changes made to accommodate a new ISP should also apply to the incumbent ISPs operating in the county. Some of the areas that should be investigated include:

- Granting rights-of-ways to construct a network.
- Issuing permits to construct a network.
- Locating existing underground utilities where fiber is to be buried.
- Inspecting and approving that construction is following the permits.
- Requiring things like traffic control during the construction process.
- Requiring other kinds of agreements like franchise agreements or rights-of-way agreements.
- Requiring records of what's been constructed.

It's likely that different parts of the county have different local rules governing these kinds of tasks. We always recommend that the various local governments get together to review any such requirements, with the goal of modifying ordinances or processes that would hinder fiber construction.

Educate the Public

We saw a huge amount of interest from the general public as they participated in this assessment. You should determine the best way to inform the public of the results of this report and gain support for moving towards a broadband solution. One important aspect of community engagement is to provide useful information to the public to help them better understand broadband issues. It also means providing basic information that explains broadband in ways the public can understand. We've seen communities tackle public education in some of the following ways.

- <u>Publish This Feasibility Report</u>. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson.
- <u>Hold Public Meetings</u>. 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. It's worthwhile to have elected officials at public meetings to directly hear the kinds of issues that households have due to the lack

of broadband. It's vital to advertise heavily to drive attendance at meetings. CCG and Finley Engineering have been to a community meeting where only one resident attended and to other meetings that were standing room only in a large room.

- Broadband Website. Many communities that are looking for broadband solutions create a broadband web page. Such a page can be used to educate as well as inform. For example, a common educational feature is to have a lengthy section with responses to "Frequently Asked Questions." It's important that if you create a broadband website that you keep it current. You want the public to think of this site as a resource.
- 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.
- Broadband Newsletter. Cities often create a newsletter dedicated to broadband. These newsletters are aimed at educating the public on topics related to broadband and also to keep the public informed on the progress of the effort to get better broadband.
- 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.

Lobby for Larger State Broadband Grant Funding. It's going to be a lot easier to fund rural broadband projects in Wisconsin if the State steps up and increases the annual amount of broadband funding. Although the State increased grants for the 2021 grant cycle to $125 million, there are numerous other states that are setting up state grant programs of $400 million or even greater. The State needs to hear that one of their best roles will be to provide matching grants for federal grants.

Increasing broadband grant funding means lobbying state legislators to the problems caused by the lack of broadband. Legislators all heard a lot about poor broadband during the worst of the pandemic, but the pressure needs to be stay focused on the legislature to give rural broadband a higher priority and more funding. State legislators must hear loudly and often that the current level of funding is not enough if they want to see the broadband issue solved. Another good argument to use in lobbying is that anything that helps the rural areas also brings in more revenue for the State.

Be Prepared to Support Grant Filings

Many state or federal grant programs require a showing of local community support. Door County should be prepared to help an ISP by gathering government and resident support for the grant applications. This means soliciting as many letters of support as possible to support a fiber grant. We've seen counties go even further and have undertaken a local pledge drive to gather a large number of signatures to support a fiber project.

Be Persistent

It's the rare county where one ISP comes forward and provides a broadband solution for the whole county. That means that even if Door County finds a broadband solution to cover part of the county that the effort is not done, and you will need to continue with the above tasks until everybody in the county has broadband.

Tackle the Other Broadband Gaps

Most of the above suggestions concern solving the broadband availability gap – meaning getting faster broadband in the rural parts of the county. However, even when a broadband solution is found, the county is still going to suffer from issues of broadband affordability, the lack of computers in homes, and the lack of digital literacy for a lot of citizens. The county needs to put effort into solving these gaps along with solving the availability gap.

<u>Tackle the Affordability Gap</u>

This is probably the hardest gap to solve. Broadband is priced too expensively for many homes, and affordability efforts look for ways to bring less expensive broadband to the homes that most need it.

<u>Get Involved with Low-Income Subsidy Programs</u>

There are both existing programs and a new federal subsidy that can help homes save money on broadband. We're always surprised about how many eligible homes don't take advantage of these programs. The County can take two roles in maximizing the benefits of these programs by first making sure the public knows about the programs and pressuring all ISPs in the County to take part in the programs. We've learned that most ISPs don't aggressively advertise the low-income programs and that many eligible households don't participate. The first step is to review the requirements for households to participate with the various programs. You also should poll ISPs to see who intends to participate in federal low-income programs.

<u>Charter/Spectrum (Spectrum) Internet Assist</u>. Charter/Spectrum (Spectrum) 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).

<u>Federal Lifeline Program</u>. CenturyLink, Nsight Telservices, Mercury Networks Corporation, and Frontier Communications participate in the FCC's Lifeline program that is part of the Universal Service Fund. With the program, a customer can receive a discount of $9.25 per month off a telephone bill or a broadband bill for qualifying customers. The

program is cost-neutral to the ISPs – customers get the discount, and the FCC pays the difference to the ISPs.

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 the eligibility monthly of households to meet one of the above tests.

FCC Emergency Broadband Benefit (EBB) Program. The EBB program went into effect in May 2021. The funding came from the $1.9 trillion American Rescue Plan Act. The program was funded for $3.2 billion. The program will last until six months after the end of the federally declared Covid-19 emergency period or until the funds run out of money.

The EBB provides a discount of up to $50 per month towards broadband service for eligible households and up to $75 per month for households on qualifying Tribal lands. Eligible households can also receive a one-time discount of up to $100 to purchase a laptop, desktop computer, or tablet from participating provides if they contribute more than $10 and less than $50 toward the purchase price. The Emergency Broadband Benefit is limited to one monthly service discount and one device discount per household. For a household to get this discount, its ISP must be a plan participant. A household applies through its ISP.

A household is eligible if a member of the household meets one of the criteria below:

- Has an income that is at or below 135% of the Federal Poverty Guidelines or participates in certain assistance programs, such as SNAP, Medicaid, or Lifeline.
- Is approved to receive benefits under the free and reduced-price school lunch program or the school breakfast program, including through the USDA Community Eligibility Provision in the 2019-2020 or 2020-2021 school year.
- Received a Federal Pell Grant during the current award year.
- Experienced a substantial loss of income due to job loss or furlough since February 29, 2020, and the household had a total income in 2020 at or below $99,000 for single filers and $198,000 for joint filers; or
- Meets the eligibility criteria for a participating provider's existing low-income or COVID-19 program.

In the infrastructure bill that is working its way through Congress, the EBB program would be funded for many more years, but the amount of the monthly discount lowered to $30. However, that bill is not yet law. If it doesn't pass, the EBB program probably runs out of funding sometime in 2022.

Support Local Affordability Efforts

There are nonprofit organizations around the country that are tackling the affordability issue. One of the more ambitious such efforts is being made by Mobile Beacon.[1] This is a nonprofit that works

[1] https://www.mobilebeacon.org/

nationwide to bring low-cost mobile broadband to nonprofit organizations around the country, and through those local nonprofits brings low-cost broadband to low-income people.

There are numerous solutions being used by the nonprofits working with Mobile Beacon. One common effort was discussed above, which is to provide portable WiFi hotspots that are distributed from libraries. Mobile Beacon has also negotiated a deal with Sprint (now T-Mobile) to provide low-cost cellular broadband to students and others that is priced as low as $10 per month for an uncapped cellular broadband connection.

An interesting study[2] was done looking at the impact of bringing broadband to low-income homes for the first time in the Twin Cities in Minnesota through the Mobile Beacon effort.

- 94% of Mobile Beacon subscribers use the Internet daily, and 82% say they use the Internet several hours a day.
- The average home with Mobile Beacon used 41 GB of data per month. Students used an additional 25 GB per month. People searching for jobs used 14 GB more per month.
- The Mobile Beacon broadband had an immediate impact on students. Parents report that students spend an average of more than 4 hours per week doing homework on the Internet.
- The new Internet connection allows adults in low-income homes to get training. 32% of adults in the Mobile Beacon program were taking online courses.

Bridging the Broadband Skills Gap

Even if better broadband becomes available, there are many residents of the county that don't possess the basic computer skills needed to take part in the modern digital world. The county should consider finding ways to provide more computer training. This can be done in a wide variety of ways:

- Allow the Schools to be Used After-Hours for Training Adults. A number of communities use computer training centers that already exist in schools to hold after-hours training for adults.
- Develop Training Course in the Libraries. A number of communities have developed computer training programs through their libraries.

Find Solutions for the Homework Gap and Computer Gap

We heard that a lot of students could not engage in online learning from home during the pandemic. There are ways that other communities have tackled the issue – some of these solutions are underway in the county, but such efforts ought to be made more permanent.

Take-Home Computers for all School Kids. The most common solution is schools that send computers home with students. In some school systems these computers can only be used to connect to the school system network, making them homework-only computers. But other school systems have recognized that these might be the only computer in a home and let students and their families use the computer for other purposes. The biggest problem with school-provided computers are students that don't have a broadband connection at home.

[2] Bridging the Gap. https://www.mobilebeacon.org/wp-content/uploads/2017/05/MB_ResearchPaper_FINAL_WEB.pdf

Lending Mobile Hot Spots. There are many communities that are lending mobile hot spots to citizens through the libraries much the same way they lend books. A person can check out a hot spot for some period like a week or ten days, which will provide broadband that can be used with computers or tablets.

This program requires two things. First, Door County would need to buy mobile hot spots and be prepared to continue to fund them into the future. You'd also need to partner with one of the big cellular companies to provide free or inexpensive bulk cellular data to power the hot spots. Other communities have been successful in creating such partnerships. It's worth noting that these hot spots will only work where there is cellular broadband available – so you should try to put together a map of where cellular works and doesn't work – much like mapping landline broadband as described above.

Get Computers into Homes that Need Them. Communities tackle this in two ways. One is to give or lend laptops or tablets to students. Some school districts provide computers to every student while others provide them selectively to students that need them. The other alternative is to find a local nonprofit that is willing to tackle the computer issue. Most home and business computers last 3-5 years, and nonprofits have found that older computers can be upgraded fairly inexpensively and then placed in homes that need them. Such an effort can be a lot of work, but many communities have found groups willing to tackle the issue.

One such program is the nonprofit E2D[3] (End the Digital Divide) in Charlotte, North Carolina. The organization refurbishes laptops contributed by businesses in the Charlotte area and gives them to students. The organization has taken a several-prong approach to make this happen:

- They solicit used laptops from businesses in the Charlotte area. Most big businesses replace laptops every few years, and most of them have been ending up in the landfill. Now a number of businesses send all their used laptops to E2D.
- Used laptops need to be refurbished, and E2D started several computer labs in area high schools where they hire students at a decent wage to refurbish the computers and install new software. The purpose of these labs is not only to get the laptops ready to distribute, but they provide technical training for kids that is helping them move on towards college or a technical career.
- Households that get a new computer also get a live tutorial and technical support to best take advantage of the new laptops.
- Finally, the Charlotte area has a lot of homeless families, and there are thousands of homeless kids in the area. E2D has partnered with Sprint to provide mobile hot spots and data plans that are providing broadband access to homeless students and others with no broadband.

Another organization that works nationwide to fund computers is Minneapolis-based nonprofit PCs for People[4]. They provide PCs to households that need them and work with other entities, including Mobile Beacon and E2D. Door County or some local nonprofit could connect with PCs

[3] https://www.e-2-d.org/

[4] https://www.pcsforpeople.org/

for People to find ways to get computers into the hands of the neediest households in the County. A local nonprofit could also mirror what's been done elsewhere.

Create More Public Hot Spots. Door County can fund more public hotspots. Outdoor hot spots are particularly effective since students can sit in cars and use them any time of the day or night. Door County can start this process by extending the WiFi at County buildings to the outside areas surrounding the buildings. To the extent that County buildings already have decent broadband, the concept is to share it with the public. It's particularly easy to make bandwidth available to the public in the evenings when the government offices are closed, and the bandwidth isn't being used – sharing this bandwidth usually adds no cost to what is paid for broadband.

A more aggressive plan would be to create public hotspots in each rural neighborhood that doesn't have good broadband – the places where citizens need it the most. However, it might be a challenge to find the bandwidth needed to support such hot spots. You might be able to partner with the incumbent ISPs or cellular carriers which might have broadband that isn't otherwise available to the public.

Reward Businesses for Providing Public Hotspots. We've seen communities that reward businesses for creating good public hot spots. The reward can be anything from public recognition and awards to some sort of break on local taxes and fees.

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

AT&T, CenturyLink, and Frontier are the incumbent telephone companies serving various parts of the county, and for the most part, provide broadband using DSL technology using copper telephone wires. It's possible that the phone companies sere some businesses with fiber, but that is not widespread. The incumbent cable TV provider in towns only is Charter/Spectrum. There are several fixed wireless providers that claim to provide some coverage in the county, including Door County Broadband, Mercury Networks, and SonicNet. Some rural customers are using broadband provided by cellular companies with cellular hotspots. However, there are many parts of the rural county that have poor cellular reception.

Most rural homes and businesses can buy satellite broadband from Viasat and HughesNet. Rural customers can also buy cable TV from DirecTV or Dish Networks. We've heard that there are county residents who are part of the beta test for Starlink, the low earth orbit satellite company.

Following is an analysis of the prices being charged in Door County today. We know from experience that prices vary widely by customer for many ISPs. Over the years, customers have purchased bundles or participated in promotional pricing and might be charged differently than their neighbors. The wide variance in rates charged in the community means there is no longer anything that can be considered as a "standard" price in the market. Nevertheless, it's important before considering the viability of a new ISP to understand the prices in the market today.

Incumbent Telephone Companies

AT&T. AT&T is the incumbent landline telephone provider in some parts of the 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 of 2020, the company rebranded everything as AT&T again. The big news is that AT&T announced in October 2020 that it would no longer connect a new DSL customer. For now, existing customers can keep DSL, but nobody can add the product.

It's been hard recently to understand AT&T's business plan. At the end of February, the company spun off its cable TV business that includes DirecTV, AT&T TV, and U-Verse. The business went to a newly formed company that will be owned 70% by AT&T and 30% by TPG Capital. AT&T received $7.8 billion in cash, which values the new business at $16.25 billion. This represents a huge loss for AT&T, which originally paid $67 billion to acquire DirecTV in 2015. That's over a $50 billion loss after six years of purchasing DirecTV.

AT&T recently announced an even bigger deal and sold off WarnerMedia to Discovery Inc. This means AT&T will no longer own HBO and other programming that it was using as a lure for bundling. The sale net's $43 billion in cash to AT&T to pay down debt. The newly formed company will become the second-largest Media company and will combine HBO, Warner Bros. studios, TNT, TBS, and CNN with Discovery, Oprah Winfrey's OWN, HGTV, The Food Network, Animal Planet, and others. The new company will have a huge sports presence between TNT and TBS and Discovery's worldwide sports coverage.

The sale represents another big loss for AT&T. The company paid $85 billion for Time Warner and is losing $42 billion after only five years. The two sales will allow AT&T to pay down about $51 billion of its $169 billion in debt. But a lot of the remaining debt is still on the books from the original two purchases.

At the end of the first quarter of 2021, the company had over 15.4 million broadband customers and almost 15.9 million cable customers. The company lost only 5,000 net broadband customers in 2020. However, AT&T added over 1 million customers on fiber in 2020, which offset the similar loss of DSL customers. AT&T has built fiber to pass 14.5 million passings (potential customers) and is planning on passing 3 million new passings in 2021.

AT&T is offering a revamped cellular broadband product in rural areas that is the supposed replacement for rural DSL. The company advertises speeds of up to 25 Mbps. The product has a monthly data cap and charges for extra usage above 350 gigabytes in usage in a month.

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.

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. U-Verse DSL uses two copper pairs that result in twice the speed.

DSL	Download Speed	Price	Introductory Price
Basic 5	5 Mbps	$ 50	$ 40
Internet 10	10 Mbps	$ 60	$ 50
Internet 25	25 Mbps	$ 60	$ 50
DSL Modem		$ 10	
U-Verse			
Internet 50	50 Mbps	$ 60	$ 50
Internet 75	75 Mbps	$ 60	$ 50
Internet 100	100 Mbps	$ 60	$ 50
DSL Modem		$ 10	

There is a monthly data cap on total usage of 150 gigabytes for DSL customers, meaning customers are charged more for exceeding the cap. The data cap for U-Verse customers is 350 gigabytes per month. Overage charges are $ 10 for an additional 50 gigabytes of data. For $30 extra per month, a customer can get unlimited data.

Fiber Broadband. Following are the residential prices for AT&T broadband on fiber. We didn't see any evidence of this product in Door County, but it could be offered in small pockets.

Fiber	Download Speed	Price	Introductory Price
Internet 100	100 Mbps	$ 60	$ 50
Internet 300	300 Mbps	$ 80	$ 70
Internet 1,000	1 Gbps	$100	$ 90

Modems are leased at $10 per month. Customers can provide their own modem.

Data Caps. There are currently no data caps for AT&T fiber customers, although there was a cap of 1 terabyte (1,000 gigabytes) in the past.

CenturyLink is the third-largest telephone company in the country with headquarters in Monroe, Louisiana. Several years ago, the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. At the end of the first quarter of 2021, the company had 4,728,000 broadband customers. The company has a small number of cable TV customers but announced in 2020 that it is phasing out of that business line. For most of the areas it serves, the company bundles with DirecTV.

As the incumbent provider, CenturyLink is considered the "provider of last resort" in its service areas. This means that CenturyLink is required to serve all residential and business customers for basic local services, and it must provide facilities to all customers.

In recent years CenturyLink invested significant capital in improving data speeds in metropolitan areas. For example, in 2016, the company constructed fiber to pass 900,000 homes in major markets like Seattle, Phoenix, Denver, and Minneapolis. Since then, the company has merged with Level 3 Communications, and the new CEO announced that the company would not be making any future investment in assets with "infrastructure returns," meaning it's not going to build new fiber to residential customers and is probably not going to invest any more money in its copper networks. However, since that time, the company is again building small amounts of fiber each year, predominantly to businesses and large apartments. The company announced plans to build fiber in 2021 to pass 400,000 homes and businesses.

The big news that hit as this report was being written is that CenturyLink is selling its business in Wisconsin and nineteen other states. The properties are being sold to Apollo Global Management, a private equity firm. The same is for $7.5 billion for what is described as seven million passings. All but 200,000 fiber passings are served by telephone copper. The Apollo Global Management team is led by three veterans who helped to build Verizon's FiOS business, including Bob Mudge, Chris Creager, and Tom McGuire. This new buyer says it has plans to aggressively build fiber, but only time will tell if that includes rural counties like yours. The sale is not expected to be approved by regulators until the second half of 2022.

CenturyLink DSL

CenturyLink sells high-speed Internet using DSL technology. They sell 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). As discussed above, CenturyLink offers a lot of specials, with special rates available on their website for new customers. But as typical with most big ISPs, a subscriber's rates revert to "normal" rates at the end of the promotion period. Following are the base list prices for residential DSL. Note that the quoted speeds offered by CenturyLink DSL are "best-effort" speeds, meaning they are not guaranteed. Rural customers typically get speeds significantly slower than the advertised speeds.

Residential DSL

Pure DSL is CenturyLink's name for a DSL line that is not bundled with telephone or DirecTV. There is a low price for the first year, a higher price for the second year, and starting the third year the customer pays the list price:

	1st Year	2nd Year	List
1.5 Mbps download, 896 Kbps upload	$30.00	$40.00	$42.00
7 Mbps download, 896 Kbps upload	$35.00	$45.00	$47.00
12 Mbps download, 896 Kbps upload	$40.00	$50.00	$52.00
20 Mbps download, 896 Kbps upload	$50.00	$60.00	$62.00
40 Mbps download, 896 Kbps upload	$60.00	$70.00	$72.00

Pure DSL also requires a DSL modem. The charge for this seems to be negotiated and ranges from $1.95 to $6.95.

We don't expect that there is much if any DSL in Door County faster than 12 Mbps. Generally, the faster speeds are available only in the metropolitan markets.

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. Basically, CenturyLink will negotiate a price with a business customer based upon 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, each customer will negotiate with a salesperson, and rates charged in the market are all over the board for the same product.

Telephone Rates

CenturyLink's telephone rates were as follows when last tariffed. This does not mean that these are the rates any longer, and with a de-tariffed rate, CenturyLink can charge whatever it wants, within reason.

	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.

Frontier Communications is the fifth largest telephone company in the U.S. The company changed its name from Citizens Communications Company in 2008. Frontier Communications has grown through acquisitions. For instance, in 2015, it agreed to buy 2.2 million customers from Verizon in Florida, Texas, and California. The company spent $8.5 billion to buy a huge pile of customers from Verizon in 2009 and in 2013 bought the Connecticut operations of Verizon. As of the end of the first quarter of 2021, the company had 3.05 million broadband customers and 453,000 cable customers.

Frontier has struggled financially in recent years and filed for bankruptcy protection a year ago. The company recently emerged from bankruptcy and says it has plan to expand fiber. The company announced plans to build 495,000 passing for 2021, and said it plans to be more aggressive in the future. In 2020 the company sold its properties in Washington, Oregon, Idaho, and Montana to WaveDivision Capital for $1.35 billion.

Frontier is an incumbent telephone provider and is considered a provider of last resort, meaning they must make reasonable efforts to try to provide telephone service to somebody within their defined service area.

Frontier DSL. Frontier offers broadband with DSL served on copper lines. The company has three DSL products available nationwide:

	Speed	Price
Simply Internet Core	6/1 Mbps	$ 44.95
Simply Broadband Ultra	12/1 Mbps	$ 54.95
Simply Internet Elite	18/1.5 Mbps	$ 59.95
DSL Router		$ 10.00

All products also get assessed a $1.99 Internet Infrastructure Surcharge. This is not a tax and is part of the price of the product.

These are "up-to" speeds, and we know that many rural customers receive significantly slower speeds, with some reports barely faster than dial-up. As mentioned elsewhere in this report, the company has taken money from the FCC to supposedly upgrade many of the rural DSL customers in the county to speeds of at least 10/1 Mbps.

Telephone Rates

Frontier's telephone rates are still tariffed. However, like other telcos in the state, the rates have been deregulated. Frontier offers cable TV in rural areas through bundles with Dish Network.

	Monthly
Basic Calling	$ 15.50
Community Plus	$ 22.00
Frequent Caller	$ 29.00
Call Detail	$ 2.00

Frontier charges by the minute for long-distance. This means that free calling is generally only available to those living close to the serving area, while there is an extra fee to call anywhere else.

For all telephone lines, Frontier charges an additional $6.50 for Subscriber Line Charge and up to $1 for an Access Recovery Charge (ARC). There has been a proposal at the FCC to abolish the Subscriber Line Charge, in which case Frontier's rates would likely drop by $6.50

Frontier offers a dizzying array of other telephone services. This tariff lists all of the deregulated rates and includes long-distance, features, and a wide variety of business telephone services.

Cable Companies

Charter Communications (Spectrum) is the incumbent cable provider in Sturgeon Bay, Jacksonport, Egg Harbor, Fish Creek, Ephraim, Sister Bay, and Ellison Bay. One of the issues we heard during the study process is that the company doesn't serve everybody in many of these towns. There are streets and neighborhoods that never got service and the company is not required to fill in the holes. This means that there are some customers in the towns that have the same broadband choices as rural households in the county.

Charter/Spectrum is the second-largest cable TV company in the country, with over 29 million broadband customers and 16.0 million cable TV customers at the end of the first quarter of 2021. Charter/Spectrum had revenues of $48.1 billion in 2020. 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/Spectrum is the incumbent cable provider in the towns, having purchased a network that was formerly operated by Bright House Networks.

Charter/Spectrum was founded in 1993 and got its start as a cable company in 1995 when it acquired Cable South. Paul Allen, one of the founders of Microsoft, bought a controlling interest in the company in 1998. The company continued to grow through acquisition, buying a dozen smaller cable systems over the next decade. The company went through bankruptcy in 2009 and was able to walk away from $8 billion in debt, with the majority of the equity in the company going to Apollo Management. Charter/Spectrum announced in late 2017 that they were partnering with Comcast in some markets to be able to provide cellular phone products.

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 will allow the company to increase data speeds and market gigabit a data product. A gigabit data path requires roughly 24 channels on a cable network using the new DOCSIS protocol.

Along with the introduction of gigabit broadband, the company announced across-the-board speed increases for upgraded markets. Charter/Spectrum announced that the speed of the base broadband product will now be 200 Mbps. This is an increase from 100 Mbps. However, there are many markets where it cannot deliver the new faster speeds, and in some markets, the standard product being marketed is still at 100 Mbps.

Broadband Pricing

While Charter/Spectrum is a giant company, its broadband pricing structure is one of the simplest in the country. The company currently has three broadband products. As mentioned above, the base product ranges in speeds in various markets between 60 Mbps and 200 Mbps. It now markets a gigabit product in most markets.

	Speed	Price
Spectrum Internet	Up to 200 Mbps	$ 69.99
Spectrum Internet Ultra	Up to 400 Mbps	$ 94.99
Spectrum Internet Gig	Up to 940 Mbps	$129.99
Activation Fee		$ 49.99
WiFi Router (optional)		$ 9.99

The company generally gives a $10 discount when bundling with other products, although this can be negotiated. Charter/Spectrum has raised rates twice within the last year. Note that the basic and bundled Internet prices above increased by $5 at the beginning of 2021.

There are no data caps on the monthly broadband download. However, in June 2020, Charter/Spectrum 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 immediately 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 their business telephone rates.

WISPs (Wireless ISPs)

Door County Broadband, LLC was founded in 2014 and is based in Baileys Harbor, Wisconsin. Door County Broadband, LLC provides fixed wireless Internet services to both residential and business customers in Door and Kewaunee counties.

Residential Internet

Silver	Up to 4/1 Mbps	$ 54.95
Silver +	Up to 6/2 Mbps	$ 64.95
Gold	Up to 8/2.5 Mbps	$ 74.95
Gold +	Up to 10/3 Mbps	$ 84.95
Platinum	Up to 12/3.5 Mbps	$ 99.95
Platinum +	Up to 14/4 Mbps	$114.95
Diamond	Up to 18/5 Mbps	$144.95
Diamond +	Up to 25/6 Mbps	$204.95

Business Internet

Silver	Up to 4/1 Mbps	$ 64.95
Silver +	Up to 6/2 Mbps	$ 79.95
Gold	Up to 8/2.5 Mbps	$ 94.95
Gold +	Up to 10/3 Mbps	$104.95
Platinum	Up to 12/3.5 Mbps	$124.95
Platinum +	Up to 14/4 Mbps	$154.95
Diamond	Up to 18/5 Mbps	$194.95
Diamond +	Up to 25/6 Mbps	$254.95

The company charges $5 per month to get a paper bill. Vacation mode is available for $15 per month to maintain service while away, up to 6 months. Utility mode is $25 per month and allows access to devices like cameras when away, up to 6 months. The company also typically charges for any additional connection fees such as building pole to place a receiver.

Mercury Network Corporation[5] was founded in 1996 in Midland, Michigan. It is a full-service telecommunications company offering high-speed Internet, hosting, digital phone services, and computer repair. In 2004 Mercury Network acquired all the customers of LakeShore OnLine, an Internet Service Provider in Michigan. Mercury Network Corporation operates in Michigan and Wisconsin. The company offers fiber broadband in some markets but offers fixed wireless technology in Door County.

Mercury Broadband Pricing

The company advertises speeds up to 75 Mbps. Pricing is based upon the amount of broadband used in a month.

Up to 100 GB of Data	$50
Up to 750 GB of Data	$100
Up to 1,500 GB of Data	$150
Unlimited Data	$200

[5] https://www.mercury.net/

SonicNet[6], Inc is a family-owned company founded in 2007 to focus on the northern and the Upper Peninsula of Michigan. SonicNet currently has over 50 wireless towers and access points. It claims to be the largest fixed wireless broadband provider in the Northwoods.

Residential Internet

Essential Residential	Up to 5 Mbps	$ 52.75
Family Residential	Up to 12 Mbps	$ 73.85
Home Office Residential	Up to 25 Mbps	$ 94.95
Ultra Residential	Up to 50 Mbps	$115.00
Service Installation		$150.00 (one time)
Connection Protection		$ 10.00

The company offers businesses fixed wireless broadband with speeds up to 100 Mbps. Custom pricing is only quoted upon request.

Astrea[7] is a subsidiary of CCI Systems, a telecom provider established in 1955 in Iron Mountain, Michigan. The company owns traditional cable TV companies, provides network solutions, offers field and design services, operates a 24/7 call center, and runs a Network Operations Center (NOC).

CCI Systems established an ISP subsidiary 2007 which was rebranded in 2019 as Astrea. This subsidiary is now the provider for all broadband and triple-play products. In some towns, Astrea is the incumbent cable company. In some rural areas, including Door County, the company offers fixed wireless broadband. In remote places, the company resells satellite broadband from Viasat.

The company does not advertise the price for fixed wireless broadband. It says speeds may be 10 Mbps or greater.

Cellular Broadband

There are four primary cellular companies in the country—AT&T, Verizon, Cellcom, and U.S. Cellular. T-Mobile does not have facilities in the county.

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

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[6] https://www.sonicnet.us/

[7] https://astreaconnect.com/

Fixed LTE Products. The cellular companies have cellular broadband products aimed at rural home broadband customers. These data plans use the cellular network but are priced differently than data for cellphones.

Verizon. Verizon's hotspot product has four available pricing tiers based upon the monthly data allowance. The 10 GB plan is $60, the 20 GB plan is $90, the 30 GB plan is $120, and the 40 GB plan is $150. The real price killer is that Verizon bills each additional gigabit over the data cap at $10 each.

Verizon says that broadband speeds average from 5 – 12 Mbps download and 2 – 5 Mbps upload. If a customer refuses to pay the overage charges and doesn't buy additional broadband, Verizon throttles broadband to a crawl once the start of the next monthly cycle.

AT&T**.** AT&T has three hotspot plans. That includes 3 GB of data for $25, 10 GB of data for $50, and 18 GB of data for $75. The overage data prices range from $10 for 1 GB with the $25 dollar plan to $10 for 2 extra GB with the 18 GB plan.

US Cellular was founded in 1983 by TDS and is headquartered in Chicago, IL. The company is the fourth-largest cellular provider, with five million customers at the end of the first quarter of 2021. The fixed cellular products are sold by the monthly data limit rather than by speed.

Residential Internet

25 GB of data	$ 55.00
55 GB of data	$ 75.00
75 GB of data	$100.00
105 GB of data	$130.00
150 GB of data	$160.00
Modem	$ 5.95

Cellcom[8] is a subsidiary of Nsight and provides home and business broadband using its 4G LTE network. Nsight was launched in 1910 in as an independent telephone company in Pulaski, Wisconsin where it still serves as the local telephone, Internet, cellular, and TV provider. Nsight owns subsidiaries that offer a wide range of telecom product lines. Cellcom is the 7th largest cellular carrier in the country and provides services through Wisconsin and upper Michigan. In the speed tests we saw that download speeds average between 5 Mbps and 12 Mbps.

Residential Internet

2 GB	$10	$15/GB for additional usage
4 GB	$15	$15/GB for additional usage
10 GB	$30	$15/GB for additional usage

[8] https://www.cellcom.com/

The current hotspot products are some of the most expensive broadband in the world. You have to look at third-world countries to see similarly high data prices.

- Verizon plans range from $3.75 to $6.00 per gigabyte. Additional gigabytes are $10 each.
- T-Mobile data prices range from $3.86 to $5 per gigabyte. After hitting the data cap, the company throttles customers rather than provide more expensive data.
- AT&T hotspots are the most expensive and range between $4.16 and $8.22 per gigabyte. Extra gigabytes on AT&T range between $5 and $10 per gigabyte.

Satellite Broadband

There are two satellite broadband providers available to homes and businesses in Door County. Both Viasat and HughesNet utilize satellites that are parked at a stationary orbit over 20,000 miles above the earth.

There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much (Viasat claimed in their most recent financial report for June 2019 that the average residential broadband bill is $84.26). 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 satellites parked at over 22,000 miles above earth – that adds time to every round-trip connection to the web. Most real-time web connections, such as using voice-over-IP or connecting to a school or corporate WAN, prefer latency of less than 100 ms (milliseconds). Satellite broadband has reported latency between 400 ms and 900 ms.

The other customer complaint is about the tiny data caps. As seen by the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put these data caps into perspective, OpenVault announced recently that the average US home used 462 gigabytes of data per month in the first quarter of 2021. 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 (was 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 markets 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 high capacity, with the first to launch sometime in 2022.

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

	Price	Speed	Data Cap
Unlimited Bronze	$84.99	12 Mbps	40 GB
Unlimited Silver	$119.99	25 Mbps	60 GB
Unlimited Gold	$169.99	100 Mbps	100 GB
Unlimited Platinum	$249.99	100 Mbps	150 GB

There is a $12.99 per month additional fee for equipment on top of these prices. A customer must sign a 2-year contract to get these prices, with a fee of $15 per remaining month if a customer breaks a contract. Online reviews say that speeds can be throttled as slow as 1 Mbps once a customer reaches the monthly data cap.

HughesNet is the oldest satellite provider. They have recently upgraded their 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. Their packages are as follows:

10 GB Plan	$ 59.99
20 GB Plan	$ 69.99
30 GB Plan	$ 99.99
50 GB Plan	$149.99

These packages are severely throttled after meeting the data caps.

Starlink is a low earth orbit (LEO) satellite network with satellites at 800 miles or less above the earth. The company is still in beta test mode. We heard that customers in the county are using the test. The monthly pricing is $99, with a $500 installation fee. For best performance, the satellites need clear sight of the full sky since satellites pass from horizon to horizon. Reported download speeds vary between 50 Mbps and 150 Mbps.

Other Providers. Two other low-orbit satellite companies are working towards offering broadband. OneWeb, headquartered in England, promises worldwide coverage by sometime in 2023. Project Kuiper, owned by Jeff Bezos, hasn't announced a launch date but will be launching satellites by late this year or early next year.

B. Surveys / Interviews / Speed Tests

<u>Residential Survey Results</u>

As part of the assessment, we conducted an online residential survey. Online surveys are not statistically valid, meaning that the survey cannot be relied upon to answer numerical questions like the percentage of homes that will buy broadband from a new provider. The primary reason for this is that online surveys don't reach very many homes that don't have broadband, except for some respondents that take the survey at work or on a cellphone. In order to be numerically accurate, the survey would need to include a representative sample of homes with no broadband.

With that said, an online survey is useful for understanding sentiment. For instance, we can learn something useful from responses that talk about how residents feel about current broadband and existing ISPs.

The survey was conducted online using Survey Monkey in June of 2021. The survey was posted on Door County's website and was advertised on social media. The survey was well-received by the public, and we got 995 responses.

Survey Results

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

Broadband Customers

We start the description of our analysis by reporting on an odd set of responses to the survey. 134 respondents logged onto the online survey, answered the first question, and then left. The first question asks if they have home broadband. Perhaps there was something about the wording of how the County advertised the survey that led to this behavior – but it's not something we've seen before.

85% of all respondents said that they have a home broadband connection today – with 15% saying they don't have home broadband. When we look at the detailed responses, we see that 10% of respondents only use their cellphone for broadband, so the actual percentage of homes with a wired connection is 75% (85% with a home connection minus those using only a cellphone).

Again, as warned at the beginning of this discussion, we can't make any judgement on the accuracy of those percentages, other than to say that this is a much larger percentage of respondents that don't have a home broadband connection than what we normally see. The folks without home broadband found a way to take the survey, indicating that they likely have an interest in the topic.

The respondents who say they have a home broadband connection used the various ISPs in the county as follows: 25% use Charter/Spectrum (Spectrum), 21% use Door County Broadband, 20% use Frontier, 18% use satellite broadband, 4% use CenturyLink, and 2% use AT&T.

This will be discussed elsewhere in the report, but there are a lot of respondents using older or slow broadband technologies.

- Only 25% of the respondents claim to be using the cable company.
- 21% of respondents are using fixed wireless technology
- 18% of respondents are using satellite broadband
- 26% are using DSL from one of the telephone companies.
- Again, 10% of those with broadband are only using their cellphone for home broadband.

Taken altogether, 22% of the respondents who took the survey don't have a home broadband connection. The FCC reports that almost 86% of homes nationwide now have a home broadband connection. This survey gives us an indication that Door County might be far below the national average in terms of broadband penetration – a question we will look at deeper in the market research.

We asked why respondents with no home broadband don't have a home broadband connection. 72% said that broadband is not available at their home, 22% said that broadband is too expensive, 1% said they aren't interested in using the Internet, and 1% said they don't have a computer.

Broadband Not Available. We can't forget that 124 respondents to the survey said that broadband is not available at their home. We know from experience that this means broadband that works. Many of these homes have probably tried satellite broadband or cellular hot spots in the past and rejected those technologies as not work. Many homes also reject rural DSL or fixed wireless that only delivers a few Mbps speeds. It's likely that many of these homes have one of these poor broadband options and have rejected it.

Cable TV Penetration

59% of survey respondents report the purchase of traditional cable TV, meaning TV from a cable company, telco, or satellite provider. That is about the same as the nationwide average, which dipped below 60% by the end of the first quarter of this year. In Door County, 13% of households use Charter/Spectrum (Spectrum), 3% use AT&T, 1% use Frontier, and 42% use satellite.

19% of the survey respondents claim to be cord-cutters who watch all content online. There is no reliable count of the nationwide market share of cord-cutters, but most estimates put it at around 20% of households. The percentage of cord-cutters is growing rapidly, so it is expected that the number of homes with traditional cable in the county will continue to drop over time.

Another 9% of respondents use an antenna to get free TV over the air. 4% of homes claimed not to watch TV, while 8% of homes say that TV services are not available at their home.

Telephone Penetration

36% of homes still report having a landline telephone. The nationwide landline penetration has dropped below 30%. 16% of residents buy telephone service from Frontier, 9% from Charter/Spectrum (Spectrum), 7% from AT&T, 1% from CenturyLink, and 2% use VOIP (Voice Over Internet Protocol).

Cellular Service

99% of respondents say that they subscribe to cellular service – that's above the national average of 95%. 41% of homes said the cellular coverage is not adequate at their homes. That's one of the highest percentages we have seen. The poor cellular coverage is likely a factor in the above-average number of homes that still use landlines.

Customer Bills

The survey asked customers what they pay each month for the triple-play services (Internet access, cable TV, and telephone). We've found that this question always has to 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 are paying without realizing that they actually pay more due to hidden fees and additives. It's especially easy these days for customers that pay automatically with credit cards or bank debits and do not know how much they pay. With that said, here is what customers say they are spending:

Customers buying a bundle of service	$169
Customers buying standalone broadband	$ 86
Customers buying standalone cable TV	$117
Customers buying standalone telephone	$ 75

We note that the $169 average for bundles is pretty typical of what we see in other communities. The average price for standalone broadband is higher than what we see in other communities – we usually see an average between $70 and $80. The telephone price is higher than what we see in other communities – perhaps there are still homes with significant long-distance bills. Cable rates are typical of what we see in other communities.

Uses of Broadband

75% of respondents say that somebody in their homes uses the Internet to work from home. That is made up of those working at home full-time (18%), those that work several days per week (27%), those that work a few times a month (14%), and those that work from home occasionally (16%). The number of people working from home across the country has increased significantly during the pandemic – before the pandemic, we rarely saw more than 10% of homes with somebody working from home.

54% of respondents with somebody working from home said they would work from home more often if they had faster Internet.

18% of respondents report having somebody in the home using broadband for schoolwork. 64% of these households said that the broadband was not good enough to support online schoolwork.

We've learned during the last year that most of the problems encountered when working and schooling 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

51% of respondents say they are unhappy with their Internet download speeds at home, while 26% are satisfied.

39% of respondents are not happy with the customer service from their ISP, while 32% are satisfied.

61% of respondents say that they are unhappy with the value they get from their ISP compared to the price they pay, while 19% are satisfied.

These results show significantly more dissatisfaction than satisfaction.

Support for a Fiber Network

One of the key questions asked in the survey is if respondents support the idea of Door County trying to get better Internet access. 81% of respondents support the concept. Another 18% said they might support the idea but need more information. Only 1% of households said they do not support the county pursuing a better broadband solution.

We asked the reasons why respondents support bringing a new network to the county. 87% said they hope for faster speeds. 83% of households hope for more competition. 76% of respondents hope for more reliable service. 60% are hoping for lower prices, and 43% are hoping for better customer service.

Switching Service to a New Network

In probably the most important question of the survey, we asked respondents if they would buy Internet service from a new fiber network. 62% said they would definitely buy. Another 23% said they probably would buy service, and 12% said they might buy service. Only 3% said they were unlikely to consider buying service.

We also asked what factors would lead a respondent to move service to a new network. 78% said faster Internet, 57% said lower prices, 23% said better customer service, 7% said reliability, and 4% said availability.

When asked if they would buy a landline telephone, 20% of the respondents said yes, with another 10% saying probably and 17% said they might buy. However, 53% said they were unlikely to buy a landline.

Interpreting the Results of the Survey

It's always a challenge to interpret online survey results. It's first important to recognize that an online survey is not statistically valid, meaning you can't take the results from this survey and assume that they are the same answer you would get if you were to ask the questions to everybody in Door County. With that said, online surveys are considered a good way to understand sentiment and many of the questions in this survey are sentiment questions.

Following are my observations of what your survey tells us:

Dissatisfaction with the Incumbents. 51% of respondents were unhappy with download speeds, 39% were unhappy with customer service. The highest level of dissatisfaction of 61% was related to getting overall value for the price paid for broadband. These responses indicate a lot of community unhappiness with existing broadband.

Support for a New Network. 81% of residents support the idea of building a fiber network in the county, with another 18% who might support the idea if they had more information. This is overwhelmingly positive support, with only 1% who actively dislike the idea.

The high support is easier to understand when looking at the reasons for the support. The predominant reason for support (87%) was based on a hope for faster speeds. 83% of those that support the idea of a fiber network are hoping for more competition. 76% of those that support the idea of a fiber network are hoping for more reliable service. 60% of supporters are hoping for a lower price, and 43% are hoping for better customer service from the fiber network.

Customer Service. Nationwide surveys have repeatedly shown that the big cable and telephone companies are dreadful at customer service – the public rates them year after year as having the worst customer service of all businesses. Over a third of the respondents (39%) are unhappy with customer service. 43% of respondents hoped for better customer service from any new ISP option.

Competition. One sentiment that came through strongly is the desire for more competition. 83% of respondents said they would consider changing to a new network if it brought more competition to the market. That is one of the highest responses we've seen to that question. In Door County, the desire for more competition is combined with the demand for higher speeds, reliability, and lower prices.

Speed Sensitivity. This seemed to be the predominant issue for respondents. 51% of respondents said they aren't happy with broadband speeds. An overwhelming 87% said that the primary reason they would consider moving to a new network is to get faster speeds. In the vast majority of communities where we've done surveys, the primary reason people are interested in a new network is to save money.

Reliability. Reliability is also a critical issue in the county. 76% said that more reliable service would be a factor in getting them to change to a new network. That is one of the highest responses we have had to the question. We believe the desire for more reliability comes from the high number of customers using slow rural technologies like DSL, fixed wireless, and satellite.

Price Sensitivity. Price sensitivity is an important issue in the county. 60% said that lower prices would be a factor in getting them to change to a new network. When we look at what residents say they are spending today, many prices are above average. However, in communities where prices are a major issue, we see many residents buying the lowest cost options available. That's not the case in Door County. We find it likely that the 60% of respondents that are hoping for lower prices is mostly wishful thinking and not a plea for lower prices.

Potential Customers on a New Network. One of the most important reasons to do a survey is to get a feel for the number of households that might buy broadband from a new network. This is one of the questions where it matters that the survey was not statistically valid – meaning that we need to take the results with a grain of salt. However, even an online survey can give us a feel for the popularity of a new network.

62% of all respondents said they would definitely buy from a new network. Another 23% said they would probably buy, and 12% said they might buy. We interpret these results as follow:

- Customers who say they will definitely buy probably will. Every county 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. Your survey comes in far higher, with 62% of the respondents ready to immediately change to a fiber network – again, not a statistically valid number that we can rely on.
- We've always found that around two-thirds of those that say they will 'probably' change will also do so. Some won't take the initiative to make the change, and some will be lured with low-priced packages aimed to keep them on the current provider. But overall, these respondents have indicated a decent interest in changing providers. In your case, 23% 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 an ISP makes the effort to explain the benefits of the network and has products and prices the public finds attractive. In your case, 12% said they might buy broadband.

Unfortunately, we can't use these results to predict a penetration rate on a new broadband network. With that said, we've almost never seen 62% of respondents to a survey say they would absolutely buy broadband. We interpret these results to mean that there is a higher-than-average demand for better broadband.

Business Survey / Interviews

Interviews and Business Questionnaires

CCG reached out to businesses in two ways. First, a business survey was posted online, and businesses were invited to take the survey. This survey basically asked businesses to tell us their broadband story – is current broadband meeting their needs, and what they could do better if they got better broadband? We also interviewed a sample of businesses to dig deeper into specific issues. We gave businesses the option to keep their specific responses anonymous, and a number of them chose to do so. The following write-up still includes what we learned from businesses.

Altogether we got survey responses from 111 businesses in the county. We interviewed an additional dozen businesses in more depth than the survey.

Overall, we found a lot of unhappiness with broadband. We heard from a hundred businesses in the county that are not happy with their current broadband options and performance.

Here are some of the most important things we learned from the questionnaires and interviews:

- There are two distinct sets of businesses in the county when it comes to broadband service – those located in towns or near to the two major north-south highways that can get decent broadband, and everybody else who has poor broadband. Businesses that are able to subscribe to Charter/Spectrum broadband are far happier, and twenty-one businesses respondents are largely happy with Charter/Spectrum's existing broadband. It's a very different story for businesses that can't get Charter/Spectrum. Some of them have the worst broadband stories imaginable, where they have trouble doing even low bandwidth functions like taking credit card payments. Many of these businesses describe a broadband nightmare, and poor broadband is clearly hurting their businesses. One restaurant went so far as to relocate to get close to the highway to get better broadband.
- We identified what we can best describe as seasonal broadband problem. Businesses and residents complained about how broadband bogs down during the tourist season. When the county needs broadband the most, it slows down, and service is degraded across the board. This is likely due to the ISPs in the county not having robust last-mile networks.+
- As might be expected, a lot of the businesses we heard from are hotels, motels, inns, and bed & breakfasts. They universally said that there was not enough broadband to keep guests happy. Guests show up on vacation today expect to keep in touch with the office and to stream videos in the evening. Many of these establishments said that guests were largely unhappy with the broadband. We heard a lot of conjecture from businesses that the lack of broadband is a leading reason that the county is mostly seeing older visitors, and many businesses worry about the future of tourism in the county.
- We also heard a lot of horror stories from retail stores. Many struggled with taking credit cards, which can be particularly devasting to stores that take a lot of payments to sell basics. Even stores like galleries that make fewer sales have to take credit card payments manually and send them in

later when broadband is working. That means they're taking a chance on having transactions that are not accepted or even fraudulent.

- There are businesses in the county that sell online, and the lack of broadband really hurts their businesses. They can't host retail websites locally, and they often lose the ability to take credit card payments. They have trouble keeping up with shipments when the needed information is in the cloud.
- Perhaps the most common complaint we heard was from business owners who have even worse broadband at home than at the businesses. They are unable to take work home and end up bringing home broadband needs to the office. One brewer told us a story of bringing his kids to the business every day during the pandemic so they could connect to schools.
- Getting fiber is not always a full solution. We heard from the hospital, which has a gigabit connection over fiber. During busy tourist times, the speeds on that connection slow down and the hospital has troubles handling routine functions. We heard from several customers served by fiber who say that they get regular day-long outages that are blamed on fiber-cuts.
- Another common complaint is broadband outages. There was no consistent tale of outages because the problems seemed to be specific to given neighborhoods. There were businesses who complained about getting several small outages almost every day. We heard stories of regular outages that last for hours. We heard a few stories of outages that lasted for a day or two, and as long as a week.
- We also heard numerous complaints about cellular coverage. Businesses often revert to cellular broadband when landline broadband is down, and we heard that in-season that cellular coverage slows and sometimes is completely unavailable. One business that sends nurses for home visits has a terrible time with insurance and billing since they are expected to have employees log in each patient visit from the field using the cellphone. We heard from businesses that only see cellular reception from a single cellular company – which leads to frustration and unhappiness from guests and customers that use different carriers. We heard from a gas station that often can't take payments at the pumps due to poor cellular connections.
- We heard stories about specific ISPs.
  - We didn't find anybody who was happy with Frontier. The network seems to have regular outages that can drag on for a day or two. One business said they never had a full day without an outage. A business complained about losing phone service for over a week. Frontier constantly warns customers that if they disconnect for any reason, they might not get reconnected. Several businesses commented that they thought Frontier was in the process of backing out of serving in the county – we have no idea if that is true, but this is the local perception.
  - There seems to be a love/hate relationship for many businesses with Door County Broadband. This wireless ISP serves customers who are off the beaten path and often located in places where wireless broadband is a challenge. Businesses seem grateful that the ISP can bring them faster broadband than the DSL or satellite alternative, but they are still frustrated that the speeds are slow and still not adequate for their needs. Some customers have spent money to erect their own tall tower/poles to get a better broadband connection but said it didn't make much of a difference. Almost every hotel and inn that uses the ISP said that there was not adequate broadband to share with guests.
  - Businesses using CenturyLink DSL say that the number one complaint is slow speeds. One business said that faster broadband would allow the business to eliminate one full-time position – that's how much efficiency is lost from fighting with the broadband connection.

Another CenturyLink customer said they have major problems using their operational software in the cloud.

- We found the highest satisfaction with Charter/Spectrum, but many businesses still have problems. Some reported regular outages. Some had the nearly universal complaint that Charter/Spectrum bogs down in the busy season, as seems to happen with every ISP in the county. There were a few Charter/Spectrum customers who said that at peak times that broadband got so poor that they struggled to accept credit cards. We heard several complaints about Charter/Spectrum's slow upload speeds. Some came from inns who said customers were unable to connect to work servers. We heard from a video production company that was unable to upload finished videos.
- We heard from a few rural businesses that use cellular hot spots and who report a miserable broadband connection that often slows to the point of stopping.
- We also heard from a few businesses using satellite broadband. Most had problems with reception due to not having a clear view if the sky because of trees. There were two businesses that are beta customers with Starlink. They report faster speeds but say that coverage comes and goes during the day – possibly due to the fact that the company hasn't launched the full constellation of satellites.

- A number of businesses complained about expensive broadband. A common complaint from seasonal businesses is that they have to pay high prices year-round in order to keep the broadband.

We asked businesses in the county how they used the Internet and got the following responses:

- <u>Communicating with Customers</u>. Businesses routinely have portals that make it easy for customers to place and track orders and to 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. A concern in the rural parts of the county is that many businesses report that their broadband is not even sufficient enough to consistently process credit card transactions. That requires almost the bare minimum of bandwidth, which speaks volumes about the quality of rural broadband in Door County. Businesses in the County report that they are unable to maintain e-commerce websites for selling goods or services, taking customer reservations, or other routine functions necessary to conduct routine business.
- <u>Communicating with Vendors</u>. Businesses also routinely use the portals of their own vendors to buy whatever they need to operate.
- <u>Communicating with Other Branches of the Company</u>. 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. There are numerous examples of one company owning multiple restaurants and hotels in the county. We heard from one owner who conducted all business from a hotel outside of the county since the broadband was so poor at each of the county locations.
- <u>Working in the Cloud</u>. 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

several businesses in the county that reported that their broadband stopped or hindered them from working in the cloud.

- Security Systems. Businesses often have their security monitored by offsite firms. Security today also means the use of numerous video cameras (and the ensuing video streams) used to monitor the inside and outside of a business. We heard from several businesses in the county that are unhappy because they don't have enough broadband to provide a quality security camera system.
- 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. We heard from several businesses that had problems sending large files, videos, etc.
- VoIP. Many businesses now provide voice communications between their various branches using Voice over IP. A reliable VoIP system needs to have dedicated bandwidth that is guaranteed, and that won't vary according to other demands for bandwidth within the business. We heard from two businesses that struggled because their voice is provided through the cloud. A few businesses told us that they didn't have an option to using the cloud since landline and cellular telephone connections were so poor.
- 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 to each remote employee. These connections can vary between 1 – 3 Mbps per second in both the upload and download directions. We heard across-the-board complaints from businesses about the ability of owners and employees to work from home.
- 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 are burglar alarm systems that monitor physical security and sensors inside equipment that monitors data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function correctly when connected to the Internet.

Speed Tests

The Wisconsin Department of Public Information (DPI) offers a speed test to anybody living in Wisconsin. DPI shares the results with the public. On the date that we gathered the speed test described below, 19,712 residents and businesses in Door County had taken the DPI speed test. That's a huge number of speed tests and provides a deep analysis of the actual broadband speeds in the county.

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 that 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. Wisconsin used the speed test from M-Labs, which is one of the most popular speed tests. The M-Lab test tries to transfer as much data as possible in 10 seconds (both upload and download), using a single connection to an M-Lab server.
- 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, and anybody that takes multiple speed tests during the same day will see this. Taking only one speed test might not tell the real story about a given customer.
- In Door County, we universally heard that broadband speeds bog down during tourism season, so tests taken then will show slower speeds than off-season. However, the speeds really are slower when the networks are overloaded with too many users.
- 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.

With the above caveats in mind, the following are the results from the speed tests taken for this assessment. Below are two maps that show a summary of the speed test results in various parts of the county. The map below shows the sixteen neighborhoods that DPI has used in the county for aggregating speed test results.

<u>Charter/Spectrum (Spectrum)</u>

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
5	11,452	68.32	9.81
6	6	63.74	13.00
10	80	113.62	11.01
11	5	53.00	13.56
12	257	94.69	9.11
13	14	84.41	11.05
14	29	51.06	10.77

Charter/Spectrum is the incumbent cable company in Door County. 11,843 Charter/Spectrum customers took the DPI speed test. The average download and upload speeds for each neighborhood zone can be seen in the table above. The average speed across the board surpasses the FCC's definition of broadband at 25/3 Mbps. It should be noted that Charter/Spectrum says that its minimum download speed is 100 Mbps, but the stated goal is 200 Mbps.

We don't have access to the individual speed test results. We'd love to see the distribution of speed test results because this can highlight neighborhoods that have a technology or network issues. We're sure there are plenty of individual speed tests with speeds faster than 100 Mbps, but to achieve the averages shown above, we're also certain that a lot of customers are experiencing slower speeds. It's likely that Charter/Spectrum's speeds vary by neighborhood. There could be neighborhoods with older coaxial cables and others that were built later or upgraded at some point in the past. There could be neighborhoods with high-quality coaxial cable and others with problems that invite interference.

The upload speeds for Charter/Spectrum are similar to what we see around the country from other cable companies.

AT&T

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
1	4	20.04	5.17
5	62	12.72	6.51
8	18	4.79	0.49

AT&T is one of the incumbent telephone companies in Door County. AT&T provides DSL Internet over telephone copper wires. There was a total of 84 speed tests from AT&T customers. AT&T download speeds are under the FCC definition of broadband of 25/3 Mbps. However, AT&T is the only ISP other than Charter/Spectrum with upload speeds greater than the FCC definition of 3 Mbps. With that said, the speeds in neighborhood zone 8 are much slower than the other locations – which highlights that AT&T likely is using different vintages of DSL technology in different parts of the county.

CenturyLink

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
1	152	9.91	3.57
3	267	13.52	2.07
4	5	6.05	1.01
5	48	12.15	1.37

CenturyLink delivers broadband using DSL over copper telephone wires. 472 CenturyLink customers took the M-Labs speed test.

Frontier

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
5	25	7.72	0.81
6	120	5.93	0.72
7	160	9.71	1.22
8	198	6.26	0.78
10	278	5.77	0.85
12	150	6.35	0.77
14	3	2.59	0.69
16	259	9.20	1.14

Frontier is an incumbent telephone provider in Door County and uses DSL technology over copper telephone lines. 1,193 Frontier customers took the M-Labs speed test. The most noticeable result of the Frontier speed tests is that the overall overage upload speed is less than 1 Mbps.

Door County Broadband, LLC

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
1	4	2.27	2.06
2	11	4.10	0.75
3	2	7.76	1.02
5	4,103	4.70	2.04
6	130	6.33	1.78
8	33	4.82	1.46
9	555	4.17	2.10
10	179	4.42	1.63
12	214	4.57	1.68
13	10	6.70	2.30
14	227	3.12	1.72
16	25	5.28	1.60

Door County Broadband, LLC is a fixed wireless Internet provider. 5,493 Door County Broadband customers participated in the M-Lab speed test.

Satellite Providers (ViaSat or HughesNet)

Neighborhood Zone	Number of Tests	Average Download Speeds (Mbps)	Average Upload Speeds (Mbps)
1	11	18.07	1.55
3	17	5.01	2.02
5	454	12.92	1.49
6	5	19.01	1.76
7	3	16.64	1.55
12	7	18.71	1.79
15	18	3.52	1.91

These results are from the two satellite companies available in Door County - Viasat and HughesNet. 515 satellite customers participated in the M-Lab speed test. The composite average speeds in the county are similar to DSL performance.

These speed test results are much slower than what we see around the rest of the country for satellite broadband. The problem with the technology in the county is that the satellite dish needs a clear view of the sky – something that is rare in heavily wooded Door County.

Mobile Broadband

It's worth noting that the primary factor that affects the speeds of mobile broadband is the distance between the customer and cellular tower. When you see a relatively fast speed, the customer probably lives relatively close to a tower.

Cellcom

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
1	36	15.97	3.66
3	12	35.49	8.73
5	58	16.22	0.09

Cellcom customers in Door County recorded 106 speeds tests. The average speeds for customers in neighborhood zone 3 are the only other broadband in the county that fully meets the FCC definition of broadband. However, these readings could be due to customers that live relatively close to a tower – contrast zone 3 results with zone 5 where upload speeds are barely measurable.

US Cellular

Neighborhood Zone	Number of Tests	Average Download Speed (Mbps)	Average Upload Speed (Mbps)
5	5	0.77	0.27

There were only 5 U.S. Cellular customers who took the M-Lab speed test. The speed results are the slowest of any ISP in the county – but this is also a tiny sample.

Summary of Speed Test Results

The following table shows the average download and upload results of each ISP and makes for an interesting comparison.

	Download (Mbps)	Upload (Mbps)
Charter/Spectrum	67.06	9.82
AT&T	11.37	5.16
CenturyLink	12.14	2.47
Frontier	7.25	0.93
Door County Broadband	4.61	1.99
Satellite	12.60	1.53
Cellcom	18.32	2.28
US Cellular	0.77	0.27

Several things are made clear from this table.

- Only Charter/Spectrum is the only ISP meeting the FCC's definition of broadband of 25/3 Mbps.
- Only Charter/Spectrum and AT&T have an average upload speed that is greater than the FCC's target of 3 Mbps. The slow upload speeds from other ISPs explain why residents have reported problems working and schooling from home and explains why businesses have problems connecting to the cloud or providing broadband connectivity to guests.
- Satellite technology is not outperforming DSL in the county. Around the country, the satellite speeds are often considerably faster than DSL – but most of Door County is wooded and doesn't provide the clear view of the sky needed for a good satellite connection.
- Cellcom shows that mobile broadband can be faster than DSL, but it is also delivering slow upload speeds.
- The slow speeds from Door County Broadband highlight the huge challenge of delivering fast fixed wireless broadband in a county with heavy woods and rough terrain.
- The average broadband speeds for all ISPs other than Charter/Spectrum is 6/2 Mbps – far below the FCC's definition of broadband at 25/3 Mbps.

The Seasonality Issue

One of the issues we identified in our outreach to residents and businesses is that broadband speeds drop significantly during the tourist season. This is something to be expected to some extent in any community that gets a big influx of people at some times of the year. But CCG Consulting has worked with a number of communities that see a lot of tourists, and the broadband situation in Door County is much worse than we've seen anywhere. Businesses tell us that broadband gets so bad at times that they can't even process credit cards – a function that needs only a tiny amount of broadband. This issue seems to occur across all of the ISPs in the county.

We would normally suspect that this is related to inadequate backhaul. For example, we recently worked with some Minnesota counties along the Canadian border where there was not enough fiber backhaul to satisfy the needs of the ISPs.

But we see a robust fiber network in the county that feeds cellular towers and larger businesses, and this leads us to conclude that the issue is likely due to the ISPs in the county not having a robust enough last mile network. The networks function at their best when there aren't many tourists, but there is not enough bandwidth being supplied to networks to meet the higher demand of increased users during peak season. This is an issue that is worsened by the ever-increasing amounts of broadband that is being used every year, as described below under future broadband gaps. There is no easy fix for this problem. Each ISP would likely have to make significant investments to make networks more robust. It's impossible to think that any of the telcos will do anything to improve DSL. It seems unlikely that Charter/Spectrum will do a major overhaul of the network – we don't see them doing so in other markets.

C. Broadband GAP Analysis

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

- The Gap in Broadband Speeds. The broadband speeds vary widely throughout Door County.
- The Gap in Broadband Availability. There are homes with no landline broadband available. We universally heard that residents and businesses say they have no choice between ISPs.
- The Gap in Broadband Affordability. In every community, there are households 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 look forward to the natural progression of technology that will create new broadband gaps that don't exist today.

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

The Gap in Broadband Speeds

The first step in trying to define the broadband speed gap is to look at the official definition of broadband.

FCC Definition of Broadband

In 2015, the FCC established the definition of broadband as 25/3 Mbps (that's 25 Mbps download and 3 Mbps upload). Prior to 2015, the definition of broadband was 4/1 Mbps, set a decade earlier. The FCC defines 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 reports the state of broadband to Congress every year.[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 have acknowledged that there are broadband gaps but claim that the broadband situation is improving due to actions taken by the FCC. As you will see in the following report, the annual reports to Congress are largely fictional and don't describe the state of broadband in places like Door County.

The FCC didn't use empirical evidence like speed tests in setting the definition of broadband in 2015. They instead conducted what is best described as a thought experiment. They listed the sorts of functions that a "typical" family of four was likely to engage in and then determined that a 25/3 Mbps broadband connection was fast enough to satisfy the broadband needs of a typical family of four.

[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.

The FCC asked the question again in 2018 and 2020 if 25/3 Mbps was still an adequate definition of broadband. They took no action and decided that 25/3 Mbps was still a reasonable definition of broadband. There were comments filed by numerous parties in that docket that thought that the definition of broadband should be increased.

The FCC Measures Broadband Speeds

Since the FCC is required by law to state an opinion as to the state of broadband deployment, they collect data from ISPs about broadband that is deployed and sold to customers in the US. The FCC collects ISP data using a process called the Form 477 process. The FCC collects data from every landline broadband ISP in the country (they don't require this data from dial-up providers, satellite providers, or cellular companies). The FCC collects the following data twice per year from every ISP (even though we know there are small ISPs that don't participate).

- ISPs report broadband customer counts by Census Block. Those are finite geographic areas defined by the US Census bureau that typically cover between 60 and 120 homes. In a city, a Census Block might be a city block, and in a rural area, it might cover a substantial portion of a county.
- For each Census Block, the ISP reports the fastest speed available to customers.

After the FCC gathers this data from ISPs, they make it available in the form of databases showing the speeds reported by each ISP in every Census Block. The FCC also maps the broadband data in various ways. The most common maps produced by the FCC show areas that don't have broadband that meets the 25/3 definition of broadband, areas that meet the 25/3 speed, areas that achieve speeds of at least 100/10 Mbps, and areas that have gigabit broadband capability. Many other variations of these maps are also possible.

Unfortunately, the FCC rules mean that the fastest speed available to one customer in a Census Block is considered to be available to all customers. For example, if an ISP has one customer in the corner of a Census Block that can buy 100 Mbps broadband, then the FCC interprets that result to mean that every customer in that Census Block can get that same 100 Mbps speed.

There is no penalty for ISPs reporting fictitious or inaccurate speeds. Many ISPs, particularly rural telcos, have been reporting marketing speeds that are far in excess of actual speeds. As an example, an ISP might advertise DSL as a speed of "up to 30 Mbps" and report the 30 Mbps speed to the FCC. In actual practice, the DSL speeds might be significantly slower than the advertised speed, maybe only a few Mbps. Those two factors – reporting by Census Block and reporting by advertised speeds means that the FCC's reported broadband speeds are significantly overstated, particularly in rural America.

One place where coverage is often overstated is in rural areas adjacent to towns and cities that have decent broadband speeds. Homes in the surrounding area are often shown as having the same broadband capabilities as the town, even though homes might have no broadband available. This can also happen in rural areas. For example, a big telco might place a DSL cabinet at the opening to a subdivision and provide decent DSL service there. The FCC mapping will show the entire Census Block as having good DSL, even though it is only available inside the subdivision.

The FCC doesn't monitor what is reported and has allowed big reporting errors into the mapping databases. The 2018 Broadband Deployment Report reached the conclusion that the state of rural broadband was improving rapidly. It turns out there was a huge error in the data supporting that FCC report. A new ISP in New York, Barrier Free, had erroneously reported that they had deployed fiber to 62 million residents in New York. Even after the FCC required the effort to be corrected, it still drew the same conclusion that broadband was getting better, even though the revised report showed millions of fewer homes with good broadband. This raises a question about what defines "reasonable and timely deployment of broadband" if having fiber to 62 million fewer people doesn't change the answer.

All these factors taken together mean that the FCC broadband databases and maps are generally dismal. The broadband speeds in towns might be reported reasonably correctly, although the speeds reported sometimes reflect marketing "up to" speed 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. Rural areas served by DSL or fixed wireless generally overstate the broadband speeds – and these are the two technologies most widely used in rural America and in Door County.

<u>FCC to Revise Maps</u>. In January of 2020, the FCC voted to revise its data gathering and mapping system, and Congress has provided the money for this to happen.

The biggest change in the new reporting is that ISPs must draw polygons around areas where customers either have service or where the ISP is willing to provide service within ten days of a customer request. This means service areas will be specifically identified, and that whole Census Blocks won't be shown as being served due to one or two customers. This will clean up two problems. It will draw lines around areas where cable company coverage stops in towns and create a clear border. Today, reporting by Census block often shows cable coverage extending far into the rural areas surrounding towns. Second, the polygons ought to chop down on rural WISPs and telcos that claim coverage where they can't provide service.

Unfortunately, the FCC is keeping one of the worst features of the original maps and ISPs can continue to report the fastest advertised broadband speed. This is the primary problem in rural areas today where the big telcos claim 25/3 Mbps advertised speeds and then deliver a 2 Mbps product. It's our opinion that rural mapping might not change much due to this rule.

The revised mapping rules also contain a two-tier challenge process – a challenge by governments or Tribes and a challenge by consumers. The government challenge is complex in that anybody that wants to challenge must draw their own versions of the polygons in an area they are challenging. It will be a huge challenge for governments to gather the huge volume of consumer data needed to make such a challenge. A government might gather a thousand speed tests in a rural county and still be unable to draw an accurate polygon of the coverage area. The challenge process looks to be heavily slanted in favor of ISPs.

The consumer challenges don't have much power. A consumer can challenge that a broadband product is available at their home, and if they win, the carrier simply must redraw the polygon to exclude them. A consumer challenge won't bring better broadband but will clean up the maps. But if a consumer has broadband, they likely can't challenge speeds if the ISPs are justified in reporting advertised speeds instead of actual speeds.

The proposed FCC mapping rules are not going to fix the problem that the public most cares about. By accepting advertised speeds today, the FCC has excluded huge areas with dreadfully poor broadband from being eligible for federal broadband grants. As long as the FCC keeps allowing advertised speeds, the FCC databases and maps will continue to ignore the reality of rural broadband and will continue to exclude areas from grant availability.

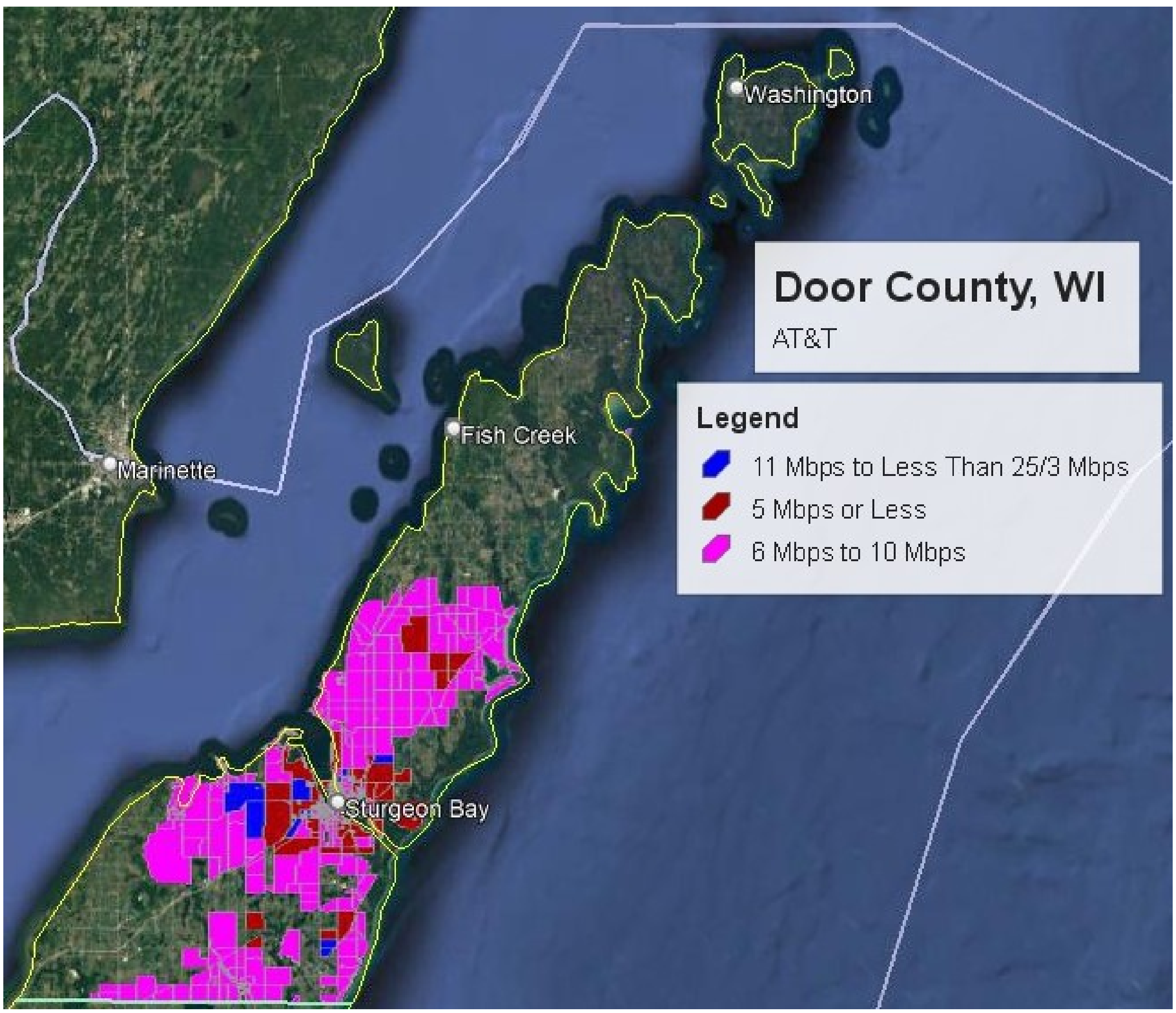
FCC Data for the ISPs in Door County

Following is a description and map showing what each ISP is currently reporting to the FCC.

AT&T

AT&T has historically offered DSL in the areas shown on the following map. It's important to note that as of October 2020, AT&T will no longer install a new DSL customer. The company has plans to instead offer fixed cellular wireless, but there was nobody with this product yet in the DPI speed tests.

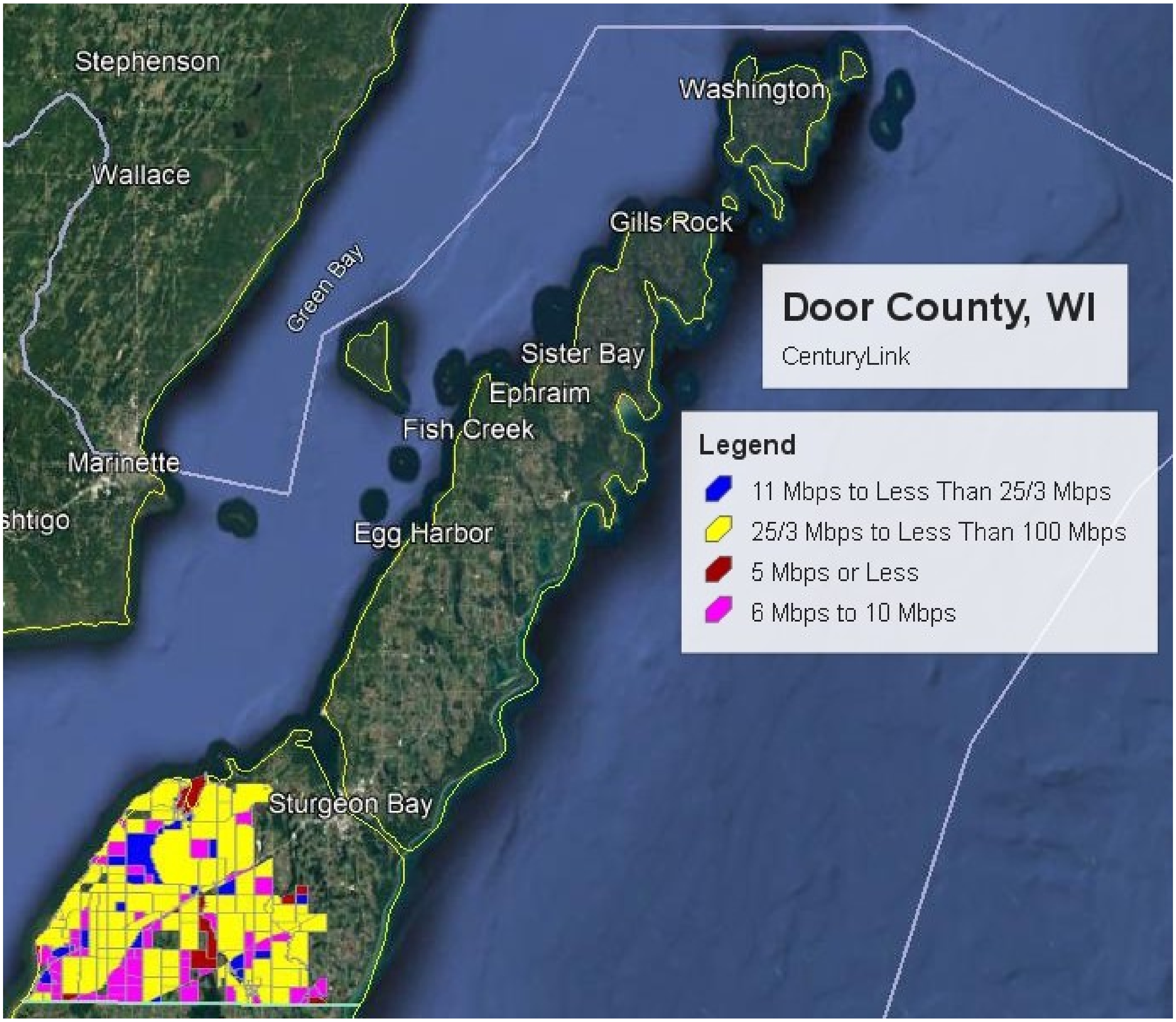
The map below shows the speeds that AT&T reports to the FCC on the 477 forms. The company shows speeds less than 25/3 Mbps in all of its service areas. In the pink areas on the map, AT&T is reporting speeds under 10 Mbps to the FCC.



CenturyLink

CenturyLink is an incumbent telephone company in the southwestern part of Door County. The map below shows the broadband speeds being reported by CenturyLink to the FCC on Form 477. CenturyLink claims speeds faster than 25/3 Mbps in the yellow areas on the map below. The other colors on the maps are for areas where the company reports speeds less than 25/3 Mbps, with the pink and red areas under 10 Mbps.

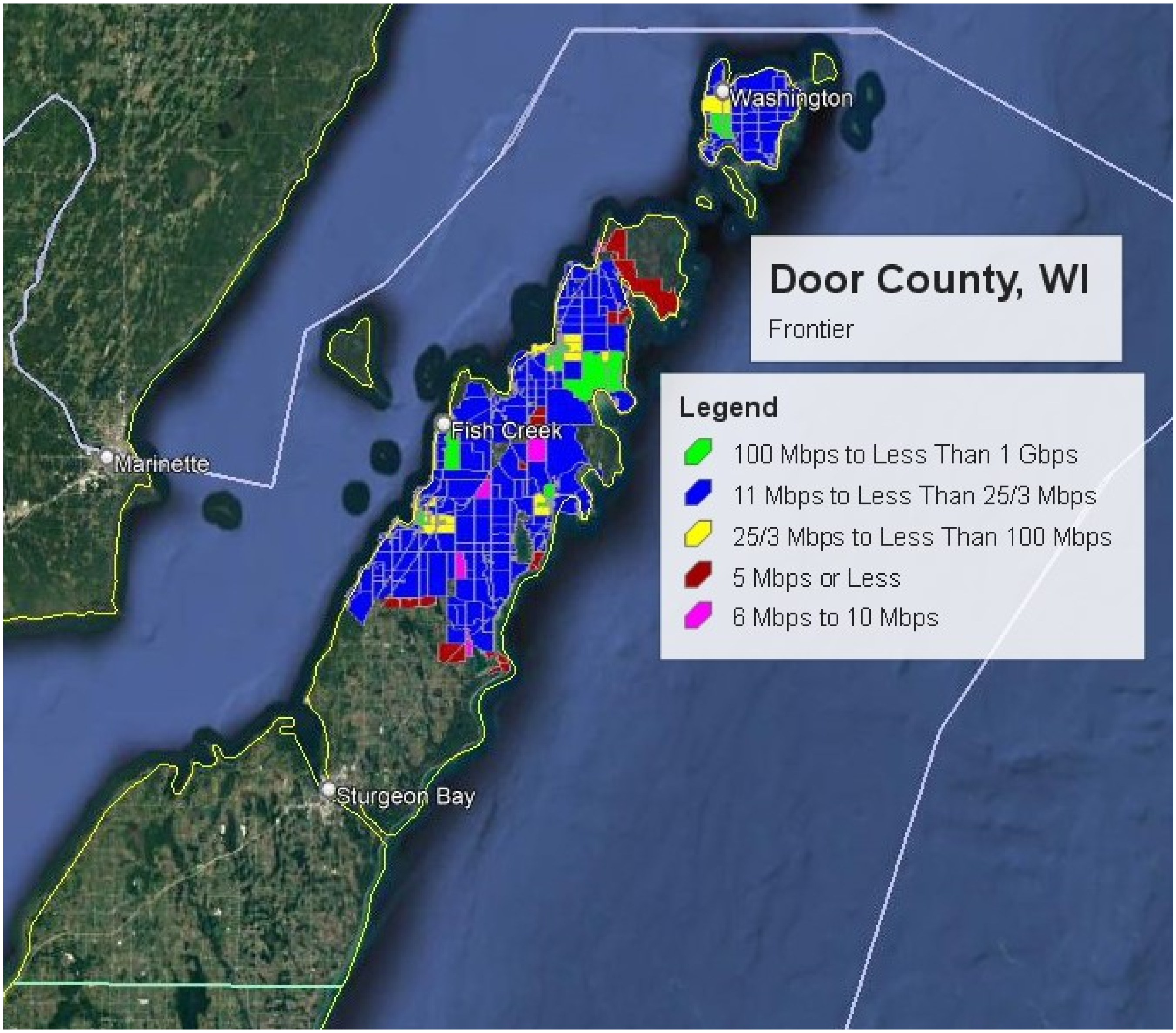
We have a tough time believing that the reported speeds are correct. The Wisconsin DPI speed tests show the company with average download speeds of 12 Mbps. We find it unlikely that the company is serving more than perhaps a small number of customers with broadband faster than 25/3 Mbps. We work around the country, and we regularly see areas where CenturyLink reports marketing speeds rather than actual speeds.



Frontier Communications

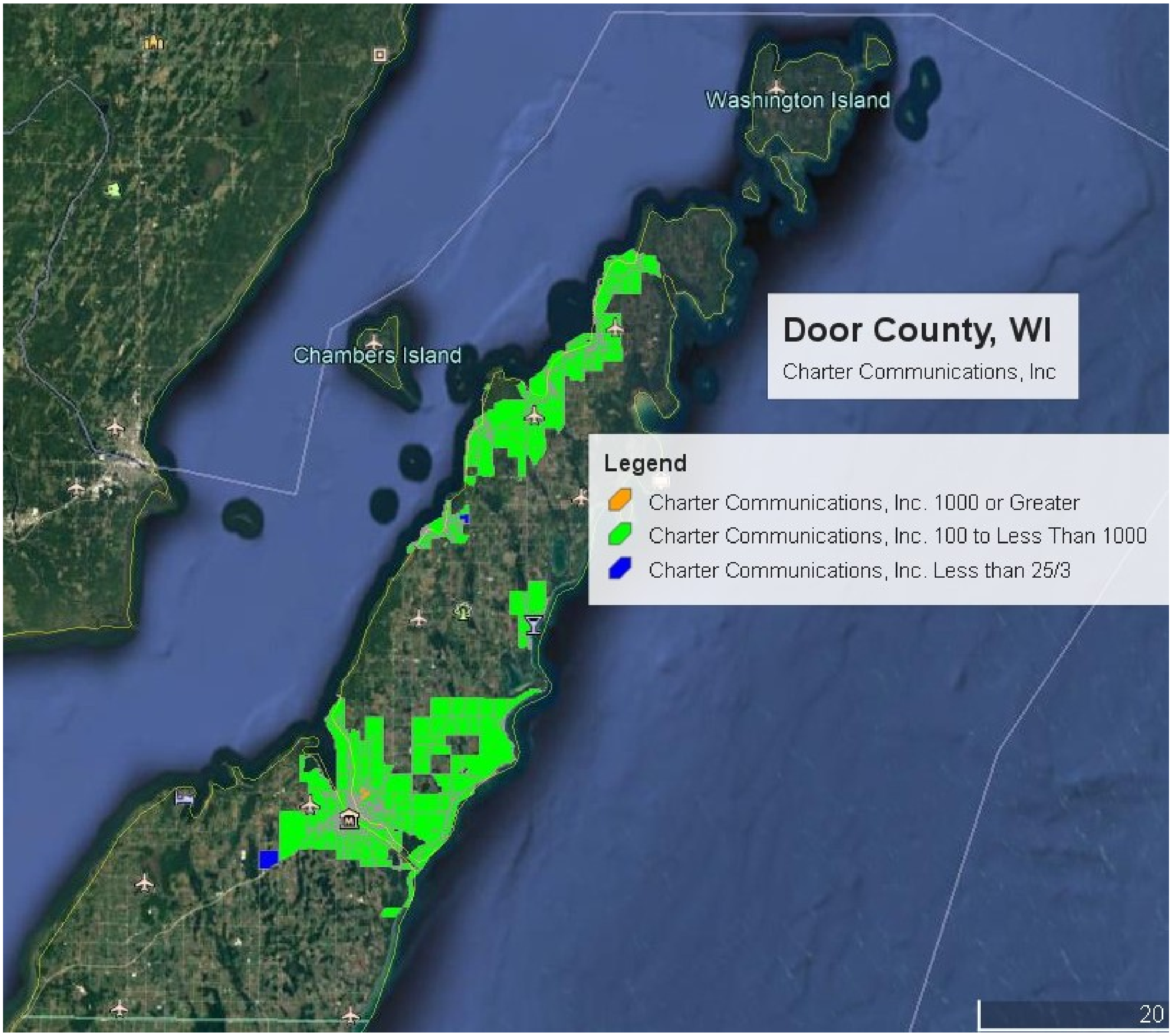
Frontier Communications is an incumbent telephone company in Door County that provides broadband using DSL technology. Frontier claims to be providing speeds greater than 100 Mbps in the green areas in the map below. It's possible that the company has a few business clients served by fiber, but there is no residential broadband in the county at those speeds. Frontier also claims speeds greater than 25/3 Mbps in the areas shown in yellow.

The Wisconsin speed test shown Frontier with average download speed of only 7 Mbps, and we find it unlikely that the company has many, or perhaps even no, residential customers with speeds over 25/3 Mbps. Like with CenturyLink we've seen many other places around the country where Frontier reports marketing speeds that are much higher than actual speeds.



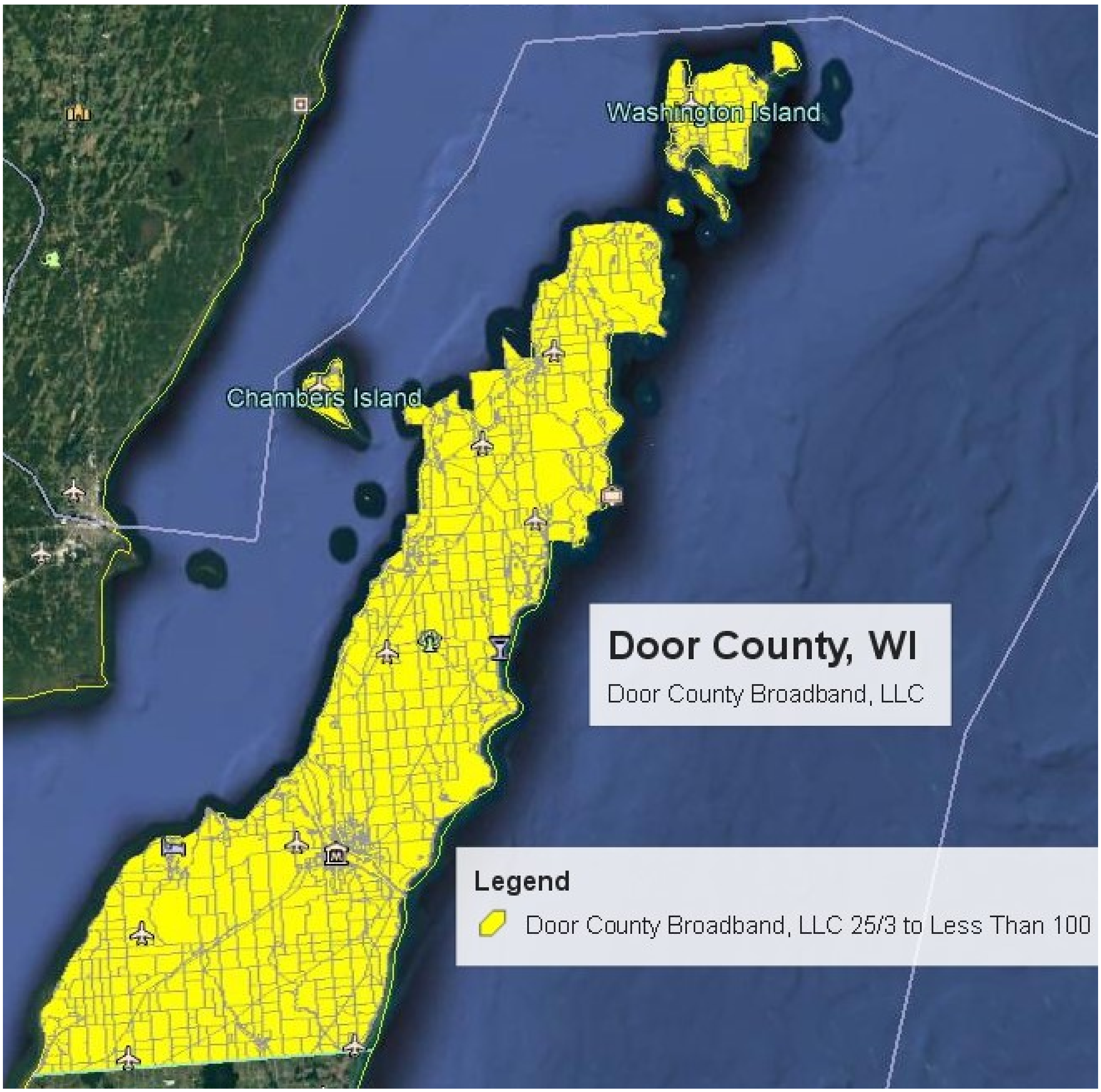
Charter/Spectrum (Spectrum)

Charter/Spectrum (Spectrum) is the incumbent cable company in Door County. The map below shows the coverage areas that Charter/Spectrum reports to the FCC on Form 477. Charter/Spectrum advertises speeds up to 1 Gbps. The actual Charter/Spectrum coverage area is smaller than the areas shown in green. The overlarge coverage area is due to the FCC mapping protocol that shows a Census block as served even if there is only one customer.



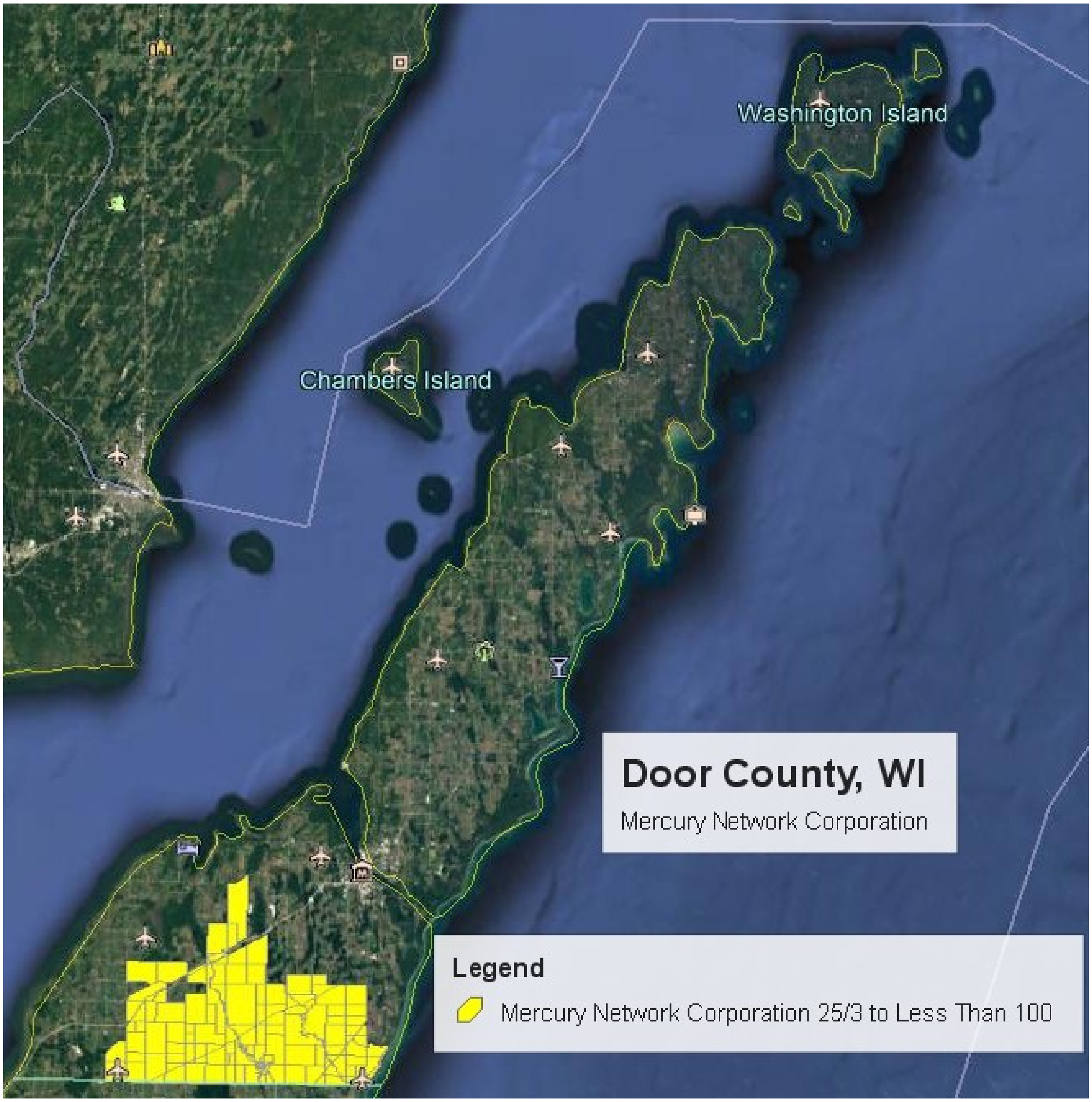
Door County Broadband, LLC

Door County Broadband uses fixed wireless technology. Below is the coverage claimed by the company on the FCC Form 477, where the company reports coverage to the whole county with speeds greater than 25/3 Mbps. This contrasts significantly with the DPI speed tests that show an average download speed of only 4.6 Mbps. This is not to say that the ISP can't deliver speeds greater than 25/3 Mbps to some customers – but the speeds delivered to most customers are likely a lot slower. It's also highly likely with fixed wireless technology that there are households that the technology can't reach.



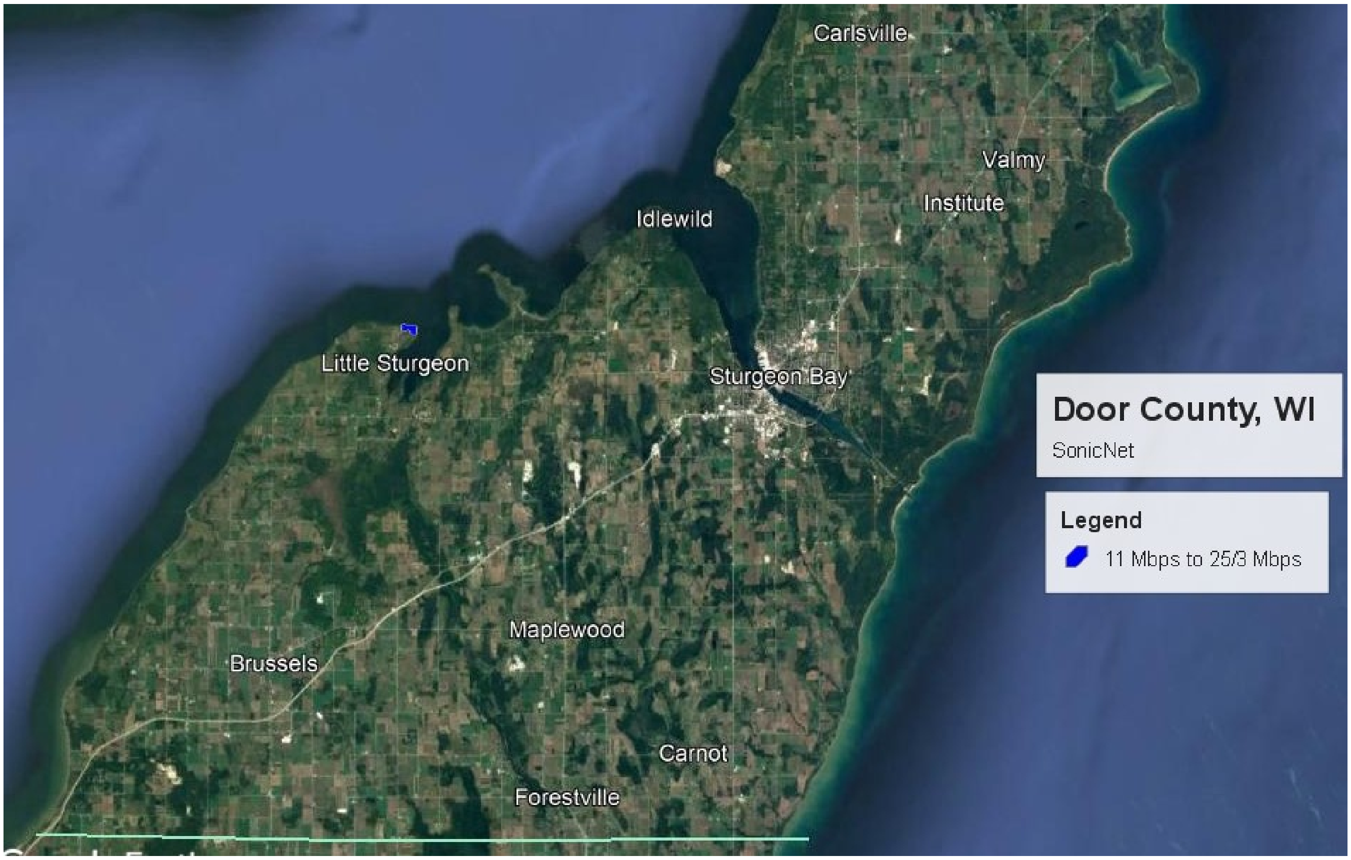
Mercury Network Communications

Mercury Network Communications is a fixed wireless provider that operates in the southern part of Door County. The map below shows the reporting of the company on the FCC Form 477. Mercury Network is reporting speeds greater than 25/3 Mbps for the entire coverage area. No Mercury customers took the Wisconsin DPI speed test. This doesn't mean they have no customers in the county, but likely not many.



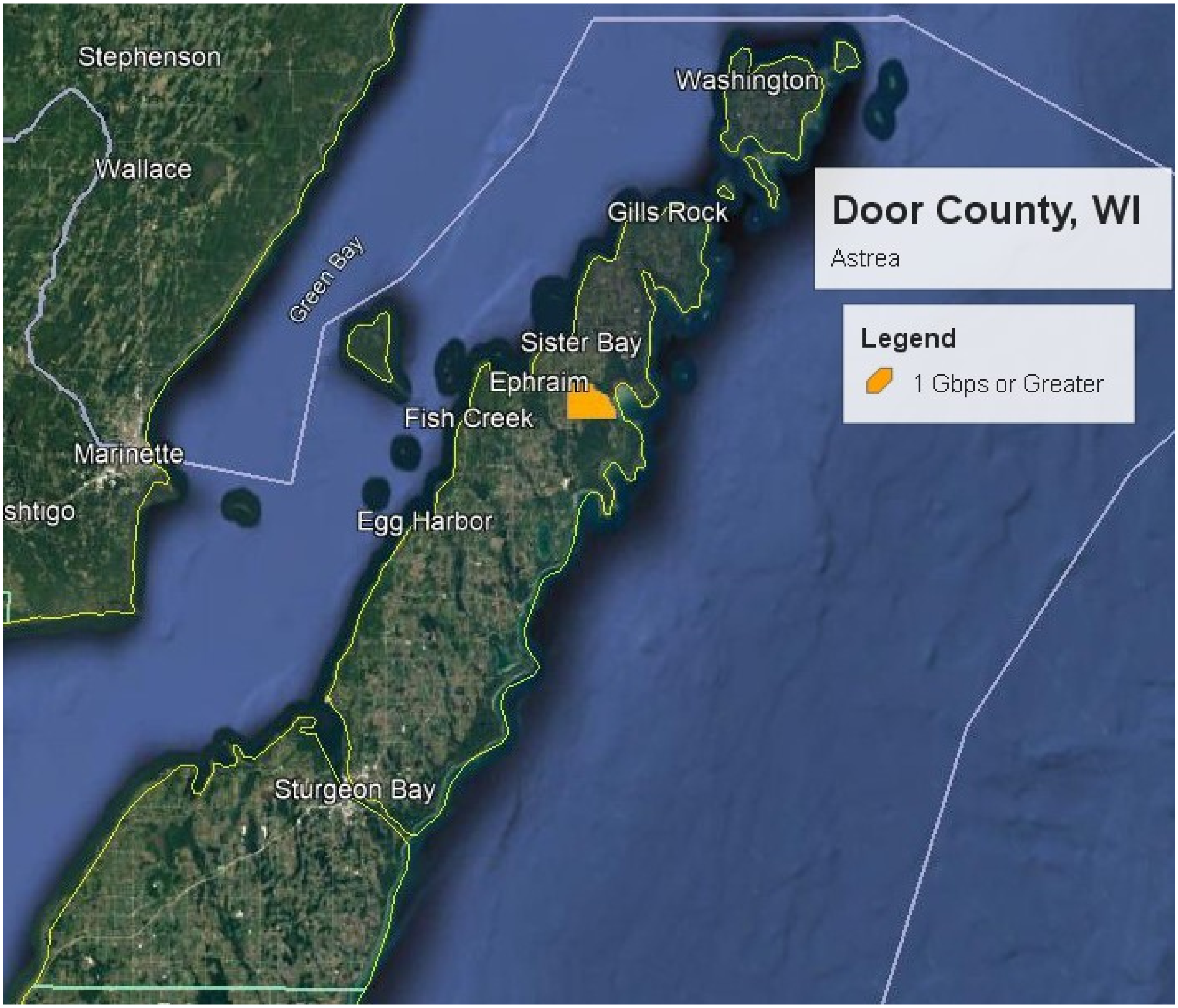
SonicNet

SonicNet is a fixed wireless provider in Door County. SonicNet claims to provide speeds between 11 Mbps to 25/3 Mbps in the area shown in blue on the map below. SonicNet claims to only provide coverage on Henderson Point just north of Little Sturgeon in Door County. No SonicNet customers took the DPI speed test.



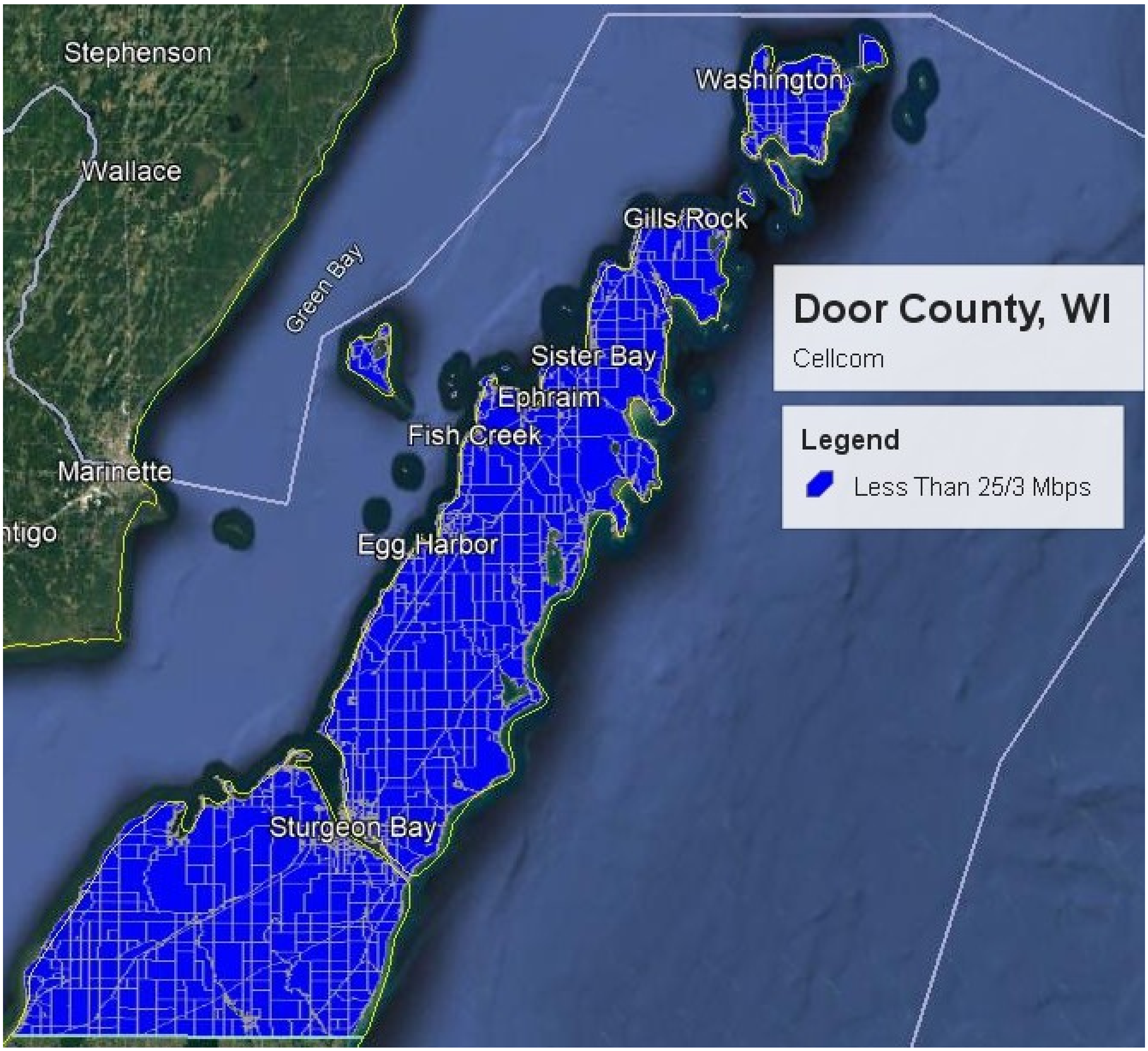
Astrea

Astrea is a fixed wireless provider operating in Door County. Astrea claims to provide 1 Gbps or greater service, shown in orange on the map below. This claim surprises us, but we pass it on because it's reported to the FCC. No Astrea customers took the DPI speed test.



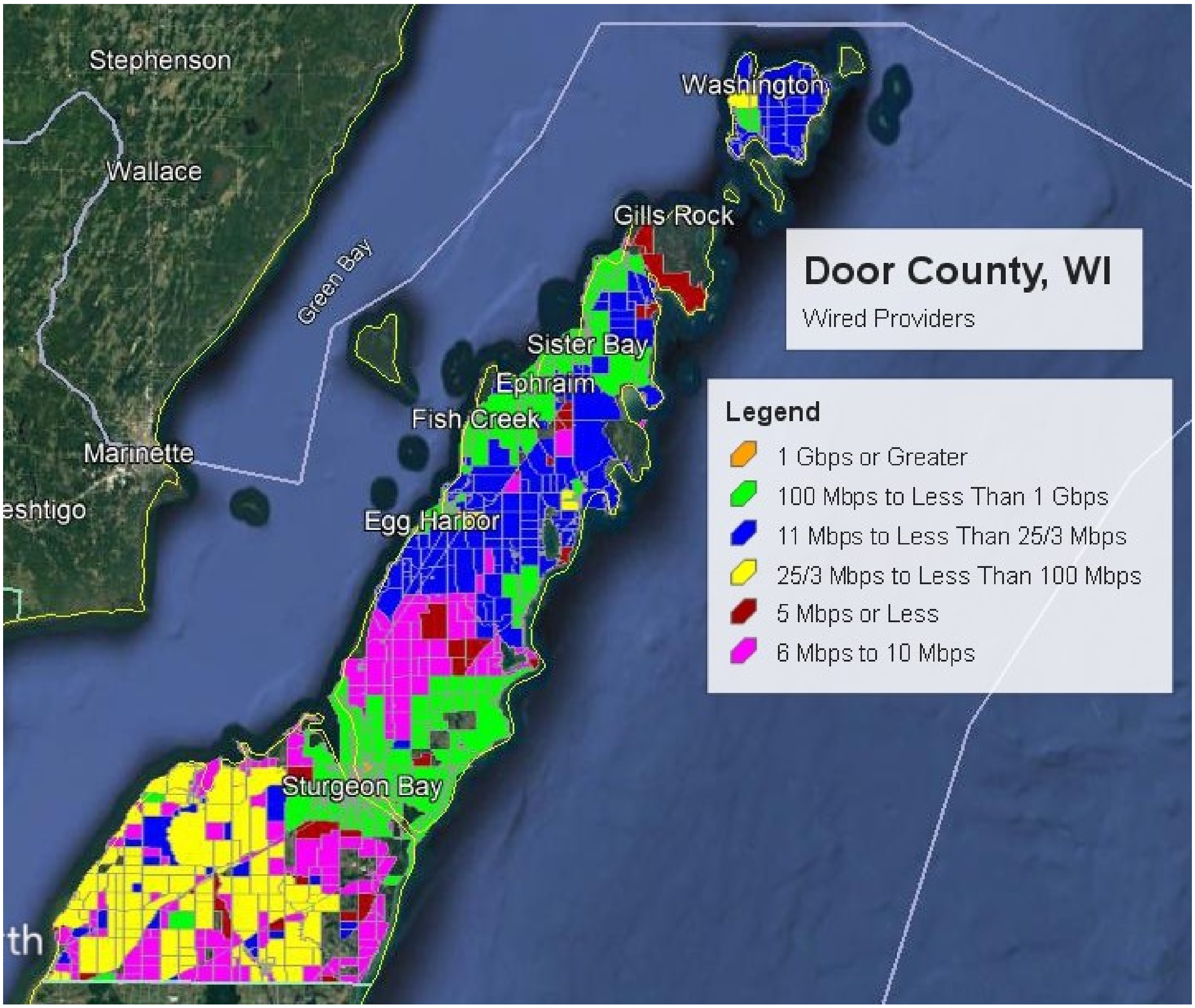
Cellcom

Cellcom provides mobile broadband. The company claims full coverage of the county in the FCC 477 reporting, with speeds less than 25/3 Mbps. The Wisconsin DPI speed tests show an average speed of 18.7 Mbps download and 2.3 Mbps upload. However, all of the DPI speed tests came from southern parts of Door County, so we have to wonder if the company has coverage in the heavily wooded areas of northern Door County.

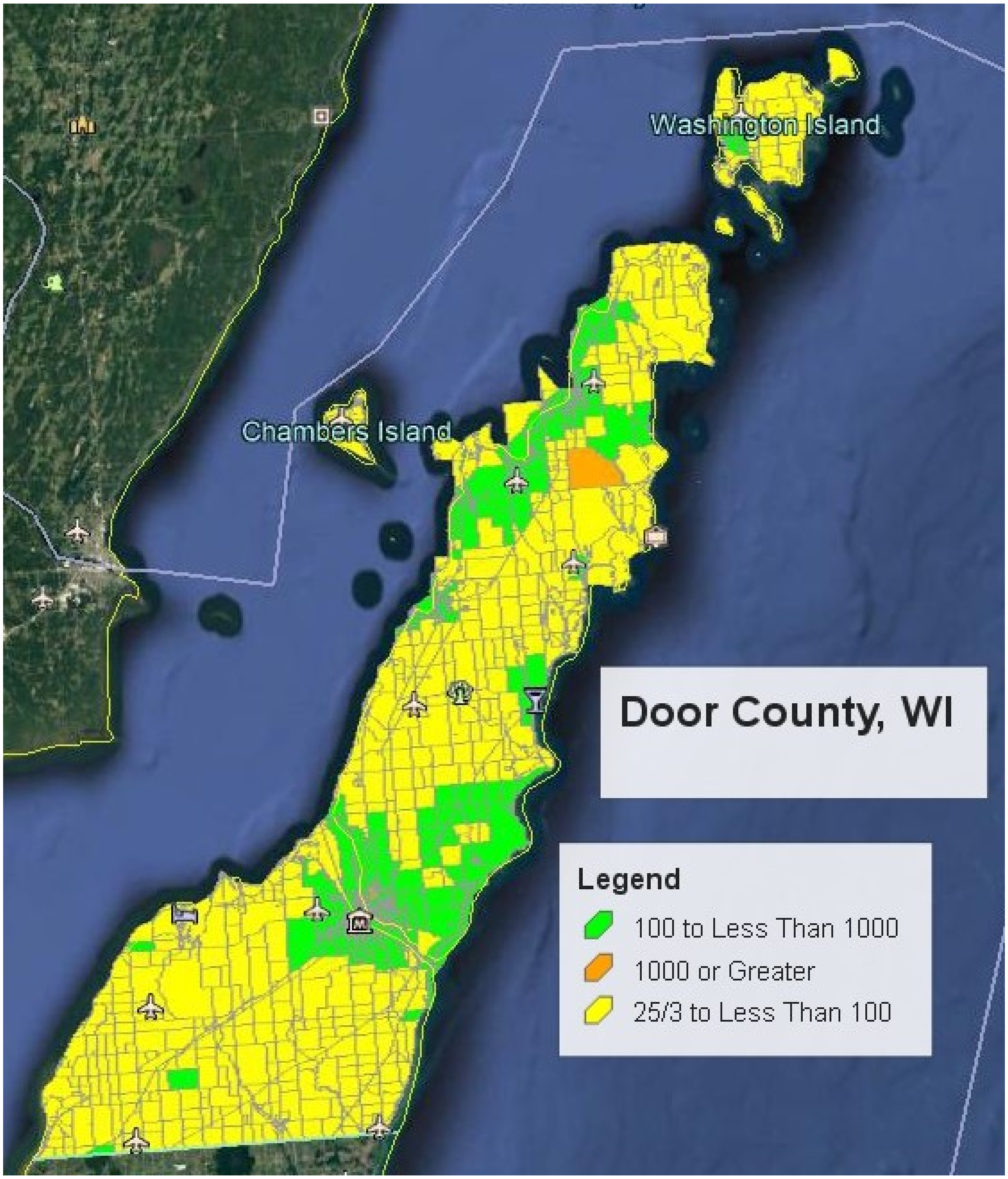


Composite Map of all Providers

The following two maps show the composite reporting of all of the ISPs that report to the FCC. The first map shows only the landline ISPs – the telephone companies and Charter/Spectrum. On this map, everything shown in green, yellow, or orange is considered by the FCC as having good broadband faster than 25/3 Mbps. We know from our analysis that the speeds claimed by Frontier and CenturyLink are likely overstated.

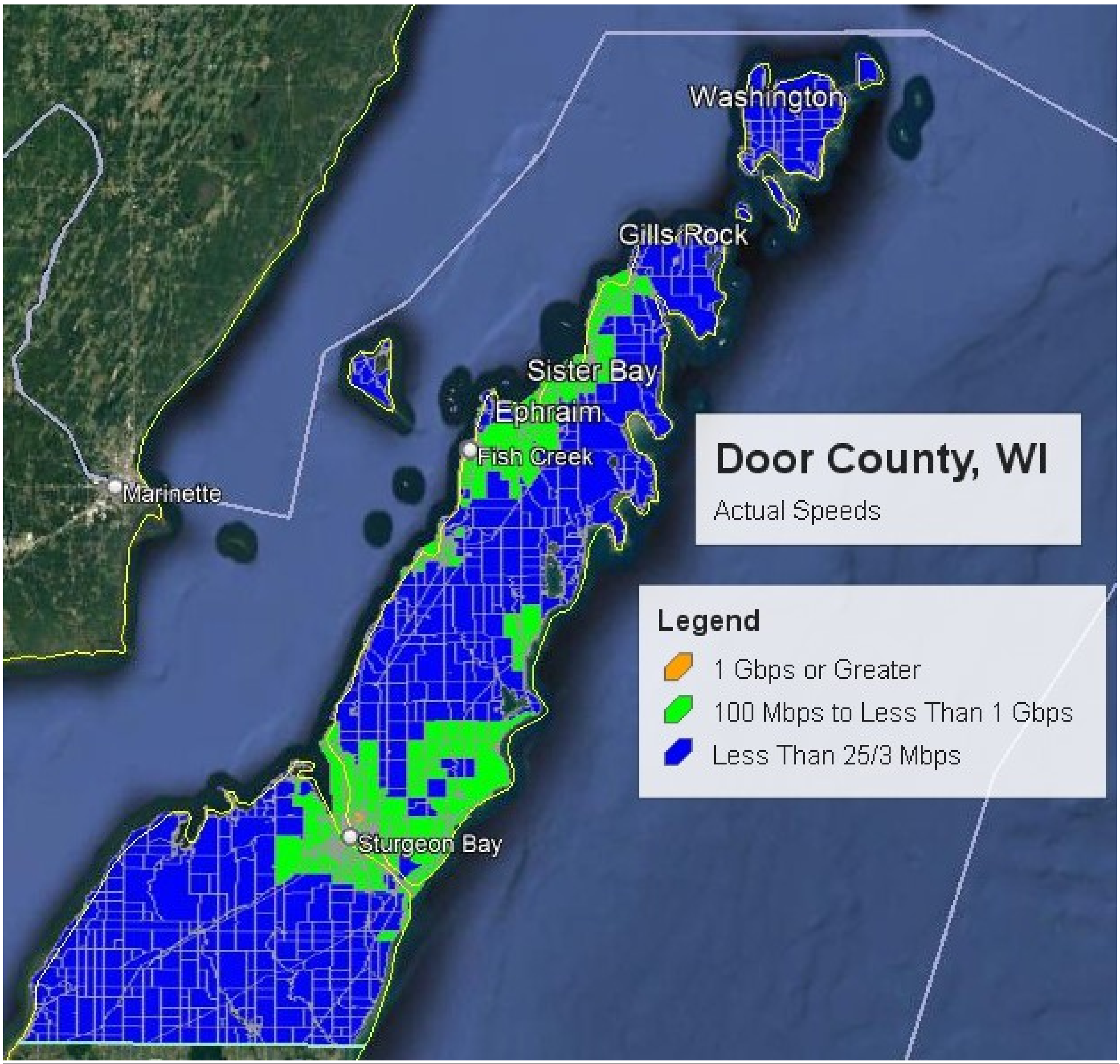


This second map shows the composite reporting for all ISPs. This map shows that every inch of the county has broadband speeds faster than 25/3 Mbps. This map explains why there were no RDOF awards made in the county – the FCC believes the county has fast broadband. The difference between this map and the one above is that wireless carriers like Door County Broadband and Mercury Network show fast speeds that don't exist.



The Real Broadband Speeds in Door County

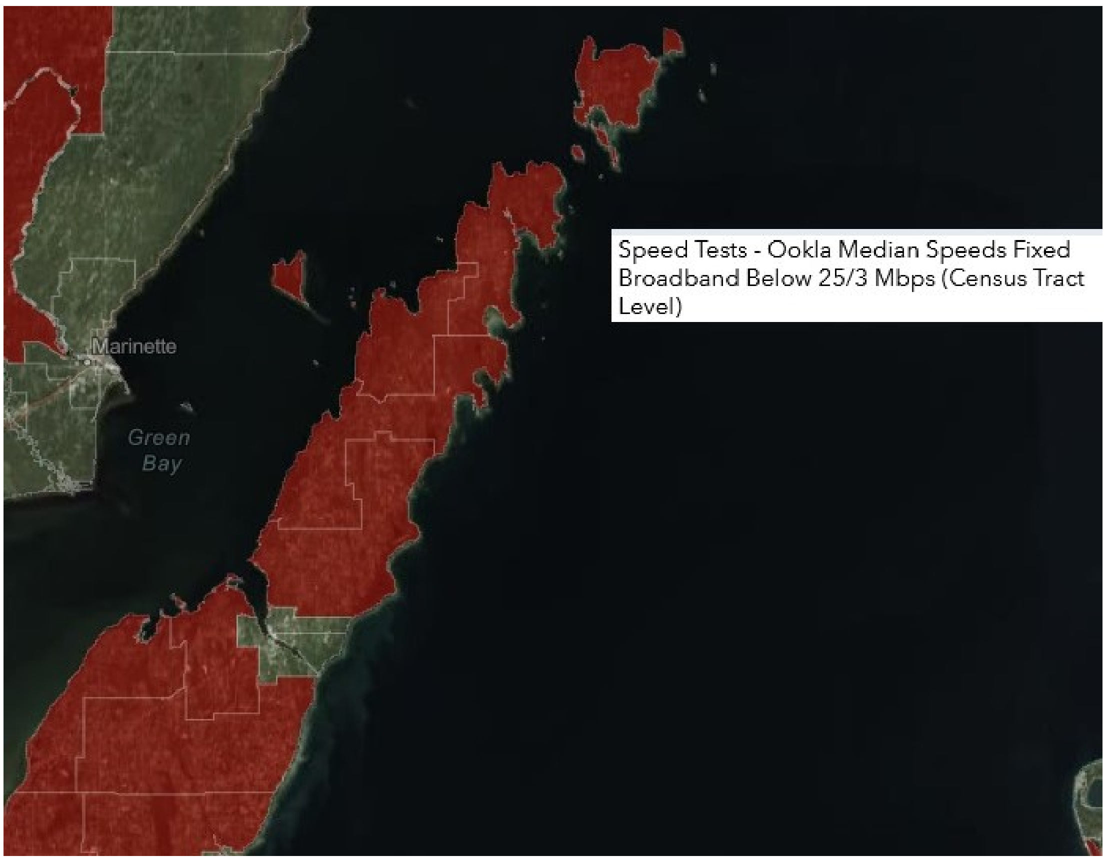
The following map represents our best guess of the actual broadband speeds in the county. The green represents Charter/Spectrum's claimed service area. We know this is too large around the edges of the towns, and that's something that would have to be analyzed street by street to get exactly right. We are highly doubtful that there is any DSL in rural areas with speeds greater than 25/3 Mbps. We're also skeptical of fixed wireless speeds greater than 25/3 Mbps – this may exist, but not nearly to the extent claimed by the WISPs to the FCC.



The NTIA Broadband Map

The National Telecommunications and Information Administration (NTIA) recently created a map that collected broadband information from various sources such as the Census Bureau, the FCC speed data, the M-Lab speed tests (same as used by DPI), Ookla speed tests, and Microsoft.[10]

On the following map from the NTIA, the red areas are places the NTIA map shows as having broadband under 25/3 Mbps. The NTIA map looks nearly identical to our best guess of the broadband speeds in the county, with the exception that NTIA seems to not be showing Charter/Spectrum's full coverage area.

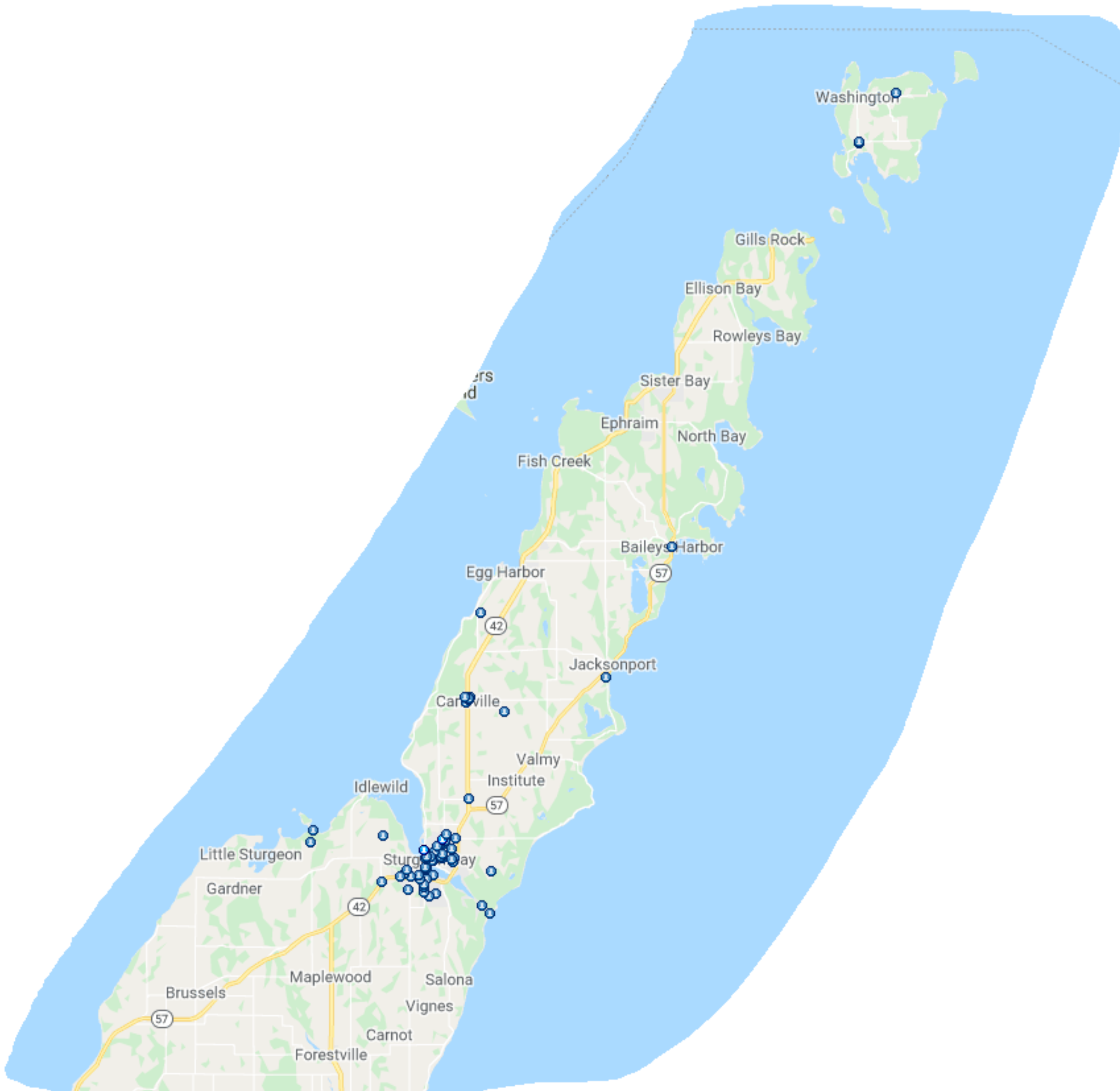


Lit Fiber Buildings

There are several national firms that track buildings in the country that are lit with carrier-class fiber. The list is generated by records obtained from the big ISPs, like AT&T, Verizon, Lumen, Zayo, and some of the big cable companies. These maps will not reflect fiber-to-the-home, if it existed – just fiber sold by the big carriers for major customers and locations. Following is a map of the buildings in Door County that are shown to have fiber. The map does not come with any identification of specific buildings. But we have to suspect that maps include locations like schools, hospitals, large businesses, larger apartment complexes, and perhaps locations where carriers house electronics. There are likely additional locations

[10] NTIA Broadband Map and information can be found at: https://www.ntia.doc.gov/press-release/2021/ntia-creates-first-interactive-map-help-public-see-digital-divide-across-country

with fiber that are not shown on the map, because local carriers like Nsight may not contribute information to these databases. The main purpose of the map is to show that there are some locations in the county with fiber – which magnifies the contrast with locations that don't have fiber.



Cell Towers

The following map shows all of the towers that are in the FCC database of towers. Essentially, a tower must be registered by the FCC if it is at least 200 feet tall. There is no way in the database to know if these towers are all active. Towers are used for multiple purposes, and some of these towers might be used for things like public safety radios. There is also no way to know which towers might be connected to fiber, although it's likely that most active ones are. The main purpose of including the map is that the large numbers of towers means that there is a possibility of fiber leading into various parts of the county that could be used by an ISP that wants to build fiber to only some part of the rural county. We know that Nsight owns fiber that goes to many towers, and it's likely that AT&T or others also own some fiber.

Consequences of Inaccurate FCC Maps

It's been CCG's belief for years that the FCC has been hiding behind the bad maps because those maps give them cover from having to take stronger action to fix rural broadband. It's likely that 90% or more of counties in the country have overstated broadband coverage on the FCC maps like what is seen on the map above. If the FCC were to acknowledge how bad the maps are, they would be required by Congressional mandate by Section 706 rules to undertake extraordinary efforts to fix the broadband problems. The bad maps have allowed the FCC to issue a report to Congress every year stating that rural broadband coverage has problems but is improving.

Unfortunately, the speeds reported by the FCC maps have other real-life implications. For example, the FCC constantly cites the statistics from the broadband mapping system when developing various policies or making decisions that impact rural broadband. The FCC is fully aware of the inadequacies of their mapping data, and yet they still cite their own faulty data as proof that broadband isn't as bad in rural America as critics might suggest.

Probably the biggest impact of lousy FCC mapping is that the FCC maps are used to define where federal broadband grants can or cannot be awarded. Areas with overstated speeds in the FCC maps are excluded from being eligible for federal grant money. In Door County, we think that many of the speeds claimed by Frontier, CenturyLink, and several of the wireless ISPs are overstated. We also think the FCC maps exaggerate the Charter/Spectrum coverage and exclude a lot of homes from being eligible for grant funding. This is an issue that we address in the recommendation section of this report – it's something the county might need to get involved in if you are to attract more grant funding.

The Technology Gap

To a large degree, the broadband speed available to a customer is dependent upon the technology used to deliver the broadband. Our reports will discuss various technologies in more detail when we describe the engineering cost estimates to bring better broadband to the counties.

The general speeds available on 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, 12 Mbps, or 16 Mbps.
- DSL delivered on two copper pairs can deliver twice the speeds. This technology is usually only deployed using the latest types of DSL and has maximum speeds of around 50 Mbps – on perfect copper.
- High orbit satellite broadband can deliver speeds as fast as 75 Mbps. The problem with this broadband is that the satellites are so far above the earth that there is a lot of delays (latency) in the signal, and it's hard to do real-time web activities like streaming video, connecting to a corporate WAN, a school server, making VoIP calls, or even shopping on some websites. Satellite speeds are greatly reduced for customers that don't have a full view of the open sky – like the many wooded parts of the county.
- Fixed point-to-multipoint wireless is capable of speeds up to 100 Mbps. Getting 100 Mbps also requires a wireless ISP to have obtained some licensed CBRS spectrum. However, the fastest wireless technology is new, and any wireless technology deployed even a few years ago can't achieve this speed. In real life deployments, the speeds on fixed wireless can be as slow as a few Mbps – which is what we see in the DPI speed test results.
- A hybrid-fiber coaxial system (used by cable companies) can deliver fast broadband speeds. Networks using the DOCSIS 3.0 standard can deliver speeds up to around 400 Mbps. Charter/Spectrum has upgraded to the most recent DOCSIS 3.1 standard and can deliver speeds up to a gigabit.
- Fiber networks also deliver fast broadband. Fiber networks with the older BPON technology are limited to speeds of about 200 Mbps per system. More modern GPON technology can deliver

speeds up to a symmetrical gigabit (same speed up and down). Newer XGS-PON technology can deliver download speeds as fast as 10 Gbps.

Every technology has some limitations in that can produce slower broadband speeds. Consider as an example the following factors that can affect the broadband speeds delivered over DSL:

- DSL speed diminishes rapidly as the distance between the customer and the DSL transmitter increases.
- The size of the copper wire serving the customer matters – the larger the gauge of the copper wires, the stronger the DSL signal.
- The quality of the copper wire slowly degrades over time, particularly if the copper gets in direct contact with the elements or with longstanding water.
- The quality of the telephone wiring inside of a home can impede quality, particularly for wires that were installed by the homebuilder rather than by a telco.
- The type of DSL electronics used to serve a customer. There are still older DSL technologies in the field that have maximum download speeds of only a few Mbps and newer DSL that can deliver speeds as fast as 48 Mbps.
- DSL will underperform if there is not enough backhaul bandwidth provided to a neighborhood. DSL is like most broadband technologies, and bandwidth is shared between users in each neighborhood. If the total usage demanded by the neighborhood is greater than the bandwidth supplied to the neighborhood, then everybody gets slower speeds when the network is busy.
- And finally, speeds can be impacted by how a customer gets broadband to devices. For example, an old WiFi router can cut down the speed between what is delivered to the home and what makes it to computers and other devices inside the home.

All these factors mean that DSL speeds vary widely in the field. Two adjacent homes can have a significantly different DSL experience. It's extremely difficult for an ISP to understand DSL speeds for customers since the speeds can vary during the day.

The same sorts of factors also apply to fixed wireless. Customer speeds vary according to distance from a tower, the spectrum used for any given connection, the types of impediments between the tower and the home (speeds are often slower in summer when the leaves are on trees). It's nearly impossible to map DSL and fixed wireless speeds in the field.

<u>Oversubscription</u>. Even when the latest and best technology is deployed, speeds can vary widely in real life due to something we call oversubscription. Oversubscription comes into play for any technology where customers share bandwidth somewhere in the network.

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

If an ISP sells a 100 Mbps download connection to 20 customers on a PON, then in aggregate, those customers can use as much as 2 gigabits of download data (100 customers X 100 Mbps), meaning this sample PON has unsold 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. But ISPs understand how customers use bandwidth, and they can take advantage of the real behavior of customers in deciding oversubscription ratios. ISPs know that a home subscribing to a gigabit connection rarely uses the full bandwidth capacity. A home doesn't use much bandwidth when people are asleep or away from home. The residents of a gigabit home might spend the evening watching a few simultaneous Netflix video streams and barely use any bandwidth. The ISP is banking on the normal behavior of its customers in determining a safe oversubscription ratio.

Most of my clients using GPON tell me that they average 40% to 50% utilization – meaning all of the customers on a PON collectively only use on average about 40% - 50% of the 2.4 gigabits of capacity at any given time. The extra capacity is there for those busy times when a neighborhood gets busier than normal. We know from experience in working with hundreds of ISPs that in this example that an ISP can provision 100% gigabit products on a residential PON and still deliver full speeds to customers for more than 99% of the time. An oversubscription of 8 on a fiber network is an extremely high-quality broadband network.

It would probably be a temporary situation if this example PON ever gets too busy. For example, if a few doctors lived in this neighborhood and were 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 subscribers to the PON wouldn't see a perceptible difference in performance.

It is possible to have problems in a neighborhood with business customers. Businesses might engage in broadband usage that uses 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 business neighborhoods. An ISP gets to know its customers and decides how to configure the PONs 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. It's fairly routine for other technologies to run into big problems with oversubscription. Anybody who has used a cable company for broadband can remember back a decade ago when 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 were oversubscribing bandwidth by factors of 200 to 1 or higher. 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, the cable companies have reduced the problem by lowering the number of households in a neighborhood node, which lowers the oversubscription ratio.

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

Unfortunately, the idea of oversubscribed networks has reared its head again during the pandemic. The issue now is not the download path but the upload link. The upload links in neighborhoods get overloaded when multiple people try to work or school from home at the same time. It was widely reported across the country that people had trouble making and keeping connections to work and school servers and Zoom calls. This didn't just happen on older technologies like DSL, and there are many reports of this happening on the networks of the big cable companies. Customers are rightfully upset if they are buying 100 Mbps or larger download product, and still can't work from home.

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

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 many Apple computers are loaded with Microsoft Office products like Word, Excel, and PowerPoint.

Microsoft decided a few years ago to record download speeds of 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 generally 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 to 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 US 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 100% of households in towns and 86.3% of rural households in Door County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 59.5% of all downloads in the county are made at speeds of less than 25 Mbps. That is an eye-opening difference between the Microsoft numbers and the FCC numbers.

It's important to note that the FCC and Microsoft are not measuring the same thing. The FCC is measuring the percentage of homes that have access and 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, even when faster broadband is available.
- Some households receive slower speeds due to issues in the home, like poor-quality WiFi routers.
- The biggest difference is probably due to the ISPs overstating the speeds to the FCC that they make available to the public. As stated elsewhere in this report, the FCC doesn't challenge speeds reported to them by ISPs. The Microsoft data highlights the problems in the FCC data.

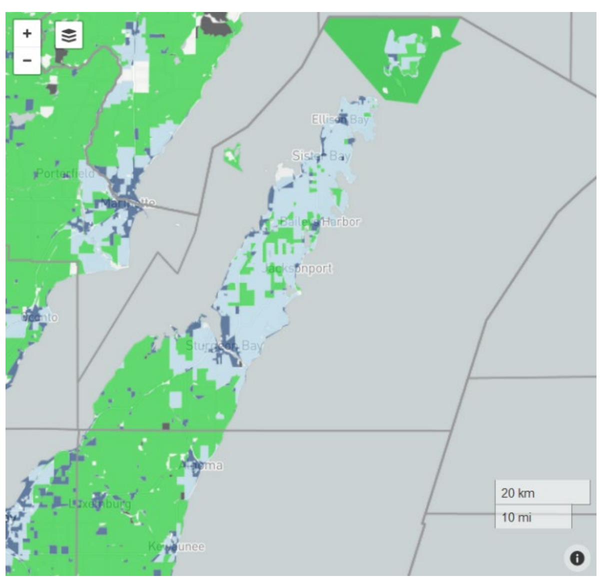
The Connect America Fund

Original CAF II

In the original CAF II program, the FCC set aside $1.7 billion per year for the six years ending in 2020 for the big telcos to build or upgrade rural broadband. These funds were made available to census blocks that had little or no broadband at the time.

- The FCC awarded these funds to CenturyLink in Door County. The company accepted $101,087 per year, or $606,521, to bring better broadband to 1,866 rural customers - $325 per home.
- The FCC awarded these funds to AT&T in Door County. The company accepted $37,967 per year, or $227,800, to bring better broadband to 688 rural customers - $331 per home.
- The FCC awarded these funds to Frontier in Door County. The company accepted $51,119 per year, or $306,712, to bring better broadband to 985 rural customers - $311 per home.

These funds were distributed over six years, with the final year being 2020. There were buildout requirements each year, and the telcos were supposed to upgrade at least 60% of the customers in the whole state at the end of 2018, 80% by the end of 2019, and everybody by the end of this year. To telcos were also allowed to collect an additional year of CAF II in 2021, a total of $190,173. There were no buildout requirements for this funding – it was just extra subsidy money. The areas covered by these grants are shown in this map, in green:



The telcos were supposed to use the CAF II funds to upgrade rural DSL to data speeds of at least 10 Mbps download and 1 Mbps upload. Note that those speeds are far slower than the FCC's definition of broadband, which is 25 Mbps download and 3 Mbps upload.

Around the country there are a lot of reports that the ISPs did not use the money for upgrades. We have some evidence these upgrades didn't happen as planned. For example, the M-Lab speed tests for Frontier shows average download speed for the whole county of only 7.25 Mbps. It's harder to know if AT&T and CenturyLink used the money as planned. Bother of these telcos show average download speeds in the county that are faster than 10 Mbps. However, the average speeds might be tilted by DSL customers living in towns where DSL speeds can approach 20 Mbps. We know that AT&T in most of the country supposedly used the money to swap customers to fixed cellular wireless. The 477 data and the DPI speed tests didn't show any customers using the AT&T cellular product. There were many places in the country where CenturyLink has been accused of not making upgrades – but others where they did.

FCC Rural Digital Opportunity Fund (RDOF)

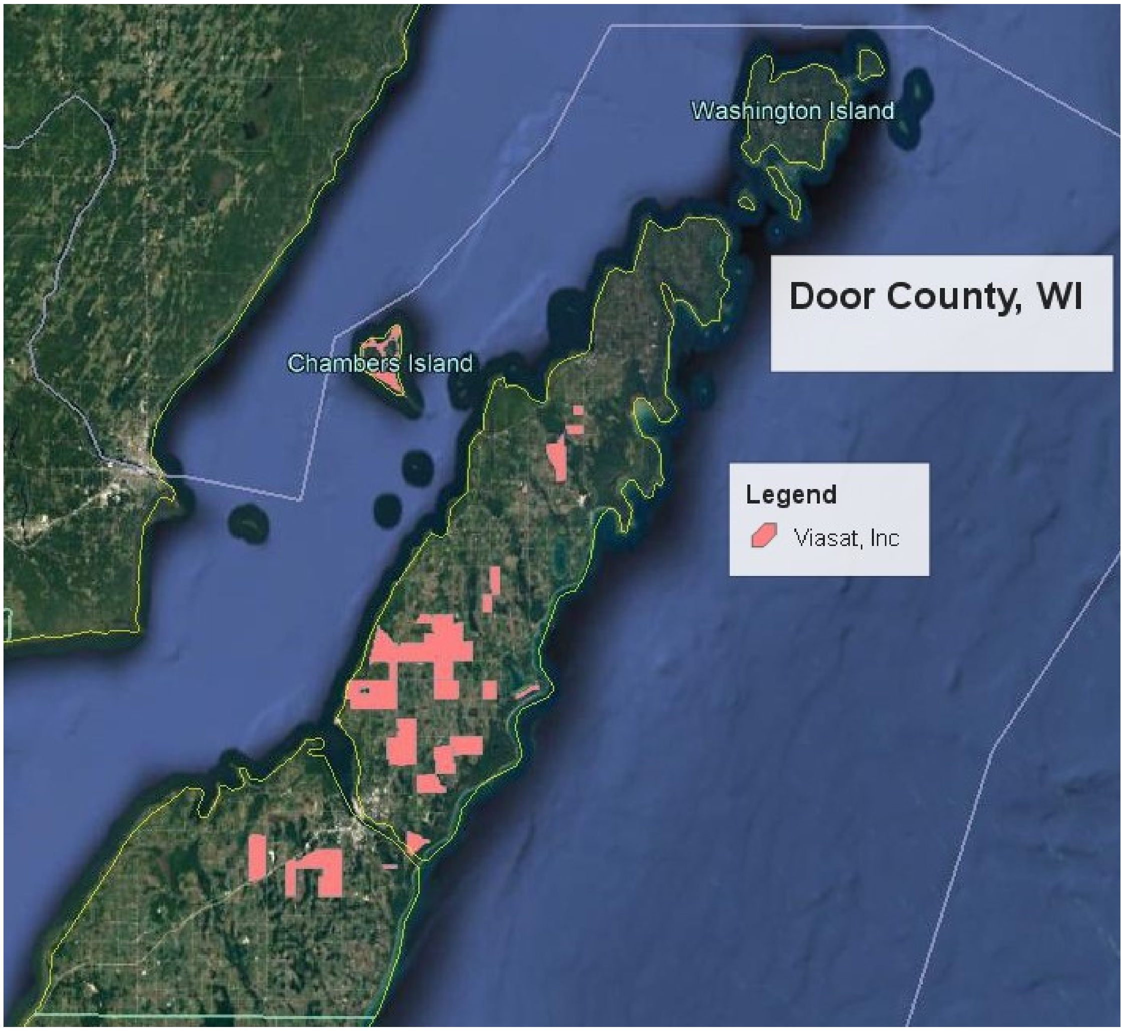
This is a subsidy program awarded by the FCC and funded from the Universal Service Fund. The first phase of this auction was conducted in the form of a reverse auction that concluded near the end of 2020. That award was slated to provide $16 billion in grants but ended up awarding a little over $9 billion. The remaining $7 billion, plus another $4 billion will be auctioned at some later date.

The FCC determined the areas that were eligible for the grants using its faulty mapping data. We think most of the county should have been eligible for this funding – yet the FCC provided zero funding for Door County. This is due to wireless ISPs and telcos claiming false fast speeds in the county to the FCC. In particular, Door County Broadband filed with the FCC and was successful in blocking RDOF funding to 516 Census blocks in the county. The FCC should only have rejected Census blocks for funding that have broadband faster than 25/3 Mbps. The state speed tests discussed earlier tell a different story. There were 5,493 speed tests done for Door County Broadband in 16 different Census tracts. The Door County download speeds were similar to DSL, with most parts of the county showing average downloads speeds around 5 Mbps. There were no Census blocks where the average speeds provided by Door County Broadband meets the 3 Mbps upload speed test.

This report recommends that the County take an active roll when there are challenges to FCC grant requests. Data like the State speed test results could have been used to convince the FCC that the Door County Broadband speed claims are overstated. To be clear, Door County is not the only ISP in the county claiming faster speeds in the FCC 477 process than is being delivered.

<u>CAF II Reverse Auction</u>

In August of 2018, the FCC held a reverse auction to award broadband funding to some of the most rural places in America. This auction was referred to as Auction 903 of the Connect America Fund Phase II. In that auction, Viasat, the high-orbit satellite company, won $231,246 in Door County to be collected over ten years for bringing broadband to 825 rural homes in the county. That's an award of $280 per home. The areas won by Viasat are shown in the map below:



Viasat was a controversial participant in the auction because as a satellite provider, it already covers the grant area and is able to serve customers there – even without the grant funding. Viasat was a poor choice for a subsidy award due to the heavy foliage in the county, which hinders satellite broadband. Viasat claimed speeds greater than 25/3 in the CAF II auction, but the Wisconsin DPI speed tests show the company with actual average speeds in the county of 12.6 Mbps. This grant funding is unusual because there is no mandate for Viasat to market or try harder to serve the customers covered by the grant.

CCG has learned through working in many rural counties that rural residents don't want satellite broadband. CCG has been doing broadband surveys for 20 years in rural America, and we can't recall ever talking to a satellite customer who was happy with their broadband service. In every survey, we encounter more people who have dropped satellite service versus those that still have it. Customers complain that satellite costs too much - Viasat claimed in their most recent financial report that the average residential broadband bill is $84.26.

Customers also hate the high latency on satellite, which can be 10 to 15 times higher than terrestrial broadband. Latency is a signal delay caused by the satellite being parked almost 22,200 miles above earth – it takes a while for a round trip communication over that distance. High latency causes major problems with any web service that is real-time. It's hard to make a voice connection with high latency. It's hard to connect to a school or corporate web server. It's difficult to watch live streaming video, although cached video like Netflix works fine.

The primary complaint about satellite broadband is the tiny monthly data caps. The company has products that satisfy the 25/3 Mbps speed requirements, starting with the Unlimited Silver 25 plan at $70 with speeds up to 25 Mbps with a monthly data cap of 60 gigabytes of data usage. The fastest plan is the Unlimited Platinum 100 plan for $150 with speeds up to 100 Mbps and a data cap of 150 gigabytes. Unlike cellular plans where a customer can buy more broadband, the Viasat plans throttle customers to speeds reported to be less than 1 Mbps once a customer reaches the monthly data cap. To put those plans into perspective, OpenVault announced recently that the average US home used 433 gigabytes of data per month at the end of the second quarter of this year. An average home would have to curtail broadband usage with a 150-gigabyte data cap.

Comparing Door County with the Rest of the World

There are numerous ways to compare Door County to the rest of the state, country, and world.

FCC Adoption Rate

How does Wisconsin compare to other states? In the 2020 annual report to Congress, the FCC reported on broadband adoption by various speeds by state. The adoption rate is the percentage of households that have purchased broadband that meets or exceeds various speed thresholds. The FCC reported the following broadband adoption rates for Wisconsin (meaning the percentage of customers who can buy the listed speeds at their home):

Homes buying at least 10/1 Mbps	67.3%
Homes buying at least 25/3 Mbps	56.1%
Homes buying at least 50/5 Mbps	51.1%
Homes buying at least 100/10 Mbps	48.2%
Homes buying at least 250/25 Mbps	1.4%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (67.3%) puts Wisconsin in the middle of the pack when compared to other states. The lowest coverage is in is Mississippi at 48.2%, and the highest is Delaware at 90.1%. It's worth noting again that these numbers are based upon faulty FCC 477 data reported by the ISPs in the state, and the actual speeds being purchased are not nearly as good as the numbers shown. As shown immediately below, the FCC numbers for Door County are greatly overstated.

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. This is where the FCC data and the faulty nature of the maps are quickly evident. The following is what the FCC reported to Congress in 2020 about Door County:

Urban population:	8,273
% that can buy at least 25/3 broadband	100%

% with 4G LTE coverage at 5/1 Mbps	100%
% with both	100%
Rural population:	19,335
% that can buy at least 25/3 broadband	86.3%
% with 4G LTE coverage at 5/1 Mbps	99.7%
% with both	86.1%

The FCC data might be true for towns, although there are often small pockets of most medium and larger towns that are not reached by the cable companies. The rural percentages are startling because the FCC data shows that 86.3% of the rural parts of the county can buy 25/3 Mbps broadband. We think it's possible that this number might really be close to zero for the rural parts of Door County. There likely are a few lucky customers that can get a speed greater than 25/3 Mbps, but we think that is a rarity in the county.

How Does the US Rank with the Rest of the World?

Cable Company from the United Kingdom has been gathering data each year that compares broadband speeds and prices from around the world.

The most recent report on broadband speeds is from 2020.[11] The rankings are based upon many millions of speed tests, and 2020 average download speed for the US is based upon over 187 million speed tests. The U.S. ranked 20th in the world in 2020 with a national average download speed of 71.30 Mbps which is behind countries like Iceland, Switzerland, Singapore, Denmark, Sweden, Netherlands, Hungary, Monaco, Aruba, and others. The average speed in the U.S. has been increasing, and was 20.0 Mbps in 2017, 25.9 Mbps in 2018, and 32.9 Mbps in 2019. During that time, the U.S. climbed from 21st fastest to the current rank of 20th. The speed increases are largely due to upgrades in speeds in urban areas by cable companies, although there are also fiber-to-the-home builds in both urban and rural markets across the country. There are a lot of criticisms of this report in that it seems that Cable Company gathers speed data from advertised speeds rather than from speed tests.

Comparing Door County with the Rest of Wisconsin

According to FCC data, three counties in the state – Forest, Price, and Taylor – have less than 50% broadband coverage. At the other end of the scale, the FCC says that Calumet, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan, Washington counties have 100% coverage of 25/3 Mbps broadband.

According to the FCC data, Door County has one of the higher percentages of broadband coverage in the state. Unfortunately, the FCC has missed the real broadband story in the county. Our quick math says that perhaps only slightly more than half of the county residents can buy a broadband product that can deliver 25/3 Mbps.

[11] Broadband speeds around the world. https://www.cable.co.uk/broadband/speed/worldwide-speed-league/

The Gap in Broadband Availability

Our analysis uncovered two issues with broadband availability. There are homes in the county that say they have no broadband available. A more global issue is that the large majority of homes and businesses in the county say they only have one option for broadband.

No Broadband Available

It's always interesting when somebody says they have no broadband available in a place like Door County. According to the ISPs almost everybody in the county can buy broadband from DSL, fixed wireless broadband, mobile broadband, or satellite broadband. How can a home with those four options have no broadband option? Consider the following:

- DSL speeds fall drastically with the distance between a DSL hub and a customer. The telcos are likely willing to sell DSL to almost anybody who orders it. But rural residents who live to far from the DSL hub have learned that speeds can be barely faster than dial-up. AT&T has stopped even pretending it can deliver rural DSL and won't connect new customers.
- Fixed wireless also is affected by the distance between a tower and a customer. But fixed wireless broadband suffers from an additional problem in that broadband speeds also are degraded by trees and other vegetation. The heavy woods in much of the county are not conducive to receiving fixed wireless. The slowest speeds registered in the county speed tests collected by the state are for the fixed wireless technology.
- We learned during the course of the study that there are areas of the county with poor cellular coverage. The chances are that most rural homes in the county can get at least some cellular broadband. But there are two problems with using normal cellphones for home broadband. First is the small monthly cap on cellular broadband usage. It wouldn't be hard for a normal household to spend $500 per month if they used cellphones in the same way they would use other types of broadband. The other issue with cellphone broadband is that the cell carriers give priority to voice over broadband – meaning that during tourist season that the broadband speeds might go to zero. There is hope since the cellular carriers are in the process of rolling out faster and less restrictive plans for home broadband.
- You might think that everybody can get satellite broadband since the satellites sit 22,000 miles above earth. However, the satellite reception can be killed by nearby hills. Of more importance is the need for a clear line-of-sight to the satellite, which can be blocked by trees or other impediments.

When somebody in Door County says they have no broadband option, it means that the above four options either don't work at their location or work so poorly as to be non-functional.

No Broadband Choice

A more widespread issue in the county is that the vast majority of homes and businesses don't feel like they have any broadband choice. People that live in towns know that the only broadband product that is function is from Charter/Spectrum. The performance of DSL or fixed wireless are far less than the performance of a cable modem, so the majority of residents and the businesses choose Charter/Spectrum because they don't feel like they have any reasonable alternative.

In rural areas, as discussed above, most broadband options are lousy. A home feels lucky if one of the four broadband options works well enough to get connected.

We know that the consequence of the lack of choice is generally higher prices. We see that in Door County where residents are paying higher than average prices for lower quality broadband than in many other places in the country.

The Gap in Broadband Affordability

The FCC reports that broadband adoption for the country is around 87%. Even after accounting for the rural areas that have no broadband option, there are many millions of customers that can get broadband at their homes but do not buy it. Numerous studies and surveys have asked why people don't buy broadband when it's available. The number one reason that is always cited is 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 2020 FCC Broadband Report shows that only 38.4% of households in the lowest quartile of earnings is buying broadband of at least 10/1 Mbps. The percentage that buys faster broadband speeds drop to only 4.7% of households buying broadband of at least 250/25 Mbps.

Fig. 12
Average County Overall Adoption Rate for Fixed Terrestrial Services by County Level Demographic Variable (As of December 31, 2018)[147]

	10/ 1 Mbps	25/ 3 Mbps	50/ 5 Mbps	100/ 10 Mbps	250/ 25 Mbps
Median Household Income ($2018)					
First Quartile (Lowest Median Household Income)	33.5%	23.4%	22.6%	18.1%	3.7%
Second Quartile	46.7%	37.2%	32.9%	27.4%	3.7%
Third Quartile	53.9%	43.3%	37.9%	30.4%	3.9%
Fourth Quartile (Highest Median Household Income)	67.0%	57.2%	53.0%	39.2%	5.2%
Population Density					
First Quartile (Lowest Median Population Density)	43.5%	30.2%	23.6%	19.3%	5.9%
Second Quartile	39.5%	29.9%	26.4%	20.9%	2.9%
Third Quartile	50.2%	41.8%	38.4%	30.8%	3.1%
Fourth Quartile (Highest Median Population Density)	67.8%	58.9%	59.4%	45.1%	5.1%

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.[12] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[13] 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 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 the monthly broadband access.

The Pew Research Center shows a direct correlation between income and broadband adoption. They've had an ongoing investigation into broadband-related issues since 2000[14]. Pew shows that as of February 2021 that only 57% of homes with household incomes less than $30,000 have broadband, compared to 92% of homes with household incomes over $75,000.

Demographics in Door County

The assorted studies all suggest that demographic factors are a considerable influence on whether homes can afford broadband. This section of the report looks at some of the key demographics in Door County. These statistics are based on the 2010 Census plus updated estimates as late as 2019. The 2020 Census data is likely not going to be released in detail until early in 2022.

- Population Growth. The 2020 Census reports that the county population grew 8.2% 2010 and 2020. Wisconsin as a whole grew 2.7%. Most of the growth can at the end of the Census period and is likely due to the pandemic.
- Population Ages. The county has a lower percentage of children (3.9%) than the state (5.7%) and a lower percentage of persons under 18 (16.3%) than the state (21.8%). Door County has a significantly higher percentage of those over 65 (30.5%) compared to the Wisconsin average of 17.5%.
- Home Ownership. There is a higher percentage of home ownership in the county (79.9%) than the State average of 67%. The average home in the county costs $214,100 compared to the state average of $180,600.
- Education. The percentage of those with a high school diploma (94.4%) is slightly higher than the state average of 92.2%. The percentage with a bachelor's degree or higher is (33.7%) is slightly above the state average of 30.1%.
- Income. The median household income ($61,560) is nearly the same as the state average of $61,747. Per capita income ($38,744) is higher than the statewide average of $33,375. The percentage of homes in poverty (9.3%) is slightly below the state average of 10.4%.

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

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

[14] Demographics of Internet and Home Broadband Usage in the United States | Pew Research Center

- Unemployment. In May 2021, the unemployment rate was 5.4%, down from a high of 9.6% during the pandemic. However, the unemployment rate in the years before the pandemic varied between 3% and 4%.

Our overall assessment of the demographic statistics is that most of the demographic factors in the county would indicate a reasonably high level of broadband demand. For example, one of the primary factors that depresses home broadband purchases is household income. The county has a relatively low poverty rate.

There is a higher-than-average percentage of residents over age 65. Just a few years ago, this would have indicated a likely lower broadband penetration rate – but the percentage of older people that use the Internet is now nearly the same as younger age groups.

Comparing US Broadband Prices to the World

Cable Company of the United Kingdom also tracks broadband prices around the world. The most recent comparison of prices is from 2020.[15] The average price of broadband in the US in 2020 is $50. It's worth noting that these prices were gathered from advertised prices, and most big ISPs in the country advertise temporary special prices that expire after a one or two-year period. The price also doesn't include the cost of a modem or WiFi router. The average price of the US ranks as the 119th most affordable out of 206 countries. However, it's worth noting that most the countries that are more expensive than the US are either third world countries or island nations. The few exceptions of first world countries that are more expensive than the US are New Zealand, Norway, and Switzerland.

In that same report, the US looks better when looking at advertised prices compared to advertised bandwidth. In that comparison, the average cost per megabit of speed in the US is $0.26, placing the US 27th in terms of affordability. However, we know that many ISPs advertise speeds that are faster than what they actually deliver – but this may be true in other countries as well. We also know that many ISPs in the US charge prices to many customers that are higher than advertised prices. The actual price of broadband in the US is higher than is shown in this analysis.

Low-Income Broadband Programs

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

Charter/Spectrum (Spectrum) Internet Assist

Charter/Spectrum (Spectrum) 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).

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[15] Broadband prices around the world. https://www.cable.co.uk/broadband/pricing/worldwide-comparison/

Federal Lifeline Program

CenturyLink, Nsight, Mercury Networks Corporation, and Frontier Communications participate in the FCC Lifeline program that is part of the Universal Service Fund. With the program, a customer can receive a discount in Wisconsin of $9.25 per month off a telephone bill or a broadband bill for qualifying customers. The program works by the telephone companies providing a discount to customers, and the FCC then reimburses 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 the eligibility monthly of households to meet one of the above tests.

The telephone companies don't tend to aggressively pursue giving this discount to eligible households – but they will enroll anybody that qualifies and who asks for the discount.

FCC Emergency Broadband Benefit (EBB) Program.

The EBB program went into effect in May 2021. The funding came from the $1.9 trillion American Rescue Plan Act. The program was funded for $3.2 billion. The program will last until six months after the end of the federally declared Covid-19 emergency period or until the funds run out of money.

The EBB provides a discount of up to $50 per month towards broadband service for eligible households and up to $75 per month for households on qualifying Tribal lands. Eligible households can also receive a one-time discount of up to $100 to purchase a laptop, desktop computer, or tablet from participating provides if they contribute more than $10 and less than $50 toward the purchase price.

The Emergency Broadband Benefit is limited to one monthly service discount and one device discount per household.

A household is eligible if a member of the household meets one of the criteria below:

- Has an income that is at or below 135% of the Federal Poverty Guidelines or participates in certain assistance programs, such as SNAP, Medicaid, or Lifeline.
- Approved to receive benefits under the free and reduced-price school lunch program or the school breakfast program, including through the USDA Community Eligibility Provision in the 2019-2020 or 2020-2021 school year.
- Received a Federal Pell Grant during the current award year.
- Experienced a substantial loss of income due to job loss or furlough since February 29, 2020, and the household had a total income in 2020 at or below $99,000 for single filers and $198,000 for joint filers; or
- Meets the eligibility criteria for a participating ISP's existing low-income or COVID-19 program.

For a household to get this discount, its ISP must be a plan participant. Households apply though the ISP.

In the infrastructure bill that is working its way through Congress, the EBB program would be funded for many more years, but the amount of the monthly discount lowered to $30. However, that bill is not yet law. If it doesn't pass, the EBB program will probably run out of funding sometime in 2022.

The Computer Gap

One of the things that digital inclusion advocates have learned is that it's 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 cellphones 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 Pew Research Center in 2019 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	56%	81%	94%
Smartphone	71%	85%	97%
Desktop	54%	83%	94%
Tablet	36%	55%	70%
All the Above	18%	39%	64%

Other studies have shown that the percentages of homes that have any these technology tools is even smaller for homes making under $25,000 per year.

A big problem 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 3 or 4 years.

The above numbers highlight the problem of getting broadband into low-income homes – a solution is needed for both broadband and for a computer. As will be discussed below, low-income homes also often need computer training.

The historical solution to a lack of computers was to put computers in libraries and public places. However, in communities like the rural parts of the counties, this solution is inadequate for many reasons. First, it requires students to travel to where the computers are. In communities where a lot of students don't have computers, it's difficult to have enough 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 compared to 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 today just 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.

There are a number of different approaches that communities have tried to solve the computer gap that will be discussed below in the section talking about solutions for the digital divide.

The Gap in Broadband Skills

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

Workers with upper-income jobs are faring extremely well. For example, starting jobs for new computer, engineering, and similar tech graduates are at an all-time high. It's a good time to be a high-tech worker. However, 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). These 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 rather that need people 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.

In the early days of the computer age, the federal government operated many training programs that taught basic computer skills. Today it seems to be 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. Since the federal and most state governments don't offer any significant training programs in computer literacy, it's up to local communities to find their own solutions.

A Pew Research Center survey in 2016 showed that a lot of adults were interested in digital training. 60% of adults were interested in learning how to use online resources to find trustworthy information. In today's world of misinformation, I would think that percentage is even higher today. 54% of adults were interested in training that would make them more confident in using computers and the Internet.

Future Broadband Gaps

This gap analysis so far has 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 broadband speeds are a moving target – that is, 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 nearly the same rate since the early 1980s. Home and business need for bandwidth has been doubling every 3 to 4 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 nearly 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over time, households needed more speed, and the 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, the cable companies have captured the lion's share of the market by offering Internet speeds starting between 100 Mbps and 200 Mbps.

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 POPs. Both companies estimate that home Internet need for bandwidth downloading as well as the need for broadband speeds are growing currently at about 21% annually. Business use of bandwidth is currently growing at 23% annually.

This report earlier discussed how the FCC set the definition of bandwidth in 2015 at 25/3 Mbps. If you accept that speed as an adequate definition of bandwidth in 2015, then growing the requirements for speed every year by 21% would result in the following speed requirements by year.

Download Speeds in Megabits / Second

2015	2016	2017	2018	2019	2020	2021
25	30	37	44	54	65	79

This is somewhat arbitrary because it assumes that the broadband needs in 2015 were exactly 25 Mbps. For example, if the actual broadband need for the average household in 2015 was 22 Mbps, then the predicted speed for 2020 would be 57 Mbps. What is not arbitrary is that the need for bandwidth and speed increases over time.

If we accept the premise that 25 Mbps was the right definition of broadband in 2015, then it's reasonable to believe that the definition of download broadband today ought to be at least 79 Mbps. That would infer that there is a broadband availability gap today for any household that can't buy 79 Mbps broadband.

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 include combined download and upload usage.

1st Quarter 2018	215 Gigabytes
1st Quarter 2019	274 Gigabytes
1st Quarter 2020	403 Gigabytes
1st Quarter 2021	462 Gigabytes
2nd Quarter 2021	433 Gigabytes

This data shows several things. First, it shows extraordinary growth in the average use of broadband across the county. From the first quarter of 2018 to the first quarter of 2019, the average use of household broadband grew by 27%. Usage skyrocketed due to the pandemic. From the first quarter of 2019 to the first quarter of 2020, during the pandemic, the average use of household broadband grew by an astonishing 47%. During the pandemic in 2020 the average household broadband usage grew by another 20%.

OpenVault only recently began reporting upload and download speeds separately. At the end of the third quarter of 2020, the average home downloaded 359 gigabytes of data and uploaded 25 gigabytes of data. By the end of the 2020 this had grown to an average of 483 gigabytes of download data and 31 gigabytes of upload data.

One of the most startling numbers to come from OpenVault is what they call power users – homes that are using more than 1 terabyte of data per month. Consider the following statistics showing the percentage of homes that use a terabyte of data per month:

4th Quarter 2018	4.0%
4th Quarter 2019	7.3%
1st Quarter 2020	10.0%
4th Quarter 2020	14.1%
2nd Quarter 2021	12.3%

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 1.5% of all households at the end of the second quarter of 2021.

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 2020 and 2021.

	June 2020	June 2021
Under 50 Mbps	18.4%	10.5%
50 - 99 Mbps	20.4%	9.6%
100 - 199 Mbps	37.8%	47.5%
200 - 499 Mbps	13.5%	17.2%
500 - 999 Mbps	5.0%	4.7%
1 Gbps	4.9%	10.5%

In just the last year, the number of households subscribed to gigabit broadband has doubled, while the number subscribed to slower speeds is dropping precipitously. Many millions of homes over the last year 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 43% over three years. At the same time, the number of homes using more than a terabyte of data per month has grown by 500% over three years. While there may be no direct correlation between having a faster broadband plan and using more broadband, total broadband usage is likely 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. In the recent past, the peak period for broadband usage – the busy hour – was always in the evenings. During the pandemic, the amount of usage in the evenings has remained flat, and all of the increased usage came during the daytime as employees and students used broadband and video conferences to function.

OpenVault says that nationwide broadband usage peaked in the third week of March 2020. It will be interesting going forward to see the 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 the 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 that 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 be periodically increasing 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.

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. Practically every home that uses 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 towards 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. This applies the 21% historical annual growth rate for bandwidth to the broadband speed predicted by cisco for 2020. Forward predictions are always criticized for being too aggressive, but when considering that the need for broadband has been growing at roughly the same rate since 1980, it's not a big stretch to predict broadband needs into the future.

Download Speeds in Megabits / Second

2020	2021	2022	2023	2024	2025	2026	2027
65	79	95	115	139	169	204	247

The download speeds in this table get 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 2030 would be 438 Mbps, in 2035 would be 1.1 Gbps, and 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 a blazingly fast broadband connection. A fiber network will be able to keep up with this kind of future demand. There is already fiber gear today that can deliver 10 Gbps broadband to residential customers.

It's possible that the cable company networks could also keep up with this demand, but it would require several major upgrades in technology to do so. The Charter/Spectrum network in the county 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. That's going to require an upgrade to DOCSIS 4.0 to get speeds faster than 1 gigabit.

It's not hard to put this prediction into perspective. Cable companies that serve around 65% of all broadband customers in the country already advertise minimum speeds today of between 100 Mbps and 200 Mbps. In markets where the coaxial cable is in good condition, big cable companies already provide 200 Mbps broadband today as the target speed for their introductory broadband product.

It's not hard to imagine that seven years from now that the national definition of broadband ought to be around 250 Mbps. That doesn't mean that the FCC will continue to increase the regulatory definition. Last year the agency rejected pleadings asking them to increase the 25/3 Mbps definition. There is a political downside if the FCC increases the definition of broadband – it would reclassify numerous homes as not having broadband. Today the 25/3 Mbps definition of broadband is lower than the reality of what many homes need, but my guess is that there will have to be an even bigger difference before an FCC will react and change the definition.

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 bandwidth are fiber-to-the-premise, cable company hybrid-fiber networks, and some wireless technologies using millimeter wave spectrum that are just now being trialed in a few markets.

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.

The Consequences of the Broadband Gaps

There was a time when academics theorized about the impacts of poor broadband. We don't need to theorize today because you can go to any rural community with poor broadband, and residents and businesses will fill your ear with stories of the negative consequences of having poor broadband. The problems with the lack of broadband just got magnified due to the COVID-19 crisis.

Impact of Poor Broadband for Citizens

Lack of good broadband causes major problems for rural homeowners:

- Lower Property Values: There are numerous studies showing 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. From everything that we hear, it is now difficult to attract people to move to rural places that don't have good broadband. That is a big negative for the small towns without good broadband. Without a broadband solution, the rural parts of Door County will become undesirable places to live, and this is only going to get worse over time as broadband speeds keep increasing in the places that have broadband.

- Education: The concern for the schools is that they are unable to send computer-based work home with students since they know that many of them don't have good home Internet. It's incredibly hard to raise kids today 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 inadequate for doing homework. The same is true with cellular data; we have heard horror stories of people with kids ending up with astronomical broadband bills for using broadband from cellphone hotspots for homework.

  Schools want students to be able to use broadband outside the school. An increasingly widespread 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 are lacking the tools that their peers take for granted.

  There was a major study performed to look at what is being called the homework gap by the National Center for Education Statistics (NCES),[16] an agency within the US Department of Education. 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 a computer 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 score 152, compared to 128 for students without a home computer.

  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 vast range of undergraduate and advanced degrees that can be

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

achieved mostly online. Online training courses require decent broadband speeds but also low latency since the training is usually done in real-time.

The COVID-19 crisis has highlighted the need for good home broadband for students since in many places in the country, both K-12 and college students were sent home to complete the school year online. This instantly created a crisis in rural homes in the county that didn't have enough broadband to allow students to successfully do schoolwork 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 connection of bandwidth that is carved out of the Internet path and that remains live 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 of the types of broadband available in Door County have much smaller upload speeds than download speeds, and even homes with adequate download bandwidth might not be able to establish a VPN connection due to the inadequacies of the upload path.

Many school systems are trying to recreate the classroom feel using videoconferences where a teacher and all of the students can see each other. That requires a 2-way video connection that can use a 1 – 3 Mbps connection for both upload and download. Students without good home broadband are not going to be able to participate in this kind of remote classwork.

Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it nearly impossible to make either kind of connection reliably over satellite broadband – one of the more common kinds of rural broadband connection.

Doing schoolwork from home is also going to use a significant amount of bandwidth during a month, and that raises the issue of data caps and data overage charges. Both satellite broadband and cellular broadband have small data caps and exceeding the data caps can be expensive.

- <u>Working at Home</u>: More jobs today can be done at home, even if only part-time. But people without adequate home broadband can't participate in this segment 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. Many of your residents could find work that would allow them to work at home and to make a larger income than they can make today locally – if they have great broadband. 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 early March. Across the country, employees that live in rural areas were 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 work 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 nearly impossible to make either kind of connection reliably over satellite broadband.

What's become painfully obvious due to the coronavirus crisis is that homes need more than the ability for a student to do homework or a person to work from home – because many homes have multiple students and possibly also more than one adult all trying to function on the Internet at the same time.

- Medical: We are finally starting to see a big uptick in the use of telemedicine. This is the process of using broadband to connect patients to specialists without having to make the long drive in for an appointment. Patients can talk to doctors using a video connection if the home has adequate broadband. The biggest benefit of telemedicine is being able to talk to a specialist without having to make a long trip to some distant city.

  One of the best uses that have been found for telemedicine is for administering 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 readmission rates of patients after surgery by 44%. CoBank recently sponsored a trial in Georgia for rural diabetes patients and showed a significant improvement for patients who could be monitored daily and who could communicate easily with doctors.

  One of the biggest problems caused by lack of rural broadband is the inability to support emergency services. Mobile medical staff often want to transmit large data files to the home hospital to speed-up the process of finding the best immediate treatment.

  The coronavirus crisis has highlighted the need for telemedicine. Doctor's offices and clinics all across the county shifted some of their office "visits" to video meetings on Zoom or other video platforms in order to reduce contact between doctors and patients. There were widespread reports of doctors requiring video connection for all non-emergency visits. Councilors and mental health workers also largely migrated most contacts with clients online. It immediately became clear that patients without home broadband or without a strong cellular signal couldn't make the needed video connection. There is a lot of speculation that video meetings and telemedicine will become mainstream once doctors understand how effective it can be in many cases.

- Taking Part in the Modern World: People with good broadband have access to features of the web that require bandwidth. Households with good bandwidth routinely use broadband for things like watching videos on services like Netflix, talking to friends and family on services like Skype, playing video games (many of which have largely moved online), taking online courses from numerous colleges, or even just browsing today's video-rich Internet. Many of the businesses people now interact with (utilities, insurance companies, shipping companies, etc.) assume that people have a broadband connection. Many people's social lives, for better or worse, have moved to the web; it is not uncommon to now have friends all over the country based upon some shared interest instead of based upon geographic proximity. Homes without broadband can't participate in any of these 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:

- o <u>Security</u>. 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.
- o <u>Machine-to-Machine Traffic</u>. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes have files automatically backed up in cloud storage. Numerous appliances and devices in our home periodically connect with the cloud whether providing updates or just to make sure that the connection is still live. Many cars now communicate with the cloud when in range of a home broadband connection to provide status of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that this traffic would represent over 50% of all the traffic on the web by 2023.
- o <u>Online Everything</u>. Many of the functions we do have migrated to being only online – we couldn't even begin to make a full list of things that are largely now online. This includes both major and minor functions, including things 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.

- <u>Keeping Talent at Home</u>. 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 home, and so large percentages of each graduating class migrate to larger cities and towns to pursue careers. One of the promises of fiber is the ability to create new jobs and to also 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.

<u>Impact of Poor Broadband for Businesses</u>

There are numerous consequences of poor broadband for businesses. While some businesses have unique and specific requirements, there are a number of problems caused by poor broadband that affect most businesses.

<u>Impact on Day-to-day Operations</u>. There was a discussion of this issue in Section II of the report. There, businesses had identified that ways that they use broadband today, which included the following:

- To communicate with customers.

- To communicate with vendors.
- To communicate with other branches of the company.
- Working in the cloud.
- Security systems.
- Sending and receiving large data files.
- VoIP.
- Communicating via video.
- Collaboration software.
- Supporting remote employees.
- Data backup.
- Internet of things sensors.

Impact of Poor Broadband for Businesses

There are numerous consequences of poor broadband for businesses. While some businesses have unique and specific requirements, there are a number of problems caused by poor broadband that affect most businesses. Broadband availability is mostly related to geography – businesses in any given neighborhood generally have the same good or bad broadband options as residents.

Impact on Day-to-day Operations. The list above describes the many routine ways that businesses in the county are trying to use broadband. Businesses without adequate bandwidth must forgo or compromise on how they communicate with the world and function day-to-day. Many of the businesses in the county told us that they felt constrained from doing even routine day-to-day tasks like accepting credit card payments. Businesses without good broadband almost universally told us that they would be more efficient and profitable with better broadband. A few businesses said that poor broadband is a major impediment to growing the business. The responses to the survey and interview demonstrated a lot of frustration.

Entrepreneurship. Every community has 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. As we saw in the many responses to the residential survey, there are many parts of the county with poor home broadband options.

Economic Development and Jobs: Reliable and affordable broadband is still one of the key elements in traditional economic development to lure new companies to a community or to keep existing companies from leaving. As vital as broadband is to residents, it’s more important to businesses.

We heard several stories of companies with hundreds of jobs that decided to not locate in the county in recent years due to the poor broadband. We heard from many existing businesses that are struggling badly due to poor broadband that might consider relocating somewhere else.

Perhaps of even more concern is that the entire county seems to be broadband starved. During the busy tourist season, broadband speeds from all of the ISPs slow down, including in the areas with otherwise decent broadband. This means businesses, in particular, don’t have enough broadband at the times of the year when they need it the most.

Supporting Tourism. The demand for broadband has grown significantly over the last five years. In our opinion, the county will be facing a time of reckoning soon. Our daily lives are becoming more dependent on being connected to the cloud, and visitors to the county are going to insist on being able to stay connected to their businesses and daily life while visiting the county. CCG has done similar studies in a number of communities that are driven by tourism, and none of them had broadband issues as bad as those faced in Door County.

Future Uses of Broadband for Businesses. As bad as broadband is today, the county is going to get locked out of the future without better broadband. There are several trends that we are seeing that require world-class broadband. For example, consider the emergence of smart factories. The pandemic uncovered major problems in the U.S. supply chain, and both political parties are now talking about a big government push to bring manufacturing back to the U.S., particularly in vulnerable areas like medicines and electronics. Any factory built today is going to rely on robotics and automation, including relying on cloud connectivity to direct and monitor the manufacturing, marketing, and shipping processes. Smart factories will still require employees, so losing out on this market segment will keep good-paying technical jobs out of the county. Over the past decade, the U.S. has created over 900,000 jobs in newly built "smart" factories.

Agriculture / Other Industries: many industries now have specific requirements for broadband. Perhaps the easiest way to demonstrate this is to talk about how broadband is transforming one specific industry—agriculture. A similar list can be made of the specific uses of broadband for numerous other industries.

We are also on the verge of seeing a huge demand for smart agriculture. Over the last decade, there has been huge research and development into the development of smart farming vehicles, technology that simplifies animal herd management, sensors, and monitors that measure every aspect of growing crops to allow precise watering, feeding, and weeding or crops. We're seeing the farming supply chain and consumers willing to pay a premium price for crops that they can track from planting to delivery to the store. Smart agriculture means somehow bringing good broadband to the field, the grazing lands, the feedlot, and the barn. This can only happen in areas that have good broadband basic infrastructure.

The most data-intensive farming application is the creation of real-time variable rate maps of fields. Farmers can use smart tractors or drones to measure and map important variables that can affect a current crop, like the relative amounts of key nutrients, moisture content, and the amount of organic matter in the soil. This mapping creates massive data files that are sent off-farm. Expert agronomists review the data and prepare a detailed plan to get the best yields from each part of the field. The challenge farms face today is getting the data to and from the experts in a timely manner. Without fast broadband, the time required to get these files to and from the experts renders the data unusable if the crop grows too large to allow machines to make the suggested changes.

Using sensors for monitoring livestock is the most technologically advanced area, and there are now dairy farms that measure almost everything imaginable about each milking cow. There are also advanced sensor systems monitoring pigs, chickens, egg farms, and other food animals. Ranchers that have good cellular data coverage over range areas can track the location of every member of their herds.

There has been a lot of progress in creating self-driving farm implements. These machines have been tested for a few years, but there are not a lot of farmers yet willing to set machines loose in the field without a driver in the cab. But the industry is heading towards the day when driverless farming will be an easily achievable reality. Smart devices have moved past tractors and now include things like automated planters, fertilizer spreaders, manure applicators, lime applicators, and tillage machines. Machinery now comes with sensors that will alert a farmer of a problem and can even automatically order a replacement part before a working machine fails.

One of the more interesting trends in farming is to record and report on every aspect of the food chain. When the country stopped eating romaine in late 2018 because of contamination at one farm, the industry started to develop a process where each step of the production of crops is recorded, with the goal to report the history of food to the consumer. In the not-too-distant future, a consumer will be able to scan a package of lettuce or other crops and know where the crop was grown, how it was grown (organic or not), when it was picked, shipped, and brought to the store. This all requires creating a blockchain with an immutable history of each crop, from farm to store, and making this history immediately available to stores and to consumers.

The industry has been developing soil sensors that can wirelessly transmit real-time data on pH, soil moisture, soil temperature, transpiration, etc. These sensors are still too expensive today to be practical – but the cost of sensors is expected to drop drastically with sales volumes. Research is even being done to create low-cost sensors that can measure the health of individual plants in orchards and similar environments.

The smart farm today measures an immense amount of data on all aspects of running the business. This includes gathering data for non-crop parts of the business, such as the performance of vehicles, buildings, and employees.

II. ENGINEERING DESIGN AND COST

The RFP asked us to consider technologies that can bring better broadband to the rural parts of the county. We considered both wireless and fiber technologies, and this section of the report discusses our research and conclusions.

A. Wireless Network Design

There are numerous wireless technologies in use in the broadband world:

- Fixed Wireless. This is also known as point-to-multipoint wireless technology because the network consists of putting a transmitter on a tall tower and beaming broadband to and from a dish placed at the customer location.
- Mobile Broadband. This could be the broadband available on cellphones. It also can be configured on a point-to-multipoint basis. This technology is only available to ISPs that have purchased the needed spectrum, and that mostly means the cellular carriers. However, Charter/Spectrum does own some of this spectrum.
- Millimeter-wave Wireless. This technology uses extremely high frequencies that can transmit large amounts of data, but for only a short distance. This technology is being used today by Verizon using a configuration commonly referred to as fiber-to-the-curb. Fiber is built close to customers, and broadband is beamed from the pole to the home. This technology is currently more expensive to deploy than fiber-to-the-premise, and also doesn't work well in heavily wooded areas.

The only one of these technologies that could be considered in the rural parts of the county is fixed wireless. This technology is already in use by several wireless ISPs (WISPs) in the county – and the question that we asked is if a new deployment could produce faster broadband speeds than what these WISPs are delivering today? Our conclusion is that a new network built with the best wireless technology available could deliver broadband speeds between 50 Mbps and 100 Mbps to some customers in the county – but the network would still suffer from trees and terrain. That means many homes would see slower speeds and some probably couldn't be reached at all. This would be an improvement over the current fixed wireless broadband, but it would still not deliver the kinds of speeds we think your residents want.

The key to making this technology work is to use multiple bands of wireless spectrum to be able to maximize the bandwidth to any one customer based on local conditions. There are several current frequencies of spectrum that can be used for this purpose:

- WiFi: WiFi is short for wireless fidelity and is used generically when referring to any type of 802.11 network. The FCC has currently set aside two swaths of frequency for WiFi: 2.4 GHz and 5.7 GHz. In a point-to-multipoint network, these two frequencies are often used together. The most common way is to use the higher 5.7 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 speeds can be slow at the far end of 6 miles. Nationwide many wireless carriers advertising speeds in the range of 25 Mbps. We know of networks doing speeds up to 75 Mbps for short distances. Such a network must have fiber built to the radio transmitters, and also can't carry too many customers on a given radio system.

The FCC has approved the use of 6 GHz WiFi for outdoor use, but we haven't seen this incorporated yet into radios. This would add more power for customers that live within the first few miles from a tower. There may be interference issues with 6 GHz in that there are around 100,000 existing outdoor microwave links using the frequency. Anybody operating near one of the existing links might have some restrictions on usage.

- 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 get priority to use the spectrum.

  The spectrum also must be shared among users in the public space – something that will be monitored by authorized SAS administrators. The FCC has named five administrators: Amdocs, CommScope, Federated Wireless, Google, and Sony. It's expected that the cellular carriers are going to heavily use the free public spectrum to deliver 5G, so in many places this spectrum might be too busy for using in 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 two WiFi bands used for fixed wireless today and has great operating characteristics.

- White Space Spectrum: The FCC has been doing trials in what is called white space spectrum. This is spectrum that is the same range as TV channels 13 through 51, in four bands of frequencies in the VHF and UHF regions of 54–72 MHz, 76–88 MHz, 174–216 MHz, and 470–698 MHz. The FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices. The FCC approved greater use of these frequencies for point-to-multipoint radios.

  The FCC auctioned a lot of this frequency in 2018, with the buyers ranging from the big cellular companies to Comcast. This was called an incentive auction because TV stations that gave up their spectrum got a share of the sale proceeds. The FCC is now expected to make some of this spectrum available for rural broadband. The rules have not yet been worked out, but they will probably be something similar to what governs WiFi and be available to anybody.

  There are two possible uses for the spectrum. On a broadcast basis, this can be used to make better hotspots. A 2.4 GHz WiFi signal can deliver just under 100 Mbps out to about 100 meters (300 feet). But it dies quickly after that, and there may be only 30 Mbps left at 200 meters and nothing much after that. Whitespace spectrum can deliver just under 50 Mbps out to 600 feet and 25 Mbps out to 1,200 feet.

There is potential for the spectrum to extend point-to-multipoint radio systems in rural areas. White space radios should be able to deliver about 45 Mbps up to about 6 miles from the transmitter.

One issue in using the spectrum is that FCC rules require the radios using this frequency to use what they are calling cognitive sensing. This means that an unlicensed user of the spectrum must yield usage to any requests for spectrum from a licensed user. While this would not be a problem in rural areas where there is only one user of the white space spectrum, where there is a mix of licensed and unlicensed users, the unlicensed provider needs to pair radios with other spectrums to be able to serve customers when they have to cede usage to a licensed user.

There are several factors that are critical to a 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, and 5.0 GHz. Radios are now starting to integrate white space spectrum and CBRS spectrum. Having more spectrum 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 why many WISPs deliver speeds under 10 Mbps.
- Terrain/Topology. There are often physical barriers like hills or heavy woods that can limit or block customer bandwidth. The spectrum used for this technology requires a good line-of-sight, meaning that there must be a clear, unimpeded visual path between the tower and the customer. Customers that live in valleys or behind hills generally can't get service. If the signal passes through trees to reach a customer, the strength of the signal is diminished – and this is the primary problem with this technology in Door County. The signal can also degrade when rain or snowstorms block some of the signal.
- 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. It's our understanding that tower height is a major issue in the county and some towns have limited tower height to 100 feet – which is inadequate for creating a high quality fixed wireless network.

Finley Engineering considered a fixed wireless design for the county. The network that makes the most sense is as follows:

- We looked at existing towers and selected twelve towers that would collectively provide coverage to all of the rural parts of the county. These towers do not reach into Sturgeon Bay, but the wireless technology does not perform well in towns for a variety of reasons.
- We assume that each tower already has fiber connectivity – there are very few rural cellular towers that are not connected to fiber. We know that Nsight reaches many, if not all, of the towers.
- For purposes of this analysis, we assume that transmitting antennas could be placed on the existing towers. It's possible that some of these towers are too full to allow a new carrier. In that case, new towers would need to be constructed. The price for a new tower of the needed height will cost

around $200,000. It would be important to place a new tower close to existing fiber routes, or else new fiber would also have to be constructed.

- The cost at each of the towers is about $103,000. This covers the cost of a small cabinet at the base of the tower, the radios, and dishes that go onto the tower, the electric work to connect the cabinet.
- We've assumed top-of-the-line radio electronics. That is needed in a place like Door County, where it's going to be a challenge connecting to many customers. Better radios improve the chance of making and holding a connection. We've assumed the radios can use both WiFi and CBRS unlicensed spectrum.
- The radios at each tower would have six sectors. This is needed to be able to serve more customers from a tower. A single radio at a tower can only serve around sixty customers. The easiest way to think of sectors is as separate radios. The wireless carrier will point each sector in a different direction. A 6-sector radio could accommodate 360 total customers at a tower. Unfortunately, you can't put additional radios at the same tower site, so 360 customers are the most that can be served with a quality connection. One of the reasons that some WISPs have slower speeds is that they oversubscribe the radios and add more than 60 customers to a sector. As has been discussed elsewhere in this report – all broadband networks can bog down if an ISP tries to serve more customers than can be supported by the technology.
- In total, this means that a maximum of 4,320 customers could be served in this network. The real count that could be served from this network would likely be smaller than this because some of the towers might not be within range of 360 potential customers.
- We estimate the cost of the radio at each customer sight at $750. This includes a top-of-the-line radio for $375 along with $95 of hardware for mounting the radio and bringing the connection into the home. It can cost more to install some customers. For example, if there is no line-of-sight, an ISP will sometimes erect a tall pole at the house to get the antenna above the tree line. Such costs are usually passed on to the customer.
- We've estimated $300 labor per connection – but that could be done for an ISP with a full-time installation staff. But internal installations are costly when you add up the technician time and tying up a vehicle during an installation.

The key question to answer about this network is the broadband speeds that can be achieved. If this network was sitting in an open environment with no trees, then this network would be able to deliver around 100 Mbps download to customer – with the bandwidth speeds decreasing after the first few miles from a tower.

But that is not the case in Door County. This proposed network could deliver 100 Mbps broadband to customers that have a pure line-of-sight between the tower and the customer location. We think that would be a relatively small percentage of homes. This could be determined by undertaking what is called a spectrum heat map, which overlays the reach of spectrum from a given tower across the terrain and tree cover.

Most homes in the rural areas are going to have impediments between a tower and their home or business. Some locations can't be reached if the home is in a small valley or blocked by a hill from seeing an antenna. But the major impediment to good broadband is tree cover. We find it likely that an ISP with the best radios that can be bought we be able to deliver more than 50 Mbps to a large percentage of households.

That is something that might be worth exploring further. But we abandoned this idea in favor of fiber for the following reasons:

- There are already several WISPs operating in the county, and that means there is going to be interference with the radio signals. Interference translates into slower broadband speeds, and so speeds could be even lower than discussed above. This network also relies on the CBRS spectrum to achieve faster speeds. It's possible that one of the cellular companies could use this spectrum in Sturgeon Bay, and that would greatly decrease the use of the spectrum for rural broadband. We know that there are problems with cellular coverage during the peak season and adding the CBRS spectrum would be the easiest way for the cellular companies to fix that problem. Since cellular companies would have priority for the spectrum, it might turn out that speeds are much slower than what was discussed above.
- The total cost for the above network is around $4.5 million. That's a far smaller cost than building fiber. However, the cost will likely be at least somewhat higher than this. There will inevitably be a few towers that don't have space for more radios, meaning anybody tackling this plan would have to probably build a few towers. It may be a challenge to place new towers to achieve optimum coverage while being close to existing fiber – so there could also be the need to build some fiber.
- Compared to fiber technology, much of a wireless system has a relatively low expected life. Most of our clients have found that customer radios have to be replaced roughly every seven years – which means spending over $1 million every seven years in perpetuity.
- It's highly unlikely that any of this equipment would be eligible for federal or state grants. Theoretically, federal grants will probably support technologies that can claim 100/20 Mbps speeds. But that speed could not be honestly claimed in Door County. Even if this technology is grant eligible, current grants typically give priority to faster technologies.
- Another grant issue is that many grants require the grantee to cover everybody. This technology will not reach every home due to impediments in the terrain. Further, there could be more customer demand than could be satisfied with this network.
- Probably the biggest concern about making this investment is that there might be enough grant money coming to build fiber. Fiber will largely kill the WISP industry in the county – we see this everywhere that ISPs build fiber. This would be a terrible investment if somebody builds fiber within a few years of the deployment of the wireless network.

When considering all of the above factors, we can't recommend pursuing a fixed wireless strategy. There are too many reasons why a new wireless network won't work as well as hoped, and perhaps an even bigger risk that grants will be awarded to build fiber, which would kill a new wireless business plan.

B. Fiber Network Design

Fiber Technology Options

The fiber design considered two technologies. Active Ethernet technology has been in widespread use for more than 30 years; passive optical network (PON) technology has been used for over 15 years. These are both mature technologies that are widely used and well-understood industrywide.

GPON / XGS-PON – Passive Fiber Technology

For the last fifteen years, the industry standard for passive optical networks has been GPON. As recently as last year, there was still at least a 15% or greater price penalty for buying 10 Gbps PON technology using the XGS-PON standard. But recently, we've seen quotes for XGS-PON that are nearly identical in price to buying the GPON that's been the industry standard.

New technology is almost always more expensive for two reasons. First, manufacturers hope to reap a premium price from those willing to be early adapters. You'd think it would be just the opposite since the first buyers of new technology are the guinea pigs who have to help debug all of the inevitable problems that crop up in new technology. But the primary reason that new technology costs more is economy of scale for the manufacturers – prices don't drop until manufacturers start manufacturing large quantities of the new technology.

The XGS-PON standard provides a lot more speed. The industry standard GPON technology delivers 2.4 Gbps download and 1 Gbps upload speed to a group of customers – mostly often configured at 32 passings. XGS-PON technology delivers 10 Gbps downstream and 2.5 Gbps upstream to the same group of customers—a big step up in bandwidth over GPON.

The price has dropped for XGS-PON primarily from the use by AT&T in the U.S. and Vodaphone in Europe. These large ISPs and others have finally purchased enough gear to drive down the cost for manufacturers. One of the best features of XGS-PON is some manufacturers are offering this as an overlay onto GPON. The new technology requires swapping out some cards in a GPON network to provision some customers with 10 Gbps speeds. This means that anybody using GPON technology ought to be able to ease into the technology without a forklift upgrade.

XGS-PON is not a new technology, and it's been around for at least five years. But the price differential stopped most network owners from considering the technology. Most CCG clients claim that their residential GPON networks average around 40% utilization, so there have been no performance reasons to need to upgrade to faster technology. But averages are just that, and some PONs (neighborhood nodes) are a lot busier, meaning that ISPs are having to shuffle customers to maintain performance.

With the price difference finally closing, there is no reason for somebody building a new residential network to not consider the faster technology. Over the next five years, as customers start using virtual reality and telepresence technology, there is likely to be a big jump up in bandwidth demand from neighborhoods. This is fueled by the fact that over 10% of homes nationwide are now subscribed to gigabit broadband service – and that's enough homes for vendors to finally roll out applications that can use faster speeds.

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 generally inserts the signals for the various products being delivered to customers.

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, generally 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 the 32 separate fibers that go to customers. The splitter cabinets can be located at the same location as the 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 32 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.

One of the biggest benefits of the GPON network is a saving in fibers in the network. Only one fiber is needed to serve an OLT, and one fiber goes from the OLT to each splitter. The fiber is only divided into individual customer fibers at the splitters, which can happen deep into the network.

One consideration when designing PON networks is the optical distance from an OLT port to the customer Optical Network Terminal (ONT). A design that allows for a 1.32 customer split has a distance limitation of 20 km (12.4 miles). That distance limitation is generally not a problem in city network but can be a challenge in rural areas.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, DZS, Nokia, Juniper, and Calix.

<u>PON Advantages</u>

- <u>No electronics in the field</u>. 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.
- <u>Less field maintenance and more reliability</u>. 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.
- <u>Less fiber needed</u>. PON uses significantly fewer fibers than an active system. A PON network carries up to 64 customers (we recommend not more than 32) on one fiber, while an active network needs a home run fiber for each customer. Less fiber means lower capital costs, less loading on poles, quicker fiber installations with less splicing, and smaller fiber management systems.
- <u>Higher density electronics</u>. Because PON electronics have only one optical port for every 32 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.
- <u>Ability to still use active Ethernet</u>. 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.
- <u>Location Flexibility</u> 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.

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 to make sure that the OLTs and ONT operate within the limitations of the network. 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 could put up to 32 to 64 subscribers out of service.

Active Ethernet (Active E)

An Active E network is essentially a fiber "home run" from the central electronics core, meaning that one fiber goes from the core electronics directly to each customer. This technology has several advantages and is well-suited for serving large businesses where the customer requires more stringent network uptime and higher bandwidth. An Active E network also can provide symmetrical data capabilities (upstream and downstream data rates are the same) at high data speeds. The downside to Active E is that more fibers are required in the network since fibers are not shared between customers. Electronic costs are generally also higher since there is a dedicated laser at both ends of the connection to every customer. Active E also has higher data capabilities and can inexpensively provide for data rates up to 10 gigabits per second. Faster speeds are possible, but with significantly higher electronics costs. One of the biggest advantages of Active E is that it's easy to change the connection to a single customer as customer requirements change – the laser serving that customer can be changed without affecting any other part of the network.

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

- 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 support fewer customers in the same rack space. This means larger chassis and more rack space, which equates to more environmentally 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 generators.
- Expensive growth after construction. This may be the biggest drawback. It can be expensive to add new customers in the middle of the network because that means somehow adding more fiber between the electronics and customers.

After considering the various pros and cons, Finley Engineering chose passive technology as the best electronics solution for the county. The most crucial factor is that a PON network significantly reduces the number of fibers needed to reach around the county, which significantly lowers the cost of construction.

Aerial versus Buried Fiber

The network design provides for aerial fiber where current utilities are on poles and for buried fiber where current utilities are buried. In Door County, this mostly means that the designed network uses aerial fiber.

However, when it is time to build the network, a final construction design might change our assumption at various places in the network due to local issues. The following are a few key issues that usually drives this decision:

- Cost. Most fiber overbuilders will choose the lowest-cost construction option. There will be places in a network where it saves money to bury fiber rather than put it on a pole. This could be due to costly aerial construction due to poles that are already full of wires from other utilities. It could be a timing issue where the delay involved in waiting to coordinate getting onto busy poles adds too much cost to a project. It's important to note that labor is the highest cost of building fiber – so choosing a construction method with the least amount of labor effort is almost always the lowest cost alternative.
- Topography. Door County has natural characteristics that make it more challenging to construct fiber than many other places in the state. For example, buying fiber is more costly due to the underlying escarpment and the variance in rocky terrain. All kinds of fiber construction are more challenging in heavily wooded areas. The normal high wind from the Great Lakes adds a challenge to hanging fiber on poles.
- Special Circumstances. There are special circumstances that can make it more expensive and time-consuming to build fiber. For example, it's often expensive and time-consuming to gain the needed rights-of-way to build fiber across bridges, under railroad tracks, or under freeway overpasses. There are sometimes extra steps needed to build along state highways.
- Rights-of-Way. Most public roads already have a defined public right-of-way along the sides of a road. Such areas are usually designated by state laws or local ordinances that specifically define the right-of-way. Utilities are allowed to construct in existing rights-of-way, but only to the

extent that they do so without harming existing utility infrastructure. Rights-of-way can become an issue if the fiber design hopes to build in places that are no pre-defined public rights-of-way. This could include building on private lands or roads. It might mean wanting to build up alleys instead of main streets. It might mean wanting to take shortcuts across open land to avoid building long stretches of fiber where there are no potential customers.

- Local Issues. We were told by several ISPs that it's often a challenge to build in the county due to an overall local desire for maintaining the peninsula's character. This can result in ordinances that might make it more difficult to build infrastructure – such as the County's restriction on the placement of towers. But it also manifests in landowners not wanting to grant rights-of-way to construction project. We've been told that the accumulated impact of local issues makes it harder to build infrastructure in Door County than in other parts of the state.
- Maintenance. Sometimes there are external factors that influence the aerial versus buried discussion. Aerial fiber is subject to damage from weather, and communities with predictable hurricanes might choose to bury fiber even when it costs more. We've worked in communities that used the construction of fiber as the impetus to move other utilities underground for aesthetic reasons.

Aerial Fiber Basics. There are several factors that can influence the cost of aerial cable. We've estimated these various factors in making construction cost estimates, but actual pricing will require detailed field engineering that will determine the best construction method to use in various sections of the aerial network. The following discusses the primary factors that affect aerial construction costs.

Probably the key factor is the location of the new fiber on existing poles. There are two possible ways to put fiber on poles. Electric utilities have the option of putting fiber in the power space, meaning close to the existing electric lines. If the new fiber is to be placed closer than 40 inches from the neutral wire, the installation must be done using contractors who are qualified to work in the energized supply space. This adds to the installation cost since qualified installers with that skill generally are paid higher salaries than other installers. Electric companies rarely allow anybody else to use the power space.

Every other fiber building must place fiber in what's called the communications space, which is everything more than 40 inches below the electric neutral wire. The big issue of using the communications space is if there is enough room for the new fiber wire. The NESC electrical code requires specific clearances between distinct kinds of cables on poles, and any new construction is expected to meet these codes. There must be sufficient space between the different providers on a pole. For example, a new fiber must be separated by 18 inches from the cable above or below it. There are also minimum clearance rules for the lowest that any cable can be above ground for the safety of those beneath the pole. These rules are in place to provide safety for technicians that work on cables during and after storm damage.

Invariably in any community, there will be poles that have sufficient room for new fiber, and other poles that are too full, where the spacing is not adequate for a new fiber. This often differs from pole to pole, even on the same street. Some of the spacing issues might be due to poles that are too short or where shoddy construction was used by other utilities that placed wires on a pole.

When there is not enough room to put a new fiber, something called make-ready is triggered. Make-ready rules have been established by the FCC and by state regulators and are a highly specific set of processes that must be followed to add a new wire to a pole that is too full. The most important aspect of make-ready is that federal rules dictate that cost of make-ready is fully the responsibility of the new provider. That seems particularly unfair when many of the problems might be due to poor practices by a cable company that hung wires that weren't in code.

Make-ready costs are of two types – rearranging poles or replacing poles. On many poles, the space can be made for a new provider by moving existing wires higher or lower to make space. This can be time-consuming because the rules require that the existing wire-owners be given the opportunity to do the work themselves. It can take a while to coordinate this process when there are multiple companies with facilities on a pole. It's also fairly common for competitors of a new fiber provider to take as much time as possible in this process.

Sometimes poles are so full or in bad shape that the only way to fit a new fiber is to replace a pole with a taller one. The cost of placing the new pole and of moving everybody else's wires to the new pole is also the responsibility and cost for a new fiber builder. This process can take even a longer time than the process of moving wires.

It's not unusual for a fiber builder to decide in some cases that it's far easier and less expensive to bury the fiber rather than slog through the time-consuming and expensive make-ready process. A new fiber builder might decide on certain streets that the time saved by burying might be worth any extra cost.

<u>One-Touch Make-Ready</u>. The FCC passed new rules that went into effect in May of 2019 that is supposed to make it easier to get onto poles. The new rules apply only in the thirty states that follow FCC pole attachment rules, and Wisconsin is one of those states.

The most meaningful change in the rules is a new classification of poles as either simple or complex make-ready. The order defines how to make this classification. Simple poles are generally those where rearranging wires is all that is needed to fit in a new fiber wire. Complex poles are those that either need extensive work or full replacement. In practice, the new attacher will suggest this determination, although it could get overturned by the pole owner.

There are streamlined new rules and timelines for completing the make-ready on simple poles. If the pole owner is unwilling to commit to fixing simple poles in the needed time frame, then the new attacher can make the changes after properly notifying the pole owner. The new attacher is free to rearrange any existing wires as needed, again after having properly notified all the parties. These new rules eliminate situations where a pole owner refuses to cooperate with a new attacher, as happened in a few cities where AT&T fought Google Fiber. Something to consider is that the rules require using a make-ready contractor that has been pre-approved by the pole owner – but there are ways around this in some circumstances.

These new rules can mean a significant improvement in the construction schedule where the needed changes are for simple poles. However, the new rules are not necessarily faster for complex poles. Those are poles where the make-ready could cause damage to existing wires or where the old pole must be replaced. The make-ready process for complex poles has always been slow. The new rules tighten up time frames a little, but the time required to get onto a complex pole can still take a long time.

For complex poles, the process still allows the existing wire owners to work sequentially – meaning that existing companies get to do their own work, one company at a time. This coordination must be scheduled by the pole owner. The process to fix a single complex pole can still take six months, even if done perfectly. The new rules don't seem to provide a solution for when the pole owner or the existing attachers drag their feet on complex poles. Other than some slightly improved timelines, the work on complex poles looks to still be as dreadful and slow as the old make-ready rules.

It's a fairly minor issue when considering the big picture and cost of building a new network, but there are pole attachment fees that must be paid annually to existing pole owners. We've seen the rates vary across the country from under $10 per pole per year to over $50. Burying fiber bypasses these rent payments.

<u>Considerations for Burying Fiber</u>. There are two key issues that impact the cost of burying fiber. The major issue is the conditions of the soil in terms of being easy or hard to bury fiber. Just as an example, there are places in the country like Iowa and Minnesota where the topsoil is fifteen feet deep. It's cheaper in such places to bury fiber than it is to put it onto poles. But that's not true of most places and not true in Door County. Rocks in the soil can add significant cost to buying fiber, and in some cases, there is so much rock that it is nearly impossible to bury fiber. To some degree, some of this issue can be mitigated by burying fiber in roadways where the soil was already excavated in the past in creating the roadbed.

But there are a lot of places where burying would be expensive even without rock. For example, there are a lot of roads in the county where the trees come up to the roadside. Even if there is a public right-of-way in such places, it can be exceedingly difficult to bury fiber.

The other issue that impacts the cost of burying fiber is the method of construction. It costs more at the construction stage to put fiber into conduit – although eventually, which might be a big saver for maintenance and eventual upgrade or replacement of fiber. Following are the primary methods used to bury fiber:

> <u>Trenching</u>. This is buried construction where a 12-inch-wide ditch is dug in the street or along the side of the road, the fiber is placed in the open ditch, and then the ditch is refilled. This is generally the most expensive type of construction, particularly if ditches have to be dug in city streets – the cost of digging and then replacing asphalt can be costly. Trenching is also disruptive, and city streets must be blocked off until a new surface has been poured and cured in the ditch. Trenching is typically used only in situations where other methods of construction won't work. In a typical urban build, you would expect less than 1% of the total construction to involve trenching.
>
> <u>Boring</u>. Boring is the most common method of burying fiber. In boring, a "pothole" is dug in the street, which means a hole approximately 2 feet by 2 feet. A boring machine is inserted into the empty pothole and laterally drills a hole through the substrate of the street. Empty conduit is then pulled through the freshly dug hole. Conduit is flexible and durable plastic tubing. Eventually, the fiber building will push or pull fiber through the empty conduit. Boring costs can vary widely depending upon the composition of the substrate. If roads were originally dug out to a three feet depth when constructed, then it's relatively easy to bore through an area. Boring is much harder and expensive, and sometimes impossible, in areas where there is native rock close to the surface of the street. There is often an intermediate condition called cobble, where the substrate under the street includes boulders that were put back into the hole when a street was repaved.

Plowing / Direct Burying. In rural areas where there is an unpaved shoulder along roads, a common construction method is to direct bury the fiber into the ground. This involves using a heaving truck that plows a furrow in the ground, just as would be done by a tractor on a farm. The plow pushes fiber into the ground at the same time that it buries. There is most often not even any follow-up construction since the plowed furrow naturally closes after the plow passes. Direct burying needs a reasonably wide right-of-way and shoulder along a road. It's not going to work where trees and tree roots are in the right-of-way.

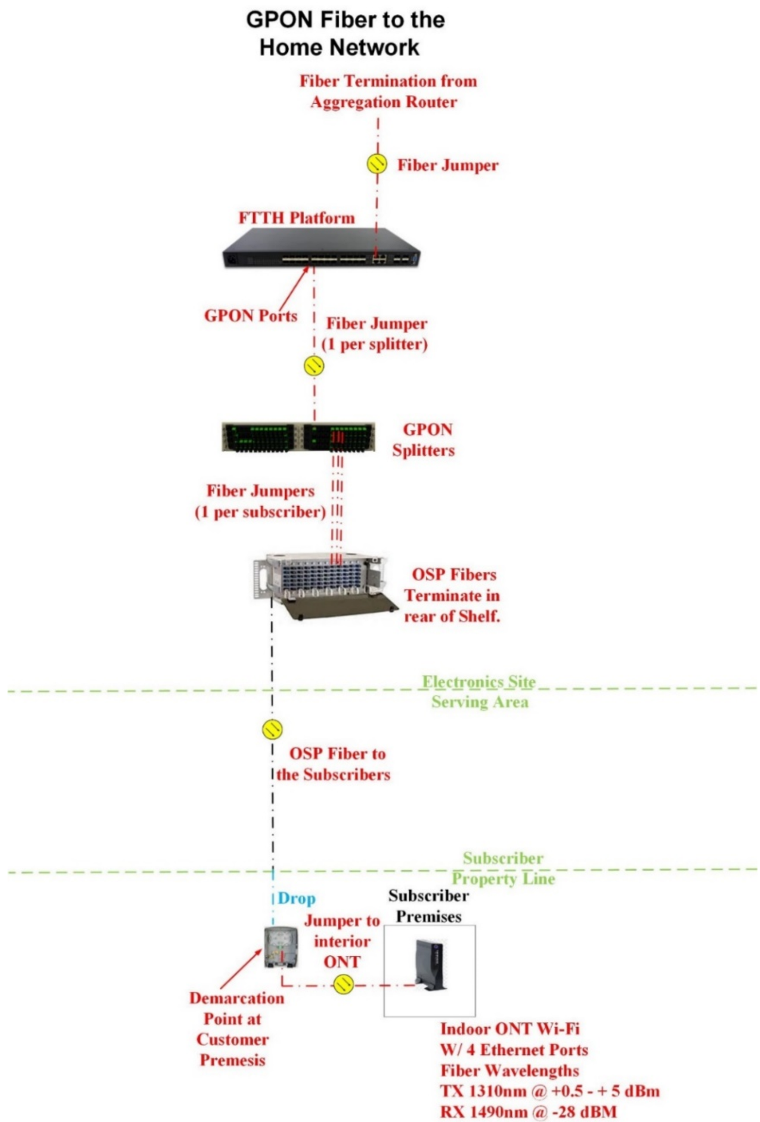
The Components of a Fiber Network. There are several major components of a fiber network, and sometimes the design decisions depend upon which type of fiber is being constructed. For example, there might be different decisions made for fiber that goes along a major business corridor versus fiber that is built in an older residential neighborhood. Fiber networks generically have the following major elements:

- Feeder Fiber. This is the fiber that starts at the core of the network and stretches to the various neighborhoods to be served. In a large enough network, the feeder fiber is built in a ring configuration in a closed loop or circle of some type. This allows the use of electronics that can transmit in both directions on the ring so that a single fiber cut doesn't disrupt service.
- Distribution Fiber. This is the fiber that generally is built up and down streets to pass each potential residential or business customer.
- Drop Fiber. This is the fiber that is built from the street to reach the premise of each customer served by the network.

Note that these three network components are not necessarily exclusive. Some fibers along a main street might be fulfilling all three of these functions. There might be fibers along the street that are part of a fiber ring that reaches the various parts of the network. There might be distribution network that connects to neighborhoods, and there are likely customers along the road that are served with drops.

Network Configuration

The following diagram shows the configuration of the network, starting with one of the hub sites and ending at each customer premises.



<u>Connection to the Internet</u>. The central office in this design would probably be located at the network node closest to where the network will be connected to the Internet. Ideally, there would be at least two diverse connections from this core to reach the Internet so that if one fiber path out of the city is cut, the network will continue working.

<u>Central Core</u>. Our design assumes the connection at the IP core network can be made using two 80-gigabit Ethernet routers. Using two routers allows balancing the Internet traffic load across two connections (send some Internet traffic on each route) and also assures that ISP providers will remain connected to the Internet should a fiber get cut or one of the routers fail.

Not shown on the diagram is a pair of redundant 10-gigabit Ethernet switches that are located in each hub. The primary purpose of these routers is to light the fibers on the backbone fiber and communicate with the two neighboring hub locations. These Ethernet switches can also be connected to other electronics at a hub site that is used to provide customer products. For example, the Ethernet switches can be connected to DHCP/DNS servers that route and receive traffic from the Internet. They can be connected to network management servers that give technicians access to look at the network. They could be used to connect to electronics that provide telephone service, smart-home services, or other future services for customers.

Optical Line Terminal (OLT). This is the electronics used to light the fiber to customers. This is the top piece of electronics shown on the diagram. Our design places an OLT in each hut in the network. OLTs must be powered, and so each hut location will contain equipment needed to provide power, including batteries and other backup power to keep the network functioning in case of a power outage.

An OLT is configured with circuit cards which can each serve between 128 to 256 subscribers. Multiple cards can be installed in each OLT chassis, and multiple chassis can be installed in each hub site, meaning that it's easy to right-size each hub and also to scale the network to accommodate future growth.

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 cabinet is used to neatly arrange and manage the fibers coming into or out of the splitters to make it easy to identify the specific fiber serving each 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. The PON cabinets in the design are of varying sizes that depend on the customers served from a given hut location. These cabinets are usually sited in areas adjacent to road access. The exact location of PON cabinets would be determined as part of the detailed fiber plant design.

Below is a picture showing the insides of a typical PON cabinet site. This site includes both a PON cabinet and a splitter cabinet.

Fiber Drops. The local distribution fibers start at a PON cabinet site to reach every customer location. The Finley fiber design provides enough fiber for every passing, even if customers don't buy service.

The customer drop is typically a small-count fiber (two to six fibers). There are two primary methods to connect a drop to the network. First is fusion splicing, where the glass in the drop is melted and fused to the class on the network. The 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. Splice cases are installed everywhere in the network to provide future access for connecting customers – even in locations where there are homes or businesses that might not initially take service.

The other kind of drop is pre-connectorized. Drop cables of various lengths come with pre-installed connectors that are snapped into the network connection (much like connecting a cable to a TV or computer).

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, and which 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.

Originally the ONTs were only placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. There is now also an indoor ONT that is powered from an indoor outlet, much like the cable modems used by cable companies. The cost of the two kinds of units is nearly identical, so the assessment doesn't choose between the two types of units.

Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other ISPs prefer indoor units since they are protected from the weather. The industry is split on this choice, but it appears that internal units are becoming the most predominant choice for new construction. One major benefit of an indoor ONT is that the device is paired with an indoor WiFi router to provide good wireless connectivity within the home.

ONTs are available in multiple sizes that can fit to serve different-sized homes or business customers. The assessment assumes that the smallest unit will be used for most customers, including most small businesses. These units provide up to four Ethernet streams, which is sufficient for most customers.

Historically, many FTTP networks have been designed with battery backup for the ONT. However, most ISPs have stopped providing batteries. The batteries were historically installed to power telephones in the case of a power outage. Old copper phones received power from the line and could be used when the power was out. However, fiber wires carry no power, and an external battery is required to maintain phone service. In 2015 an FCC ruling declared that every voice provider must offer a battery backup solution for customers that buy telephone service that is not delivered on copper. That ruling said that fiber ISPs only have to make these units available and that customers could be charged the full cost of the unit.

Regardless of the type of ONT (indoor or outdoor), it will be necessary to drill through the side of the home to bring wiring. 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. Much of the wiring needed inside a premise is driven by trying to get wires to a cable TV settop box, but our models assume that ISPs won't be offering traditional cable TV.

The Fiber Design Methodology

The engineering estimate was made using a method we call sampling. This involves the following steps:

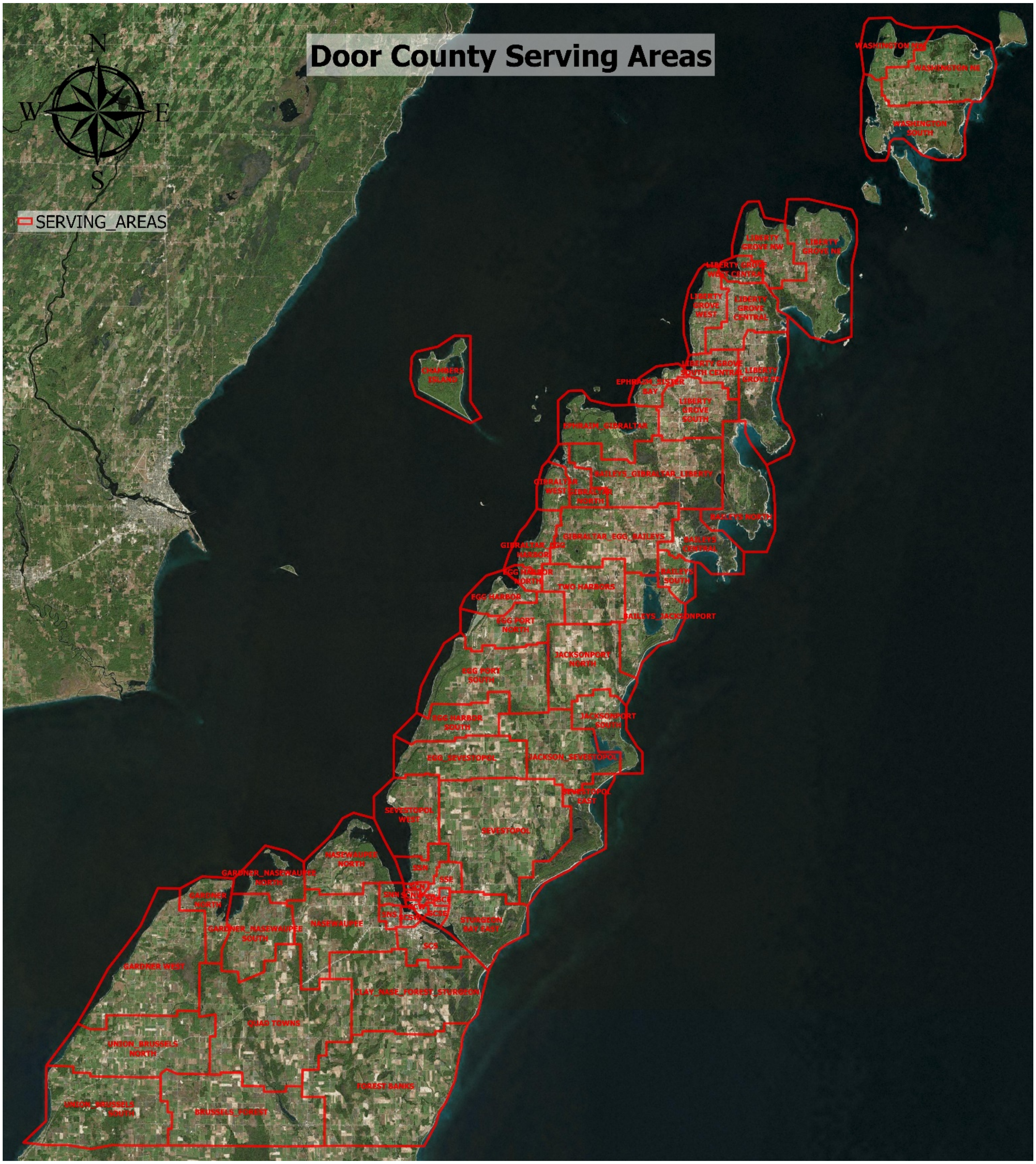
- Finley Engineering processed the GIS data for the county to determine the location of all potential customer locations and the locations of roads.
- We processed this raw information through an engineering program that helped us to determine the most logical neighborhood serving areas. A serving area in this case is a cluster of homes and businesses that might most logically be served from the same set of fibers and electronics. We segregated the county into 61 neighborhood clusters.
- A Finley engineer visited multiple locations in each of the neighborhood clusters to note local conditions such the amount of aerial versus buried utilities, the conditions or the poles, the soil conditions for burying fiber, and any other local information that might affect the cost of fiber construction. Finley did not visit Washington Island, but the electric cooperative there was able to describe the factors that affect the cost of fiber construction.
- Finley next analyzed the data and determined the best locations for ONT electronics hubs. Finley determined that the best configuration was to locate 25 ONT cabinets throughout the county.
- After analyzing the feedback from the field visit, Finley picked nine neighborhood sectors that most represented various characteristics such as the amount of aerial and buried fiber, the home density, etc. For these nine neighborhoods Finley did a complete network design down to the home.
- Next, Finley looked at all of the remaining neighborhoods and associated them with one of the nine hubs. For example, a neighborhood might be 60% like one of the sample hubs and 40% like a different one. This determination was made by using field notes and examining each neighborhood on Google maps.
- Next Finley conducted the full network design. This process began with each of the 25 ONT sites to determine the size the fiber needed to reach each neighborhood and along each street.
- As a last step, Finley applied pricing to the designed network. They talked to local and regional construction companies to understand the cost of fiber construction in the area. The pricing was then applied to the units (like feet of buried cable of a certain size) for each of the 61 sectors – and costs were then aggregated to get total costs.

We know from experience that this method of estimating costs is pretty accurate. By visiting multiple places in the county, we get a good feel for local conditions. For nine sectors the costs were calculated as if we were going to build these areas. By judiciously comparing each other sector to the nine sectors we know we've made a decent estimate of cost for each of the neighborhoods.

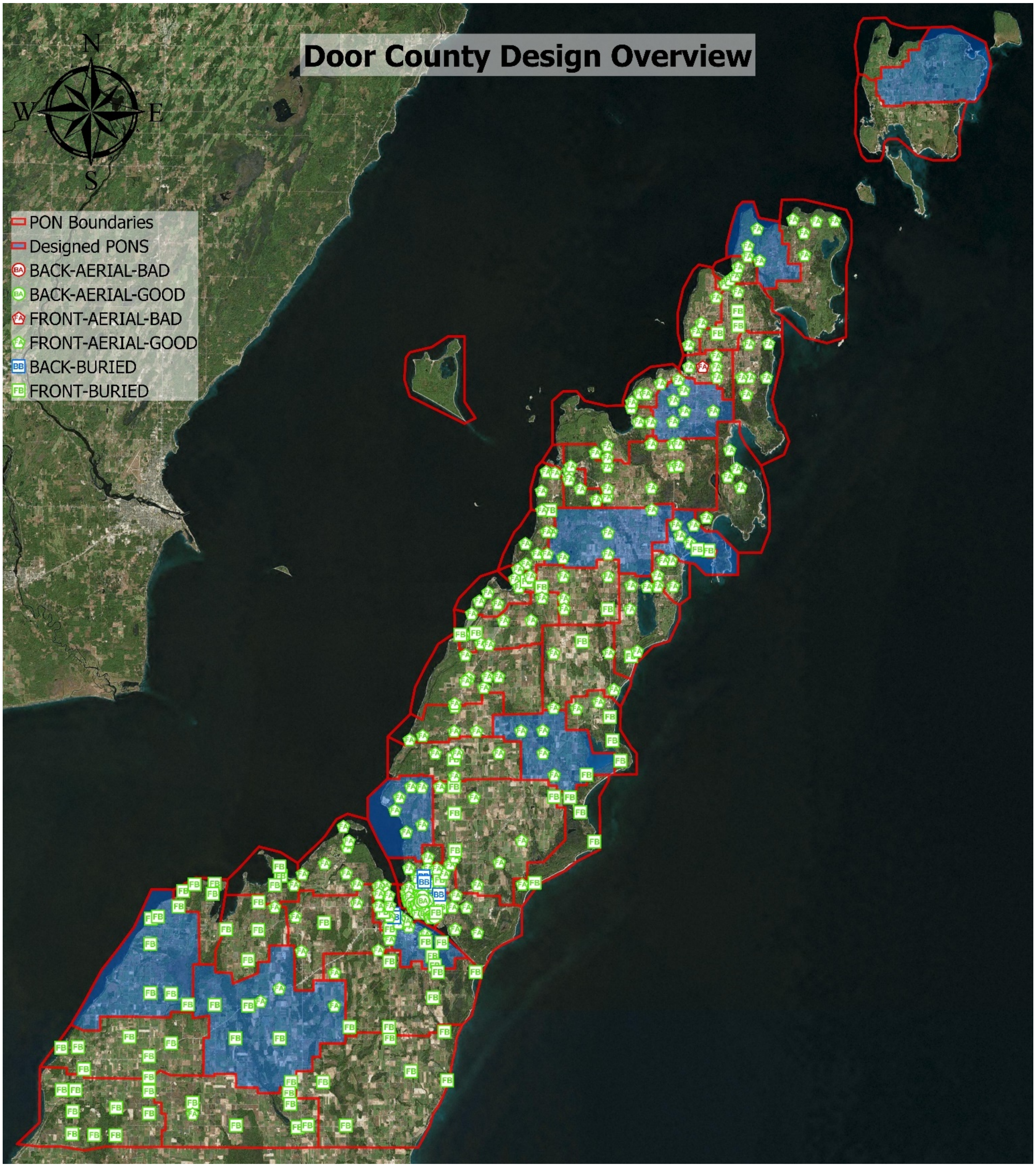
Examples of the Design Process

Following are three maps that demonstrate some of the most important steps in the design described above.

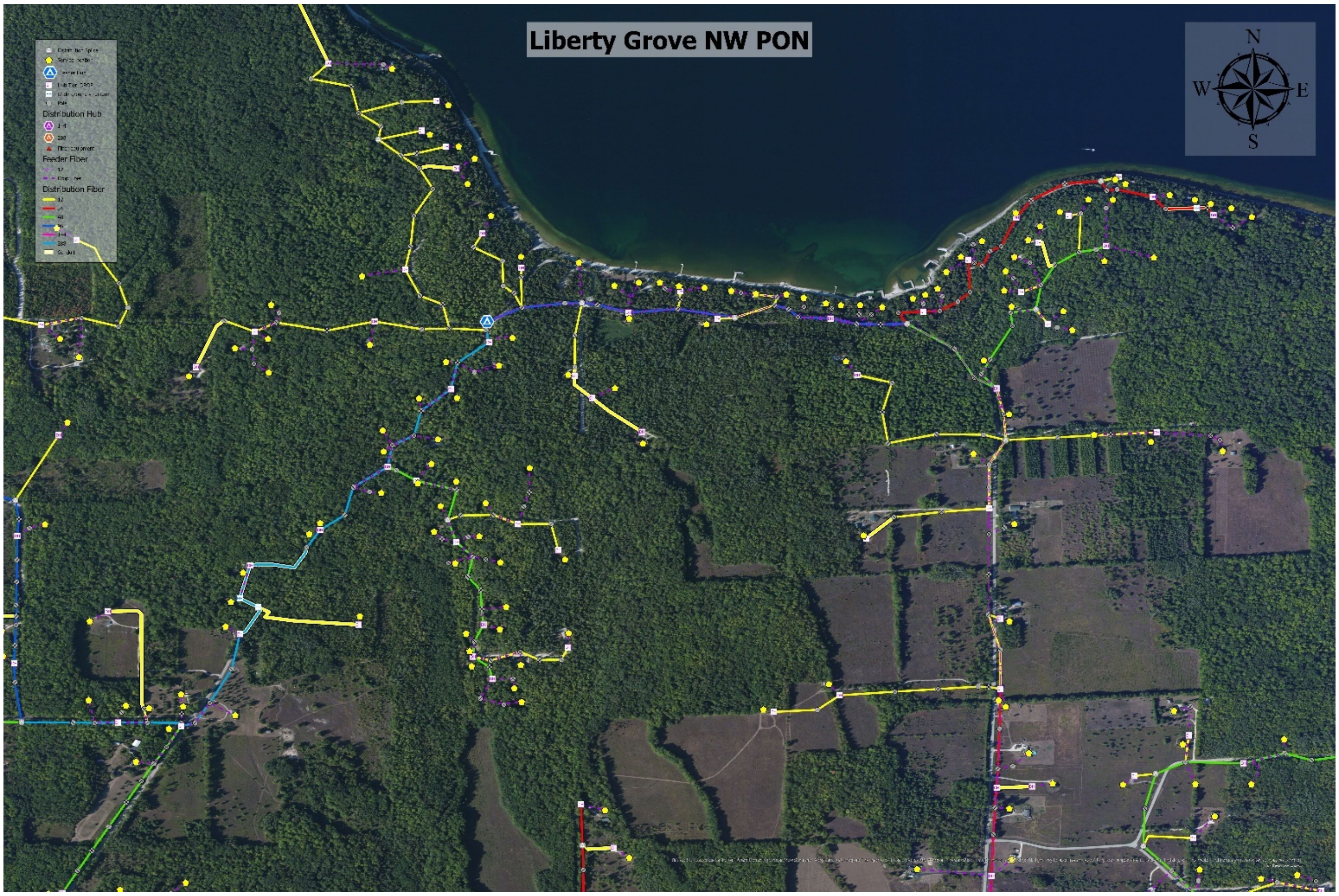
This first map shows the 61 neighborhood serving areas that were studied.



This map shows all of the places where a Finley Engineer visited to note local conditions that can affect construction costs.



This final map is an example of the detailed design undertaken in the none sample neighborhoods. This particular neighborhood is a rural area near to Liberty Grove. The yellow dots represent homes or businesses. The lines are fiber routes, with the different colors representing fibers of different sizes and also indicating aerial or buried construction.



Fiber Design Parameters

Following are a few more details of the factors that went into creating the fiber design. One of the key elements in our network design is understanding the number and the distribution of residential living units and businesses. The telecom industry uses the term passing to mean any home or business that is near enough to a network to be considered as a potential customer.

Finley Engineering primarily used the county's GIS records to understand the location of potential customers, the locations of roads, etc. Our engineering software plotted every passing into our design system, and this helped to determine the size of the fibers that were needed to serve any particular neighborhood.

We counted passings as follows in the county:

Passings	Rural	Total County
Residential	11,685	25,086
Business Customers	1,031	2,599
Total	12,716	27,685

The passings include:

- The first category consists of single-family homes, mobile homes, duplexes, and townhouses and apartment buildings with six or fewer living units. The assumption was made that in practice, each of the living units would get a separate fiber drop and a separate customer ONT.
- Larger apartments for the above count any residential building with more than six living units. See the fuller description below about serving MDUs (multi-dwelling units).
- Businesses. The passing data included a detailed listing of business locations – something we often don't get, and this category includes standalone businesses, churches, government buildings, schools, utility barns, and any other structure for which there might be a need for a fiber connection.

The Finley Engineering design provided enough fiber to serve every existing passing. We also considered the amount of capacity on the network needed for future growth. One of the primary reasons to use PON electronics is that it's relatively easy to expand the network for growth. Every fiber route in the network has been provided with extra fibers. A PON network only requires a few fibers to open up a new PON node, which could be expanded to serve huge numbers of new customers. The excess fiber in the network assigned for growth means that an ISP could respond to growth anywhere in the county.

The network design applied a 1.5 fiber factor, meaning there are 50% more fibers than what are needed to serve the existing buildings. This factor was used throughout the network, starting with the core hub out to the neighborhoods serving customers.

Finley utilized standard fiber cable sizes for the fiber network design; the fiber cable sizes used were 12, 24, 48, 72, 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. Standard-sized fiber is also generally priced more competitively.

Our design tries to determine the right-sized fiber cable for each route. One of the highest drivers of the cost of deploying fiber is the labor needed to splice fibers together, so our goal is to not limit the size of fibers when possible. Every splice in a network also adds a small amount of signal loss, so the ideal network is one that includes the least number of splices.

Connectivity to the Outside World. The only path for an ISP to reach the outside world is along the fiber routes headed to the south off of the peninsula. Luckily, there are enough existing ISPs that there should be multiple options for buying connectivity.

Summary of Fiber Construction

The assessment contemplated building fiber to every part of Door County where there are homes or businesses. Finley Engineering identified the following road miles of fiber required to bring fiber everywhere:

	Miles	Cost	Cost / Mile
Total County	1,574 miles	$99,571,592	$63,260
Rural Study Area	1,092 miles	$60,298,125	$55,218

This highlights that fiber construction is always more expensive, on a per mile basis, in towns compared to rural areas. There are numerous reasons for the higher costs. One of the primary reasons is that homes are more densely packed in cities and that means a lot more fiber access points and lot more fiber splicing. Buried construction is generally, but not always more expensive in cities due to issue of running fiber under paved streets and sidewalks, which increases the cost of returning streets to original condition after construction.

Electronics Parameters

All the network architecture, the design elements, and the electronic equipment used in this design have been used successfully by Finley Engineering in past projects. We note that Finley and CCG are both vendor-neutral and are not recommending any specific vendors for network components. The design doesn't refer to any specific brand of routers, switches, or FTTP electronics.

There are several key considerations when designing the electronics for a last-mile network. The electronics design is key because it can affect how the network is constructed.

- The first decision is to choose between active or passive fiber electronics, which was discussed earlier in the discussion above. The electronics in the design opted for passive electronics.
- Another important decision is whether to centralize or distribute the electronics in the network
- Another decision is the topology of the network deciding between a star versus a ring configuration.
- A final design consideration is to determine whether to use distributed splitter locations or local convergence points for splitter locations.
- A fiber design should also account for the need for future capacity.

Choice of Technology. As mentioned earlier, the design uses passive PON electronics. The advantages of this technology were discussed above. From a cost perspective, this technology made the most sense in the city because it decreases the size of the fiber bundles in each neighborhood. The electronics for a passive network are also less expensive since this is the primary technology used in the world to deliver residential fiber. In today's market, the cost of using active Ethernet adds at least 15% to the cost of the network electronics.

However, our design also allows for the use of active electronics, and every fiber route is designed with few extra fibers that could be used to bring a dedicated fiber signal up to 10 gigabits to a customer that wants larger bandwidth. Effectively, the network design incorporates the best of both fiber technologies.

One of the design decisions to make with a PON network is the number of customers to place on a single PON. The technology allows up to 64 customers to share a single feeder fiber. We elected to limit each neighborhood PON to 32 customers. The primary reason is to ensure that each customer can be provided with a gigabit broadband product, if desired. Even with GPON technology, there is enough bandwidth on a single PON (2.4 gigabits download) that there is almost always a gigabit of bandwidth available to any customer at a given second. This network design concept is referred to as oversubscription, which is described below.

Specific Design Parameters. Finley started the electronics design by dividing the county into 61 Passive Optical Network (PON) serving areas – each serving area having from 200 to 550 passings (430 average) in each serving area. This design concept is known in the industry as a distributed network, meaning that electronics are spread throughout the network rather than all being placed at a few centralized hubs. There were a few reasons we chose the distributed network:

- This makes sure that no customer is more than 12 miles away from a neighborhood hut. This distance limitation means 12-miles of fiber along a road, not a 12-mile circle.
- This design makes it easier to activate neighborhoods as the fiber is being built. Once a neighborhood ONT cabinet has been connected to the network core, an ISP could begin selling services in that area while the rest of the network is under construction.
- A distributed network also allows for more redundancy in case fiber is cut. This will be discussed more below.

The goal was to never use a fiber cable with more than 288 fibers since larger fibers add a lot of cost to the network. From a design perspective, the way to keep fiber sizes reasonably small is to utilize neighborhood splitter cabinets. As mentioned earlier, the fibers to reach customers begin at the splitters, so moving the splitters deeper into the neighborhoods means a lot smaller fiber bundle. Each of the PONs has one to four splitter cabinets. The design puts a few splitters inside the local ONT hut to serve customers located near the hut. But most splitters have been moved out deeper in the fiber network closer to customers.

Redundancy. When possible, a good network fiber design should include some consideration for fiber route redundancy. We built local redundancy into the network using a method we've come to like. Each PON hub (that contains the OLT) is connected to the two nearest adjacent PON cabinets. This allows for the reestablishment of service quicker in the case of a major local fiber cut. This configuration is probably best described as a mesh network.

Fiber cuts are inevitable, so the money spent on redundancy pays dividends in the long run. Adding redundancy adds costs because this configuration requires additional electronics for huts to connect to neighbors.

Multi-Dwelling Units (MDUs)

Door County has some residential buildings that have multiple tenants. In the telecom industry, we refer to these buildings as MDUs – this could be anything from duplexes through large apartment buildings, condominiums, and townhouses. The cost can vary to build to some MDUs:

- Most ISPs treat smaller MDUs the same as single-family residential buildings. For example, an ISP is likely to build to drops and use two ONTs to serve a duplex because it would typically treat each resident in a duplex as a separate customer. ISPs differ, but many ISPs use this same strategy for any building with 4, 6, or 8 units. From a cost perspective, our assessment treats each unit in such buildings as if each unit is a separate passing.

- Cost can vary to serve larger MDUs. There are always a few MDUs in every market that are costly to serve, as will be explained below. But for the most part, the cost to serve the residents in most MDUs is in the same ballpark as the cost to serve individual homes. There will be a saving on fiber drops for a larger MDU since one fiber drop can serve the whole building. But this savings is generally then offset for the cost of running fiber inside or outside the building to reach the individual units. The electronics cost per unit for most MDUs is similar to the cost for single-family homes.
- One exception to this is a huge high-rise MDU that contains hundreds of units, like is found in large cities. The cost for serving really large MDUs is specific to the building – some cost less per unit than serving sing-family homes, and some cost a lot more, all depending upon the specific issues of the building.
- Because of modern wiring techniques, the cost of getting fiber to individual apartments is rarely an issue. There will invariably be some older apartment buildings that cost extra to serve for some reason, such as having solid concrete slabs between floors that make it hard to run fiber. But ISPs have gotten adept at finding ways to bring fiber inside most apartment buildings.

Our analysis assumes that the average cost to add an MDU unit to the network is the same as adding a single-family home. We've found that in most markets that this is a reasonable assumption.

We identified twenty-one MDU complexes in the county, most located in Sturgeon Bay.

Aside from the cost issue, there are other roadblocks for being an ISP for MDUs, and any ISP that builds fiber will find out that there will be some apartments they are unable to serve. Following is a brief discussion of the primary kinds of roadblocks that we see when trying to bring fiber everywhere:

<u>Exclusive Arrangements</u>. In 2007 the FCC put some restrictions on cable companies and other ISPs from entering into certain kinds of exclusive arrangements with property owners. At the time, the FCC learned that cable companies were signing devious contracts with landlords that gave the cable company exclusive rights for keeping out other competitors. Landlords were signing contracts that gave the cable company a perpetual, exclusive right to the building. The FCC largely forbade the most egregious practices where ISPs forced exclusivity. However, the FCC did not ban all such practices. For example, exclusive arrangements are still possible when prompted by the property owner, and under FCC rules and various court rulings, property owners are not required to allow access by ISPs to their building. It's likely that there are existing exclusive arrangements with ISPs in the city that would not allow a new fiber network owner into the building.

<u>Financial Roadblocks</u>**.** Property owners often create financial roadblocks for a new ISP:

<u>High Access Fees</u>. Property owners can charge a significant fee to an ISP to gain access to their buildings. This could include excessive fees to connect facilities into basements or rooftops. Alternatively, they might charge high rent to use communications spaces.

Forced Revenue Sharing. Property owners might demand that any ISP entering their building must share customer revenue with them. This is of particular concern for a municipal provider because in many states, a city could not enter into this kind of arrangement. CCG has numerous municipal clients that could not find a way to pay commissions in the same manner as is done by commercial ISPs.

Only Partial Services Allowed. Sometimes the property owners include some basic level of telecommunications service in the rent. For example, they might already include a video package that they receive from satellite and distribute to apartment units. Such arrangements might be a financial roadblock if they make it hard for ISPs to profitably provide other services to tenants.

Ownership of Existing Communications Infrastructure. Property owners don't always own the existing telecom infrastructure in a building. Sometimes such infrastructure was installed by the cable company or other ISP, and those entities maintain ownership through a contractual arrangement with the property owner. There are several categories of assets where ownership by somebody other than the property owner can be a roadblock.

Existing Wiring. A cable company, telephone company, ISP, or CLEC might own the existing telephone copper, coaxial cable, category 5 cables, or fiber. Private owners don't have to make their facilities available to anybody else. In some cases, businesses within multi-tenant buildings own their own wiring inside their rented space, but that is rarely a roadblock for the business owner to choose to change service providers.

Normally a fiber overbuilder is not going to want to use the existing wiring if they want to offer gigabit speeds. However, there are times when that might be desirable. For example, some fiber buildings have elected to use G.Fast delivered on the existing telephone wires to deliver broadband with speeds up to 300–400 Mbps. This can be a lot cheaper than rewiring some older buildings. But the telephone company might claim ownership of the copper wires.

Existing Conduit. An existing ISP may have installed conduits or ducts within a building and won't allow access to other ISPs. This could be a conduit between floors of a building (referred to as riser infrastructure), conduits between different buildings in a campus environment, or conduits distributing cables along hallways and other pathways.

Other Existing Infrastructure. An existing ISP might own other key telecommunications infrastructure. This might include communications cabinets or boxes that tie into existing power and wiring. It might mean they own the racks that take up all of the existing space in a telecommunications closet. Alternatively, it could mean towers or other rooftop infrastructure.

Entrance Facilities. Larger buildings will often have an existing entrance facility of some sort used to provide access to all utilities from the street into the building. This could be owned by the property owner or owned by one or more of the existing utilities, including non-telco utilities such as the electric or water utility. It's sometimes an issue to gain access to these entrance facilities. For example, an electric utility might be leery of allowing more than one ISP into their existing facility due to perceived safety or risk issues.

Owner Requirements. Property owners often have other restrictions that make it difficult to enter and wire buildings.

Buried Utilities. Property owners might not allow any outdoor wires above ground. This would mean that drops and connections between buildings must be buried. In many cases, that would mean boring connections under driveways and parking lots—which is not always a safe process since the locations of other utilities are not always well known or marked on private property. The expected industry requirements for utilities using public rights-of-way may not be followed on private property. For example, buried conduit and fiber in public rights-of-way generally require some use of a technology that allows the infrastructure to be detected by anybody trying to locate existing technology. However, infrastructure without such marking technology would be invisible to a locator.

Aesthetic Issues. Probably one of the biggest roadblocks encountered when wiring MDUs is the aesthetic requirements of the property owner. For example, one of the more common techniques for adding new fiber in hallways is to place the wiring in the corners of the ceiling and cover it with some kind of protective strip. Sometimes the only path to reach units might be to string wires in some manner on the outside of the building. If a property owner won't allow the use of these techniques for aesthetic purposes, then it either means the building can't be wired with fiber, or it can be wired only at a much higher cost than expected.

Boxes on the Outside of Buildings. Property owners might not allow boxes, cabinets, or other equipment terminals to be attached to the outside of buildings or even to rooftops.

Access Issues. Another impediment encountered by ISPs is one of access, or the ability to undertake the steps needed to best serve tenants. This includes:

Type of Building Construction. There have been numerous construction techniques used over the years in building MDUs, and some of the methods used in older buildings can add significant cost to serving the buildings. For example, older buildings might have plaster and lath walls between units and for ceilings that can add cost or make it impossible to drill holes for new wires. Some old buildings have solid concrete slabs between floors through which the property owner might not allow drilling of new holes.

Access to Communications Space. ISPs generally need a space within a multi-tenant building to place hub electronics needed to serve the building. Such equipment is most commonly placed in a space reserved for telecommunications equipment that might be in a small room or closet. Problems can arise when the existing communications space is full and there isn't room for a new ISP.

Access to Power. ISPs need access to power. This can be a problem if a new ISP can't get a separate electric meter.

24/7 Building Access. Property owners often make it a challenge for an ISP to gain access to their equipment.

Access to Apartment Units. Property owners sometimes create roadblocks making it hard for ISPs to install or repair facilities inside of apartments. Some property owners only allow access when accompanied by an MDU employee. Landlords might also charge a fee to the ISP for every visit. More commonly, there can be costly delays when there is nobody available to accompany a technician.

Restrictions on Sales and Marketing. It's fairly routine that ISPs are not allowed to sell or market inside MDUs in the same manner that is done for single-family homes. For example, there might be no-solicitation rules in MDUs that don't allow for door-knocking sales campaigns.

Security Issues. ISPs want their equipment to be kept safe from the public and from other ISPs. This means providing secure space. Ideally, that means being able to put a cage or lockable box around gear in space used by multiple service providers. Sometimes this is not possible to do because of space or other limitations.

Administrative Requirements. Landlords often have specific legal or other issues they expect ISPs to follow:

Surety. Property owners may require ISPs to be bonded or to have a set level of insurance. This kind of bonding or insurance is not something that many ISPs are able or willing to obtain, making it a challenge to satisfy such requirements.

Contracts Required. Property owners may require ISPs to agree to a standard contract before entering a building. This can be a problem because there are often legal terms in standard commercial contracts that municipalities meet.

Dispute Resolution. Property owners might want an ISP to agree to arbitration or some other way to solve disputes that might be a problem for a municipality.

It's important to understand these various roadblocks because almost any item on this list could add to the complexity and cost of bringing fiber to an apartment building. For example, there might be a willing MDU owner that wants fiber, but then once they realize that adding the fiber will violate their aesthetic requirements, it may turn out that it's too costly to get fiber to the building. CCG has clients who have heard things like, "I'd love to have fiber in the building, but I don't want any of my tenants to see the wires or electronics used to get it to their unit."

However, sometimes it's small issues that might make it impossible to serve a given building. For example, it can be impossible to serve a building if the overbuilder doesn't have a secure location to place core electronics or doesn't have access to building entrance facilities.

Most ISPs that serve MDUs have a detailed checklist listing the specifics of the above issues. An ISP will generally walk through the MDU and determine the best wiring plan and then go over the checklist with the MDU owner. It's not uncommon to find one or more issues that are a roadblock to implementation. Sometimes roadblocks can be overcome by the ISP spending more money to solve the issue. It's also the case that sometimes the roadblocks cannot be overcome.

C. Competing Technologies

Existing Technologies

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

- AT&T, CenturyLink, and Frontier serve Door County with copper telephone wires using DSL technology.
- Charter/Spectrum uses Hybrid Fiber Coaxial (HFC) technology.
- There are several wireless ISPs (WISPs) that are delivering broadband using point-to-multipoint fixed wireless technology.
- Some rural homes buy broadband from satellites.
- Some rural homes get broadband using the data on their cellphone plans.
- There is a small amount of Metro Ethernet used to bring fiber directly to large businesses, schools, cell towers, etc.

Technology is Improving

I recently reviewed all of these technologies and realized that every technology in use for broadband is better now than three years. We don't spend enough time talking about how the vendors in this industry keep improving technology.

Consider fiber. We recently have been recommending that new fiber builders consider XGS-PON. While this technology was around three years, ago it was originally too expensive and cutting edge to consider for most ISPs. But AT&T and Vodaphone have built enough of the technology that the prices for the hardware have dropped to be comparable to the commonly used GPON technology. This means we now need to start talking about FTTP as a 10-gigabit technology – a huge increase in capacity that blows away every other technology.

There have been big improvements in fixed wireless technology. Some of this improvement is due to the FCC getting serious about providing more broadband for rural fixed wireless. During the last three years, the agency has approved CBRS spectrum and white space spectrum that is now being routinely used in rural deployments. The FCC also recently approved the use of 6 GHz WiFi spectrum that will add even more horsepower. But there have also been big improvements in the radios. One of the improvements that isn't mentioned much is new algorithms that speed up the wireless switching function. Three years ago, we talked about fixed wireless speeds of 25 Mbps to 50 Mbps, and now we're talking about speeds over 100 Mbps in ideal conditions.

Cellular data speeds have gotten much better across the country as the cellular carriers have introduced additional bands of spectrum. The national average cellular speeds are now double to triple the speeds of just a few years ago.

Three years ago, the low-orbit satellites from Starlink were just hype. Starlink now has over 1,600 satellites in orbit and is in beta test mode. Customers are reporting speeds from 50 Mbps to 150 Mbps. We also see serious progress from One Web and Jeff Bezos's Project Kuiper, so this industry segment is on the way to finally being a reality. There is still a lot of hype, but that will diminish when homes can finally buy satellite broadband.

Three years ago, Verizon was in the early testing stage of the fiber-to-the-curb product it calls Verizon Home. After an early beta test and a pause to improve the product, Verizon is now talking about offering broadband to 25 million homes with this technology by 2025. This product uses mostly millimeter-wave spectrum to get from the curb to homes. For now, the speeds are reported to be about 300 Mbps, but Verizon says this will get faster.

We've also seen big progress with millimeter-wave mesh networks. Siklu has a wireless product that they advertise as an ideal way to bring gigabit speeds to a small shopping district. The technology delivers a gigabit connection to a few customers, and the broadband is then bounced from those locations to others.

Cable company technology has also improved over the last three years. During that time, a lot of urban areas saw the upgrade to DOCSIS 3.1 with download speeds of up to a gigabit. CableLabs also recently announced DOCSIS 4.0, which will allow for symmetrical gigabit plus speeds, but which won't be available for 3-5 years. The download networks for both Sparklight and Mediacom are at the latest DOCSIS 3.1 technology, but it looks like both companies did not upgrade the upload data link.

While you never hear much about it, DSL technology over copper has 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.

Interestingly, the product that got the most hype during the last three years is 5G. If you believe the advertising, 5G is now everywhere. There is no actual 5G yet in the market yet, and this continues to be marketing hype. The cellular carriers have improved their networks by overlaying additional spectrum, but we're still not going to see 5G improvements for another 3-5 years.

<u>DSL over Copper Wires</u>

AT&T, CenturyLink, and Frontier provide broadband using DSL (Digital Subscriber Line). It's worth noting that AT&T stopped selling new customers using this technology in October 2020. DSL is used to provide a broadband path over telephone copper wire. These networks were mostly built between the 1950s and early 1970s. The copper networks were originally expected to have an economic life of perhaps 40 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. Maybe even more importantly, the copper networks have deteriorated due to neglect. The big telcos started to cut back on the maintenance of copper in the 1980s as the companies were deregulated from some of their historical obligations. At some point, the copper networks will die, and AT&T's decision to stop selling on the network is a good sign that it is starting to plan for the end of copper.

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 Door 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 of the 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. The newer the copper and the larger the gauge of the copper wires, the better the signal and the greater the bandwidth. Many of the copper wires in the city are likely to be 50 to 70 years old and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Charter/Spectrum is the incumbent cable company in parts of the county. The technology it uses is referred to as 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 cable 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 the networks are aging, and most of the coaxial networks were likely 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 it becomes harder to transmit the signals through the wires.

An HFC system delivers customer services 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 are not generally transmitted more than about 2.5 miles over a coaxial network from a network node. This limitation is based mainly on the number of amplifiers needed on a single coax distribution route. Amplifiers are needed to boost the signal strength for coaxial distribution over a few thousand feet. Modern cable companies try to limit the number of amplifiers on a coaxial route to five or less since adding amplifiers generally 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—the fewer the customers, the stronger and more reliable the 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 data pipe for a given neighborhood. The architecture of using neighborhood nodes is what has given cable companies the reputation that data speeds slow down during peak usage times, like evenings. However, if nodes are made small enough, then this slowdown doesn't have to occur.

The amount of bandwidth available to deliver Internet access that is available at a given node is a function of how many "channels" 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, the cable company 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) that was created by CableLabs. Most of the large cable companies upgraded about a decade ago to the DOCSIS 3.0 standard that allows them to bond together enough channels to create broadband speeds as fast as about 250 Mbps download. By now, most big cable companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically could 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 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 generally 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 1/8 to upload. Earlier in the report was a lengthy discussion about the upgrade speed crisis that has become apparent during the pandemic. The cable companies are likely hoping that issue will diminish in importance at the end of the pandemic because upgrades to provide more upload speeds are expensive.

One of the interesting parameters of a cable network is the use of radio frequencies to transmit data, meaning a cable network is essentially a captive radio network kept inside of the 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 bandwidth 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, so it's laid dormant. This 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 to data upload. DOCSIS 4.0 is going to offer an even wider range of upload speeds, as high as 684 MHz of spectrum.

Almost no cable companies have made the upgrade of upload bandwidth using the mid-split option. Doing so could significantly increase upload speeds. But this upgrade is expensive. Rearranging how the bandwidth is used inside of a cable network means replacing many of the key components of the network, including neighborhood nodes, amplifiers, and power taps. It could mean replacing all cable modems.

CableLabs has developed the 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. Comcast just did a test of the technology and achieved a symmetrical 4 Gbps signal. Don't expect this to mean that cable companies will be offering fast symmetrical broadband any time soon. There is a long way to go from the first lab test to a product deployed in the field. Lab scientists will first work on perfecting the DOCSIS 4.0 chip based upon whatever they found during the trial. It typically takes most of a year to create a new chip, and it would be surprising for Comcast to spend several years and a few iterations to solidify the chip design. Assuming Comcast or some cable company is ready to buy a significant quantity of the new chips, it would be put into the product design cycle at a manufacturer to be integrated into the CMTS core and into home cable modems.

That's the point when cable companies will face to tough choice of pursuing the new standard. When the new technology was announced in 2020, most of the CTOs of the big cable companies were quoted as saying that they didn't see the implementation of the new standard for at least a decade. This is understandable in that the cable companies recently made the expensive upgrade to DOCSIS 3.1.

An upgrade to DOCSIS 4.0 isn't going to be cheap. It first means replacing all existing electronics in a rip-and-replace upgrade. That includes cable modems at every customer premise. DOCSIS 4.0 will require network capacity to be increased to at least 1.2 GHz. This likely means replacement of power taps and network amplifiers throughout the outside plant network.

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 undertaking another costly upgrade on an aging copper network?

Satellite Broadband.

There are two satellite technologies in use today. There are currently two satellite providers using geostationary satellites (GEO) – Viasat (which was formerly marketed as Exede or Wildblue) and HughesNet. For both, the availability depends upon 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. These satellites are parked at over 22,000 miles above the earth, and when an Internet connection must travel to and from a satellite, there is a noticeable delay; that delay makes it hard or impossible to do real-time transactions on the web. Current satellite latency can be as high as 900 milliseconds. Any latency above 100 milliseconds creates problems with real-time applications such as streaming video, voice-over-IP, gaming, online education, or making connections to corporate WANs (for working at home). When the latency gets too high, such services won't work at all. 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.

The newest satellite option is low earth orbit (LEO) technology that uses satellites that orbit between 200 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 will have a latency of between 25 and 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, which has been reported as high as 900 milliseconds. The low-orbit satellites should be able to easily support real-time applications like VoIP, video streaming, live Internet connections like Skype, or distance learning.

One of the most interesting aspects of the technology is that a given satellite passes through the horizon for a given customer in about 90 minutes. This means that there must be a large fleet of satellites so that there is always one in the sky over a given customer.

There has been a lot of recent news concerning the three primary companies that are vying in the market. Starlink and SpaceX are all over the news. Starlink has been in beta test mode since last year. Starlink has begun taking $99 deposits from prospective customers and quickly picked up 500,000 people on a waiting list. There is no guarantee that any customer will be able to receive service. Starlink now has over 1,600 satellites in orbit and says it will begin offering regular service by the end of 2021. Starlink claims it will eventually launch 30,000 satellites, with over 11,000 in the first constellation.

Starlink download speeds in beta tests have been between 50 Mbps and 150 Mbps – a great upgrade for customers using rural DSL or fixed wireless broadband. Elon Musk says that by next year that broadband speeds will approach 300 Mbps, something that is doubted by a number of industry engineers who question the ability of the constellation to handle a significant number of customers.

Starlink also won a recent regulatory battle at the FCC that allows for some satellites to be inserted into lower orbits, which allows for a lower elevation angle to reach customer receivers that ought to boost speeds a bit. But Starlink faces another upcoming battle over the spectrum that is used by the satellite fleet to backhaul traffic to and from the earth. The battle is over the spectrum between 12.2 – 12.7 GHz, which is primarily owned by Dish Networks. Dish wants to use this spectrum for terrestrial 5G, and this would greatly curtail Starlink's backhaul capabilities. A recent FCC ruling warned Starlink that it might not get access to the spectrum.

Next is Jeff Bezos's Project Kuiper, which is still likely to get a brand name at some point, perhaps something as simple as Amazon Broadband. The company has contracted with United Launch Alliance, a joint Boeing-Lockheed Martin venture, to launch the first nine broadband satellite launches. It's been speculated that these launches will carry around 500 satellites into orbit – including the company's first test satellites. There have been no announced dates for the nine launches, but speculation is that launches will start this year.

Project Kuiper has plans to launch 3,236 satellites, and the company says it will need 578 satellites to begin offering limited service. The company reached an agreement with the FCC to launch half of the total satellites before 2026, although it appears the company intends to get to that number sooner.

Project Kuiper is taking a different strategy than Starlink and is launching larger, more capable satellites rather than swarms of cheaper disposable satellites. It will be interesting to see what this difference means in terms of customer coverage and bandwidth. The company has already been funded with $10 billion from Jeff Bezos, and it seems likely that the company will eventually do what's been announced.

The third major player, OneWeb, is also back in the news. Eutelsat, one of the world's largest operators of satellites, has made an investment and taken a 24% stake in the company. This adds to the existing ownership by the U.K. government and Bharti Global, a large cellular carrier in India.

OneWeb is taking a third path and plans to launch a 648-satellite fleet with larger satellites that are basically floating data centers. The company recently launched 36 satellites, bringing it to a total of 182 satellites in orbit. The company says it will be able to start serving the U.K., Alaska, northern Europe, Greenland, Iceland, and northern Canada after two more launches and plans to be able to serve the whole planet by the end of 2022. It's no longer clear after the change of ownership if the company will support residential broadband or will pursue connectivity for larger users like cellular towers and corporate users.

There has been a huge amount of hype about satellite broadband, particularly from Elon Musk. Within a year or two, a lot of the hype concerning LEO satellite broadband will be behind us as we start seeing commercial satellite fleets in operation. Of particular interest to those watching this industry will be if Starlink can achieve the broadband speeds being touted once the network is under full customer load. By the looks of the applications pouring into the company, that's not going to take long.

Mobile Broadband

There are two ways that cellular technology is being used for broadband in the county today.

First, some customers are using their cellphones as the only source of broadband and are not buying a home landline broadband connection. Today's cellular networks use a technology called 4G LTE. While the cellular companies have been advertising 4G for a decade, the first fully compliant 4G cell site was launched in late 2018.

There is a gigantic difference between cellular broadband speeds in major cities and speeds in places like Door County. Consider the two sets of numbers below. The first column of numbers is the nationwide average speeds broadband speeds for each of the cellular carriers in the U.S. as measured by reviews.org at the end of 2020. The second set of numbers is from sample speeds measured by *PC Magazine* in 26 major cities during the summer of 2020.

	Nationwide Average		26 Major Cities	
	Download	Upload	Download	Upload
AT&T	28.9 Mbps	9.4 Mbps	103.1 Mbps	19.3 Mbps
T-Mobile	32.7 Mbps	12.9 Mbps	74.0 Mbps	25.8 Mbps

Verizon	32.2 Mbps	10.0 Mbps	105.1 Mbps	21.6 Mbps

Cellular data speeds are faster in cities for several reasons. First, there are more cell sites in cities. The speed a customer receives on cellular is largely a function of how far the customer is from a cell site. In cities, most customers are within a mile of the closest cellular tower. Rural customers can easily be miles from the nearest tower. Next, the cellular carriers have introduced additional bands of spectrum in urban areas that are not available outside cities. The biggest boost to the AT&T and Verizon speeds in the large cities comes from the deployment of millimeter-wave cellular hotspots in small areas of the downtowns in big cities. It's likely that cellular data speeds in Door County are a lot closer to the national averages than the large city averages.

The survey showed that there are rural homes in Door County using their cellphone data plans for home Internet access. Since cellphone data plans have small monthly, anybody using a cellphone for home broadband is by definition, a light broadband user. These customers may spend parts of much of their day outside at home where they can use the WiFi on the cellphone to connect.

In both the surveys and in the Wisconsin speed tests, we see customers in the county who are buying mobile broadband for home usage. This technology uses the same frequencies that are used by cell phones. For the last few years, the cellular companies have marketed these plans as cellular hot spots. This mostly just means providing a larger data cap than for cellphones. However, the data caps are still relatively small compared to landline broadband.

We are starting to see the cellular carriers deploying a new generation of home cellular products. These plans tend to use the new frequencies that have been deployed in recent years to offer both faster broadband speeds and larger data caps. These newer plans may or may not have made it yet to Door County, although AT&T, Verizon, and T-Mobile all claim that they plan to offer this to most households in the country. It's worth noting that T-Mobile does not have facilities in the county today. There are also mobile broadband in the county provided by Cellcom, and U.S. Cellular.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in Door County to deliver fiber today to locations like schools, cell towers, and some businesses. This technology is often also referred to as active Ethernet.

Metro Ethernet technology generally uses lasers that can deliver speeds between 1 gigabit and 10 gigabits, although lasers as fast as 300 Gbps are available. ISPs can choke these speeds to slower levels based upon what a customer is willing to pay for.

Many ISPs dedicate a fiber for each metro Ethernet customer, but that's not mandatory. For example, an ISP could light a fiber to deliver 10 Mbps and string that fiber to multiple customers, each buying 1 Mbps service.

Future Technologies

This section looks at new broadband technologies that are likely coming within the next years to the U.S.

5G Cellular Technology

Anybody who watches TV knows that the cellular carriers are in full 5G marketing mode. If you believe the TV commercials, you'd now think that the country is blanketed by 5G, as each cellular carrier claims a bigger coverage area than their competitors. However, almost all of their claims are marketing hype.

Right now, in 2021 there are no cellular deployments that can be legitimately called 5G. Full 5G will not arrive until the carriers have implemented the bulk of the new features described in the 5G specifications. For now, none of the key features of 5G have been developed and introduced into the market. 5G deployment will come in stages as each of the 5G features reaches markets – the same thing that happened to 4G. For now, all the major 5G improvements are still under development in the labs.

We know from the IEEE forums that most 5G features are 2 - 4 years away. The same thing happened with 4G, and it took most of a decade to see 4G fully implemented – in fact, the first U.S. cell site fully meeting the 4G standards was not activated until late 2018. Over time we'll see new 5G features implemented as they are released from labs to field. Each new feature will only be available to those that have phones that can use the feature, so there will be an additional 2- to 3-year lag until there are enough phones in the market capable of using 5G features.

Most of what is being called 5G today refers to the introduction of new bands of spectrum. New spectrum does not equal 5G – the 5G experience only comes with 5G features. Older cellphones cannot receive the new spectrum bands, and so the carriers have furiously been selling new phones that can receive the new spectrum and labeling this effort as 5G.

Even when 5G is fully implemented, the cellular data speeds are not going to be blazingly fast. The 5G specification calls for 5G cellular speeds of about 100 Mbps – which was also the specification for 4G, but never realized.

5G is likely not coming to rural America for a long time. 5G is an urban technology in that it has been created as a way to greatly expand the capability of a single cell site. For instance, when fully implemented, a 5G cell site might be able to handle 100,000 simultaneous calls and data connections – far more than what 4G cell sites can handle. The cellular carriers need these expanded capabilities because it's become popular to use smartphone data. Rural cell sites will never be under the same kind of stress as urban ones due to fewer customers trying to use a given cell site, so there will be no urgency to upgrade rural sites to 5G. Even when true 5G features come to rural cell sites, it's not going to make much difference since rural cell sites are far apart, and the cool bells and whistles with 5G involve having smaller cell sites close together that can share a connection to a single phone.

5G Hot Spots

Last year there were commercials on TV showing cellphone speeds of over a gigabit. This was not 5G. The fast speeds come from a phone equipped to use a new frequency band called millimeter-wave spectrum. This is an ultra-high frequency and is 10-30 times faster than traditional cellular frequencies.

The most accurate way to think about this new technology is as a 5G hot spot, similar to a hot spot that might be found in a coffee shop, only mounted outdoors on a pole. The signal only travels a short distance, mostly under 1,000 feet from a transmitter. It needs line-of-sight and can be easily blocked by any impediment in the environment. The signal won't pass from outdoor transmitters into buildings. This technology only makes sense where there are a lot of people, such as downtown urban corridors, stadiums, and business hotels.

There is a lot of speculation in the industry that this is a novelty product being deployed to convince the public that 5G will be blazingly fast everywhere. The cellular carriers seem desperate to deploy something they can call 5G, and super-fast cellphones are a clever way to get headlines. However, it's extremely unlikely that any carrier is going to invest in cell sites that close together outside of major downtown business districts. This technology is likely to never reach to residential neighborhoods in cities, suburbs, small towns, or rural America. A lot of industry experts are asking why anybody needs gigabit broadband for cell phone, especially since this technology only works outdoors.

Millimeter-Wave Point-to-Multipoint Broadband

Another new technology that got a lot of press in the last few years is 5G point-to-multipoint radios using millimeter wave spectrum. Verizon built this technology in a few neighborhoods in Sacramento and a few other cities in 2018. Verizon took a break after the initial tests and started deploying the technology again in 2020 in a few markets like Detroit. The technology consists of deploying small cell sites on telephone or power poles and then beaming broadband to a small receiver attached to homes or attached to the inside of a window. To get fast broadband, this network requires building fiber to feed the small cell sites. Verizon achieved speeds in the trials of 300 Mbps – with a hope over time that they can get speeds up to a gigabit.

This technology has historically been referred to as fiber-to-the-curb (FTTC). The technology requires building fiber close to every potential customer and then using wireless to bring the broadband into each customer's premise.

Millimeter-wave spectrum is at extremely high frequencies of 24 GHz and higher. The only other common use of this spectrum has been in the full-body scanners at airports. The primary operating characteristic of millimeter-wave spectrum is that the signal doesn't travel far. Most engineers set the realistic top distance of this technology at about 1,000 feet from a wireless transmitter – and probably less is field deployment.

The biggest impediment to the business plan is that it requires building fiber along each street served, making this at least as costly as building fiber-to-the-home. The cost of putting fiber on poles can be expensive if there are already a lot of other wires on the poles (from the electric, cable, and telephone companies). In neighborhoods where other utilities are underground, the cost of constructing fiber can be even higher. Another challenge for the technology is that the millimeter-wave spectrum requires a clear path between the transmitter and a dish placed on the home – and that means that 5G is best deployed on straight streets without curves, hills, or dense tree cover.

The technology will only make financial sense in some circumstances. This means neighborhoods without a lot of impediments like hills, curvy roads, heavy foliage, or other impediments that would restrict the performance of the wireless network. It also means avoiding neighborhoods where the poles are short or don't have enough room to add a new fiber. It means avoiding neighborhoods where the utilities are already buried. An ideal 5G neighborhood is also going to have significant housing density, with houses relatively close together without a lot of empty lots.

This technology is not suited to downtown areas with high-rises; there are better wireless technologies for delivering a large data connection to a single building, such as the point-to-point microwave radios used by Webpass. This also makes no sense where the housing density is too low, such as suburbs with large lots. This technology is definitely not a solution for rural areas where homes and farms are too far apart.

Verizon recently announced that millimeter-wave fiber-to-the-curb will the primary strategy for expanding residential broadband. The company plans to pass 25 million homes with the technology by the end of 2025. Analysts expect all of those homes to be in major cities and surrounding suburbs and will not likely be extended to places like Door County.

III. Financial Projections

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. The business plans created are detailed and contemplate all aspects of operating a broadband business. The business plan assumptions represent our best estimate of the operating characteristics for such a business. As a firm, CCG consults for hundreds of communications entities that provide rural broadband. 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.

The primary goal of the business models is to look at the various scenarios from the perspective of an ISP that would operate the business. The purpose of these models is to provide a way for ISPs to understand the broadband opportunities in Door County. We've learned with experience that almost every ISP is theoretically interested in expanding. However, no ISP is really interested until they understand the numbers. Only then can they decide if the opportunity is something they can get financed and that meets their requirements as an investment opportunity. These studies help the ISPs understand the opportunity of expanding broadband into the rural parts of the counties.

A. Operating Models

There are several operating models that might work in the county. Following are the operating models most prevalent in the US market today.

Retail Model – Single Provider as the ISP

This scenario considers the network being built and operated by a single entity. The results would be similar if the operator was the municipality or a single commercial ISP.

We always create this model to understand the financial dynamics of the market. We've learned that if a market can't be profitable with one provider, then other options like partnerships and open-access also can't be successful since those scenarios divvy up profits between multiple parties.

We know that the county has no desire to be an ISP. However, this model could come in useful. We've worked with other counties where one ISP stepped up to serve the whole rural area. This model provides a roadmap for a commercial ISP to consider the idea.

Note that our assessment doesn't consider an ISP that wants to serve only a part of the county. The Finley Engineering analysis has been done in such a way that with a little extra effort, we could produce the network costs needed to build a portion of the county. An ISP will often look at our analysis for the whole county, and when seeing a path to profitability for the whole county will want to consider something smaller.

There are a few key advantages and disadvantages for a single ISP to tackle the entire rural portions of the county:

Advantages

Profits. A single owner/operator can make all of the profit from a fiber business.

Flexibility. A single owner/operator can make instant decisions to change products or prices and to respond to competition.

Disadvantages

Risk. The flip side of the ability to make all of the profits is that a single owner/operator also takes all of the risks. If the business doesn't succeed, the ISP can lose its investment.

Financing. The primary impediment to building and operating a fiber ISP everywhere in the county is the cost of building the fiber network. Local governments often wonder why a commercial ISP doesn't build a fiber network if there is a business plan showing it can be profitable. The fact is that there are not many entities capable of borrowing the money needed to finance a sizable fiber network. Most small ISPs are limited by the amount of equity they can bring to a new market and by the collateral they can pledge to a borrower. Even with federal and state grant funding, there may not be a local ISP capable of tackling the whole county.

Competition. One of the downsides to the community if a single ISP were to build in the rural area is that you'd be replacing the old telephone company monopolies with the new fiber owner monopoly. Unfortunately, there is no easy path for bringing multiple ISPs to serve and compete in rural areas.

Open-Access

Open-access refers to the business model where a municipal entity builds a network and then sells access to multiple ISPs. The government's only revenues come from selling access to the various ISPs. ISPs have a relationship with customers – ISPs sell, provide services, bill, and provide customer service.

The open-access model thrives in Europe but has had a more difficult time succeeding in the U.S. Europe has seen success with open-access networks because a significant number of the large ISPs there are willing to operate on a network operated by somebody else. This came about due to the formation of the European Union. Before the European Union, each country on the continent had at least one monopoly telephone company and a monopoly cable TV company. The formation of the European Union resulted in a change in the law that opened up existing state-run monopolies to competition. All of the state-owned telecoms and ISPs found themselves in competition with each other and most of these businesses quickly adapted to the competitive environment. This contrasts drastically with the U.S. market, where there is no example of any large cable company competing with another and only limited competition between large telephone companies.

When a few cities in Europe considered the open-access operating model, they found more than a dozen major ISPs willing to consider open-access (large companies that would be equivalent of getting Comcast, AT&T, Verizon, or CenturyLink agreeing to use the new fiber network). There are now open-access networks in places like Amsterdam and Paris as well as in hundreds of smaller towns and cities. The biggest networks have over a hundred ISPs competing for customers—many of the ISPs with niche businesses that pursue a specific small customer niche. Due to that level of competition, the European fiber networks get practically every customer in their market since even the incumbent providers generally jump to the new fiber network.

That hasn't happened in the U.S. There is not one example in this country of the largest telcos or cable companies agreeing to operate as a competitor on somebody else's network to serve residential customers. The large ISPs in the U.S. will lease fiber outside of their footprint to serve large business customers, but they have never competed for smaller businesses or residents in each other's monopoly footprints.

This means that open-access networks in the U.S. must rely on small ISPs. These small ISPs are generally local and mostly undercapitalized. The small ISPs have all of the problems inherent to small businesses. They often don't have the money or expertise to market well. They often have cash flow issues that put restraints on their growth. In addition, many of them don't last beyond the career of their founder, which is typical of small businesses in general.

Open-access network operators have struggled in this country due to the nature of the small ISPs on their network. Consider the example in Chelan County, Washington, which was reduced at one point to having only one primary local ISP that was selling to residential customers. The network originally had almost a dozen ISPs, but over the years, the ISPs either folded or were purchased by the remaining ISP.

A similar thing happened in Provo, Utah, before the city sold the network to Google Fiber. The network had originally attracted eight ISPs, but over time they ended up with only two. It's hard to make an argument that a network with so few choices is open-access—because the whole purpose behind open-access is to provide customer choice.

<u>Examples of Open-Access Networks</u>. Following is a list of some of the other municipal open-access networks in the country.

- The Public Utility Districts (PUDs) in Washington State. These are countywide municipal electric companies. The PUDs are restricted to offering open-access due to legislation passed a number of years ago. There are numerous different open-access models being tried at various PUDs, with the largest networks in Chelan County PUD, Grant County PUD, Douglas County PUD, and Pend-Oreille PUD.
- Utah has a similar law that applies to municipalities. This led to the creation of an open-access fiber business in Provo and another network called Utopia that serves a number of small towns. The Provo network was losing a lot of money, and the city decided to sell the network to Google Fiber for $1. Utopia is still operating a wholesale business, but the business struggled until it gained economy of scale.
- A similar law was passed in Virginia after Bristol Virginia Utilities (BVU) built a retail fiber network. The legislation grandfathered BVU as a retail provider but only allowed other cities to operate open-access networks. So far, the wholesale model has been adopted by a few cities, the largest being Roanoke, which offers open-access on a limited basis to only parts of the city.
- Tacoma, Washington chose an open-access model where the city is the retail provider of cable TV, but connections to the network for telephone and broadband are sold wholesale to ISPs.
- Ashland, Oregon, operates an open-access network, but the city also operates as a retail ISP on the network and competes against a few local ISPs that sell on the network.

- There are a number of municipal networks that have built fiber rings that are promoting "open-access" to carriers. For the most part these networks only serve business customers.
- Other communities have tried to build open-access networks but then were unable to find any ISP partners. For example, Longmont, Colorado tried to launch an open-access network, but when they were unable to find ISP partners, they decided to offer full retail services directly to residents.

Advantages

Customer Choice. The most appealing aspect of an open-access network for a community is that it offers a variety of choices to customers over the same fiber network. The further hope on an open-access network is that having greater competition will lead to lower prices and better customer service.

Disadvantages

Huge Investment. An open-access network would have the county seeking the grants and borrowing the remaining money to build fiber everywhere. Even if the county got a 75% grant to build the network, the remaining matching cost to build the network would mean a large county debt – something that very few counties are willing to shoulder.

Retail/Wholesale Revenue Gap. For the network owner (the county in this case), there is a significant difference in the revenue stream between collecting the retail revenue stream from customers versus collecting only the fees charged to ISPs. For example, the average retail revenues on a fiber network serving residential customers might be over $100 per customer per month. The average revenues on an open-access network are far smaller, at perhaps $30 - $40 per customer per month.

There are some cost savings for the network owner in an open-access environment. The network owner doesn't have to provide the triple play products. They don't have to see, bill customers, or provide customer service. But it's still extremely difficult for the network owner to be profitable with open-access. The network owner still has to cover the full cost of the debt needed to build the network. The network owner still must maintain the fiber network and provide the core electronics. In most scenarios, the network owner has to continue to install fiber drops and/or customer electronics.

Not Many Quality ISPs. Every open-access network that has been tried in the U.S. has had trouble finding and retaining ISPs on the network. Some examples are discussed above. The ISPs willing to operating in this environment are generally small and undercapitalized. Open-access then forces these ISPs to compete against other small competitors, which holds down end-user rates, but then also puts pressure on ISP earnings. Two of the largest open-access networks in Chelan County, WA and Provo, UT essentially lost most of the ISPs on their network over a decade of operations.

Leads to Cherry-Picking. The open-access model, by definition, leads to cherry-picking. If ISPs are charged to use the network, then these fees will generally lead them to not want to offer any low rates for low-margin customers. The open-access networks listed above report this as an issue. The only way to get broadband to everybody in an open-access network is for the network owner to lower their fees – and that makes it impossible to pay for the network. CCG has never seen an open-access network that has a customer penetration rate as high as would be expected if the same community had a municipal retail provider. Cherry-picking means fewer customers on the network.

No Control over Sales Performance. The network owner in an open-access network has no control over the customer sales process. That means they only do as well as the ISPs on the network. In CCG's experience, having talked to many of the ISPs that operate on open-access network, the ISPs tend to not have the resources for major marketing efforts, or else only want to serve a niche market and don't try to mass market. A retail ISP that owned the same network would try to sell to everybody – but that never happens on an open-access network.

Stranded Investments. One interesting phenomenon that especially affects open-access networks is stranded investments at customer premises. When a customer moves or stops service with a network operated by one entity, there is usually a big push to reestablish service at that location. However, in an open-access network, many ISPs don't make this same effort. Therefore, over time there grows to be an inventory of homes and businesses with a fiber drop and ONT that are no longer used and are not contributing to the cost of the business. CCG knows of one of the larger open-access networks with 25,000 active customers that has 5,000 locations where the fiber has been abandoned with no current service.

Public-Private Partnership (PPP)

PPPs initially arose internationally as a way to finance infrastructure needs that local, regional, or national governments could no longer pay for upfront or could only insufficiently finance from taxes, bonds, or other methods of raising government monies. Local and state governments collectively in the U.S. are not able to fund all of the needed infrastructure, and so more and more PPPs are being formed to finance infrastructure. There have been estimates made that there are several trillion dollars more of needed infrastructure projects in the country than can be financed by the combined borrowing power of all of the state and local governments added together.

There are three major ways that a fiber PPP can be structured depending upon 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. There are only a few examples of this in the U.S. This scenario means that a government takes all of the financial risks of building a network and then hands the operations to somebody else. This is the arrangement that is in place in the Google Fiber partnership with Huntsville, Alabama. Reports are that Google Fiber is responsible for the costs inside the customer premise and the city for the rest. There are similar partnerships between Ting and Charlottesville, VA, and Westminster, MD. CenturyLink has reached a similar arrangement with Springfield, MO.

PPP Funded Mostly by the Commercial Provider. There are many examples where a commercial provider built a fiber network and doesn't consider the venture to be a PPP. Generally, an ISP that uses the normal avenue of obtaining rights-of-way and then adheres to the franchise and permitting processes in a city is free to build fiber.

It's also not a PPP if a government gives concessions to attract an ISP. The first few markets for Google Fiber are reported to have this arrangement. It's widely believed that Kansas City granted major concessions to Google Fiber to get them to build fiber there. This may have been things like free rights-of-way, expedited permitting, use of city land for placing facilities, etc.

For this kind of arrangement to be a traditional PPP, a municipal entity 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 help the city meet some social goal, such as building out to poorer parts of the city that a normal commercial ISP might otherwise not have considered.

<u>PPP Funded Jointly</u>. When a municipality and an ISP both contribute cash or hard assets to a venture, it's clearly a PPP. There are a number of examples of telecom PPPs working in the country today. Such partnerships are structured in many different ways, and the following are a few examples.

- Zayo partnered with Anoka County, MN. This is a suburban county just north of the Twin Cities. Each party contributed money to build a fiber network together. The county received access to a 10-gigabit network connecting all of its facilities, and Zayo received connections to all of the major business districts. Zayo owns the network, but each party has affordable access to the whole network as needed. Each party is also allowed to build outward from any point on the jointly built network at their own cost.
- Nashville, TN partnered with a commercial fiber provider to build fiber to city locations as well as to commercial districts. Both parties made capital contributions. The city eventually sold its interest in the network but still retains fiber to most city buildings.
- There are dozens of small cities where the city built an initial fiber network to connect to schools, water systems, etc. and now allow commercial providers to build spurs from the city-owned ring. The financial arrangements for this vary widely. Sometimes the two parties just swap access to various locations on each other's network, and in other cases, they each pay to lease access on the other's network. However, both parties share the same network, portions of which each has funded.
- In Sibley and Renville Counties, MN, the counties, cities, and townships together contributed an economic development bond that is being used to fund 25% of the cost of a fiber-to-the-premise network.
- Several of the Public Utility Districts (PUDs) in Washington have built fiber into business and residential neighborhoods but then allow ISPs to build fiber loops and electronics and connect to the core network.
- Google Fiber recently announced that it will be partnering with West Des Moines, Iowa, in a network that can best be described as open-access conduit. The city is going to build empty conduit along every street in the city and also extend the conduit to each home and business in the city. The network will be available to any ISP, but Google Fiber is the first announced ISP. Google would pay to bring their conduit through the fiber, and the company has said it plans to complete in the whole city. This plan puts the most expensive

part of the network onto the city, although the ISP still has to pull fiber and pay to connect inside of customer homes.

- There are hundreds of examples of government entities that have built fiber routes jointly with some commercial enterprise. This is referred to in the industry as fiber sharing, and generally each contributor to the fiber route will get some specific number of pairs of fiber for their contribution. For example, this is a widespread practice with school system fiber networks.

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 lands or give them an existing building. Excused fees might mean not charging for something that would normally be due, such as permitting fees or property taxes. The government could excuse payments for poles, conduit, existing fiber, or towers. It could mean 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 is assigning a value to the time contributed by the city. For example, we've seen a city assign extra employees for free for tasks like the permitting process during a major fiber construction project.

There are almost unlimited ways to model and form a public-private partnership. The underlying requirement is that the business must be profitable for the private commercial partner to consider the idea. Commercial providers expect a healthy rate of return on any investment they make in the business. Most commercial companies won't invest in a business that doesn't return at least a 20% to 30% return on their investment.

Advantages

Smaller Government Investments. The extent to which the private partner funds the network reduces the needed investment from the public partner. A private equity partner can bring cash to the business that might be hard to raise elsewhere.

Disadvantages

Matching Goals and Expectations. One of the primary reasons why there are not a lot of telecom public-private partnerships is that it's often difficult to reconcile the differing goals of the two sides. The commercial partner is generally going to be focused on the bottom line and returns, while the community part of the business often has goals like community betterment and lower rates. One of the biggest sticking points in creating PPPs is that cities want fiber built past every home, while an ISP might prefer to build only to selected neighborhoods. It's often difficult to put together a structure that can satisfy all the different goals.

Tax-Free Funding Issues. It's difficult to obtain tax-free bond funding to support a PPP. Federal tax law makes it difficult to use tax-free financing if a project provides a major benefit to a commercial partner.

Process Driven by Commercial Partner. Communities seeking equity partners for a public-private partnership fiber optics project will have fewer choices for the structure of the business since the external partner will probably demand a for-profit business structure as a likely precondition for investment.

Length of Partnership. Many commercial investors only make investments with a mind to eventually sell the business to realize the cash value. This may be difficult to reconcile with the long-term desires and goals of a community-based fiber optics project.

Governance Issues. It's a challenge to develop a governance structure that can accommodate the government decision-making process. Governments generally have to go through a defined deliberative process, including holding open meetings to make any significant decisions. This does not match well with the decision-making process and the timeline for a commercial partner. A commercial partner might make a decision in days while a government might take weeks.

Cooperative

One interesting option is to form a cooperative, which is a corporation owned by the customers of the business. Cooperatives are a common business structure in Wisconsin.

Advantages

Higher Penetration Rate. Telecom/Broadband cooperatives tend to gain a higher percentage of the market than other business structures. In areas of the country where cooperatives are a common form of business, many residents are drawn to the idea of using an ISP owned by the customers.

Disadvantages

Extremely Hard to Finance. There is unfortunately one big drawback to forming a new cooperative, which is raising the needed funding. Many federal grants shun start-up businesses, likely due to past circumstances where newly formed ISPs got grant funding and subsequently failed. The typical lenders for the broadband industry also don't typically fund start-up businesses. There are two banks that are owned by cooperatives, and even these lenders don't like lending to start-ups. Fiber is so expensive that it's not realistic to raise the needed funding directly from customers.

This was not always the case. From 1930 through 1960 the federal government helped to launch a lot of electric and telephone cooperatives by providing long-term low-interest rate loans. This was done to attract somebody to build electric grids or telephone networks in places where commercial electric companies and telephone companies did not want to serve. Underserved communities jumped at the idea, and most of those cooperatives are still going strong today.

B. Services Considered

Following is a discussion of the products and services considered in the assessment.

Telephone Services (VoIP)

Voice over IP (VoIP) is a digital telephone service that transmits a telephone call to customers using their broadband connection rather than establishing a more traditional analog telephone connection. VoIP has been around the industry for a few decades. The first major seller of VoIP was Vonage, which still delivers VoIP over the open Internet. Most VoIP arrangements now use secure private broadband connections rather than the open Internet.

The assessment assumes that the retail provider of telephone service will purchase wholesale VoIP. This product is available from numerous vendors. These vendors own a digital telephone switch, and they deliver calls to and from customers from that switch to the ISP. Our clients tell us that offering voice is still mandatory when selling to businesses since many businesses insist on having a vendor that delivers all their communications needs.

The alternative to using VoIP is to buy a telephone voice switch and then establish a connection between that switch and the public switched telephone network. These connections are referred to in the industry as "interconnection." We've found through a number of studies that it's hard to justify buying a switch and paying for interconnection costs unless a service provider expects to serve at least 5,000 telephone lines.

Gigabit High-Speed Bandwidth

The network design for the studies can deliver a symmetrical gigabit bandwidth product to every customer in the service areas. Additionally, the network could provide speeds up to 100 gigabits for the largest businesses, although there are probably none that want more than 10 gigabits. It's anticipated that there would be residential and small business broadband products at speeds less than a gigabit. The assessment assumes the basic product is 100 Mbps, but that could easily be changed to some other speed.

Internet Services (ISP, email, web hosting, etc.)/Security

It was traditional in the industry for an ISP to provide all services related to the Internet as part of their ISP service. This included such things as email, DNS routing, virus checking, spam filtering, etc. Most ISPs also offered services like helping customers create websites and then hosting them at the ISP headend. A decade ago, there was also a booming ISP business line of providing off-site storage for customer data.

The majority of small ISPs now outsource these functions and product lines. None of these functions are profitable when considering the cost of labor to perform them. In addition, all the basic ISP functions are now available as a cloud service or from a large, centralized help desk company. Most small ISPs have decided that their primary function ought to be maintain a network and leave these various ancillary services to somebody else.

A good example of this is virus checking and security. Virus checking today means not only trying to keep viruses away from customers, but today it means protecting against larger threats to the ISP such as denial of service attacks or the many other kinds of hacking. Most ISPs have found that they can buy better protection from a company that does this function for a hundred small ISPs rather than trying to do this themselves. They've found that there is no particular glory from doing these functions well, but there is a huge liability if they perform these functions poorly.

The feasibility studies assume these functions are outsourced. There is nothing to stop an ISP from tackling some or all of these tasks, but that would be contrary to where the rest of the industry is headed.

Managed WiFi

Many small ISPs now offer managed WiFi, which means that the ISP installs and controls the WiFi network at the customer premise. It's become obvious over the past several years that a large percentage of the problems experienced by customers have been due to poor WiFi networks rather than to the broadband connection. ISPs began selling a product where they would install a high-quality WiFi modem. If a house is large, the ISP installs a meshed network with several networked WiFi routers. Since these routers are part of the ISP network, they can monitor the performance to make sure they are operating properly. Many ISPs also offer related services like helping customers connect new devices to the WiFi system – something that can be done easily from the ISP end.

This is a profitable product. A quality WiFi router costs between $100 and $200, and ISPs are charging between $5 and $10 per month for the service. CCG know of ISPs that have already sold this product to most of their broadband customers.

Other Future Products

Many ISPs are expanding their product lines to add additional product lines that rely upon broadband. Perhaps the best example of this is Comcast. They now sell home security monitoring to many millions of customers. They are now probably the largest single nationwide provider of smart home products, and they have a line of products such as smart lighting, smart watering systems, smart door locks, smart thermostats, etc. Comcast has also been selling cell phone plans to compete with the big wireless carriers. Comcast even tested a bundle with solar panels a few years ago.

CCG finds it likely that any ISP operating a fiber network will eventually offer some of these same kinds of products along with products that have yet to be developed. This could include things like medical monitoring to help the elderly live in their homes longer. It might involve low-latency gaming connections, including virtual reality and holograms. It's impossible to build a business case for products that have yet to be developed, but it's reasonable to believe that any sizable ISP will eventually offer new products.

Wholesale Bandwidth Products

Wholesale bandwidth products are those sold to other carriers or to large business customers. Such products can be a major source of revenue for ISPs in larger cities. For example, Lumen became one of the biggest sellers of wholesale bandwidth products in the country after their merger with Level 3.

Following are the kinds of customers that buy wholesale connections:

- Cellular providers in most markets buy fiber connectivity and bandwidth to connect to the traditional tall cell towers. In the last few years, we've seen the cell companies building small cell sites placed on power or light poles. Both kinds of cell sites require a fiber connection.
- Nationwide businesses like hotel chains, banks, manufacturers, etc., usually have an arrangement with a single ISP to serve all of their locations nationwide. These ISPs will consider buying from

a new fiber network, but they probably already have reasonably priced connections from TDS or Windstream.
- Complex businesses like hospitals and universities usually have complex needs and look for ISPs that can provide a lot more than just bandwidth.
- Businesses with multiple locations in Door County need connections between branches. This might include grocery stores, local banks, or other businesses that might operate multiple locations inside the county.
- Giant bandwidth users. This could be things like data centers or large stock trading houses that want large bandwidth with low latency.

Following are the typical wholesale products that are sold to the above kinds of businesses:
- Dark Fiber. This involves selling a fiber that is not connected to electronics. The ISP buying the dark fiber is responsible for providing and operating the electronics necessary to use the fiber. Dark fiber might be sold by the mile of fiber, or else by a set fee per dark fiber connection.
- Transport. These are lit large bandwidth connections sold to carriers. Transport can be sold anywhere in the network to connect to customers or sometimes just pass through the boundaries of the service territory.
- Dedicated Bandwidth. Dedicated bandwidth means that the customer doesn't share it with anybody else. The typical products on an FTTP network share bandwidth at some point in the network, but some businesses are willing to pay to buy raw, unshared bandwidth. The network can deliver speeds up to 100 Gbps.

There are only minor wholesale revenues included in the studies. There is a chance over time for greater revenues than we have projected.

C. Financial Assumptions

Incremental Analysis

It's important to note that 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 the incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover the 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 not the same as 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 was to undertake one of these business plans, they would allocate some of their existing overhead costs to the new venture. 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 venture in the accounting books. However, the cost of the salary of the existing general manager is not considered in an incremental analysis since that salary is already being paid by the existing business. If these studies were to show an allocation of the general manager, then they would not be properly showing the net impact of entering the new market.

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 somewhat conservative in the predictions of the speed of the roll-out of the business venture. That means that if an ISP could get customers faster than predicted by the projections that they can have better results than we've shown.

All scenarios anticipate that the first customers will be added to any new networks in October of the first year after starting the project. It could be possible for an existing ISP with customers in the region to start customers a little earlier.

Following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that the financing is available in January 2022. This is illustrative only and could be changed to any other future date.
- Construction. Fiber construction is assumed to last for 4 years to build the whole county and would last for three years to build just the rural areas.
- First Customer. We've assumed that the first customer could be added to the network in September of the first year. That could be optimistic depending upon the approach to construction. To get a customer this early would mean launching the business by building a few nodes the first year along with fiber to the neighborhoods nearest to the nodes. If the approach to construction is to first build the fiber backbone between nodes, then customers would not be added in the first year.

Seasonality

One of the biggest challenges for building a new ISP in an area with heavy tourism is how to deal with seasonality. CCG has worked with a number of communities with a seasonality issue and has seen a wide range of ways that ISPs deal with the issue.

> Should There Be a Discount for Seasonal Customers? We know of a substantial number of fiber-based ISPs that give no discount for seasonal customers. It can cost as much as $2,000 to connect a new fiber customer to the network and the ISPs realize that it might take a decade to recover that initial cost from a customer who is only paying for 3 – 6 months of service per year. From a pure monetary perspective an ISP is probably better off not giving discounts compared to investing a lot of capital to build to customers that don't generate enough revenue to recover costs.
>
> While this policy may sound harsh, it puts the value of making sure the business is solvent first. The challenge any ISP faces is estimating the number of customers that might use a seasonal discount and building that safely into a forecast created before financing. The business could sustain significant losses if more people accept a discount than expected.
>
> Interestingly, many of the ISPs that don't give discounts are cooperatives. Cooperatives are owned by the customers, and the issue that drives the decision to not give a discount is equity. They

understand that the rates charged to full-time customers must somehow make up for discounts given to others.

The question of giving a discount is a different question between rural areas and towns. We hear that most rural customers who want broadband will begrudgingly pay all year to get broadband that works. And in today's world many realize the convenience of being able to check cameras at any time when they aren't there. But rural customers probably have no other realistic option if they want to use broadband when they are in the market.

Most cable companies give discounts for seasonal residents. They often charge a nominal monthly fee to maintain service when customers aren't in the market, and perhaps a fee to reconnect service. But cable companies have a fully depreciated network, and they also have a tiny incremental cost to add a new customer to the network. Most homes in a cable market have a cable drop even if the home hasn't had service in many years. But we know fiber-ISPs who operate in cities that don't give a seasonal discount. They reason that those customers are just part of the percentage of the market that isn't going to buy service, and they'd rather not have customers that don't return a margin.

How Much of a Discount? We've seen a wide range of discounts applied to seasonal customers:

- Pay for What You Use. The most generous policy would be to charge only for the month that customers use the network. An ISP with this philosophy will want a full month of payment at any time that the broadband connection is activated. If somebody visits the home for a day during the holidays they get billed for a full month. Viewing a video camera in the middle of the winter would trigger a full month billing. This would requires putting a trigger into the network to create a billing event whenever broadband is used. ISPs that have tried this method report that they end up billing many customers for most of the year. But this still make a huge dent in cash flows, particularly in the off-season.
- Partial Payments. The most common solution for seasonal customers is to offer some kind of discount for the months when broadband isn't being used. For example, customers might pay full rates for months that they use service and pay a discounted rates for months they don't use service. The rates charged vary, and the most typical rate we've seen in the market is to charge half rates when broadband isn't being used – but the discount could be for any amount.
- Fixed Minimum. We know ISPs that have an expected minimum annual commitment. For example, they might require seasonal customers to agree to pay for six or nine months of service in order to get service. Customers can pay more than the minimum if they are in the market for more than the minimum time. This can be a complicated arrangement to establish from a billing perspective.
- Pre-payment. A few ISPs require a pre-payment from seasonal customers for the entire season before they get activated. They know that many customers decide to leave early and then refuse to pay for months they weren't there. This is a fairly routine to bill for service in college towns where ISPs bill up front for a whole semester, knowing that if they don't that a lot of students skip out on making the final payment of the semester.

A fiber ISP in the county needs to determine the seasonality policy early in the planning process to make sure that they will generate enough cash to be solvent. This is also an issue that could change a lot over time. As vacation homes are passed down generations, the younger generations are going to be more likely to want fast broadband when they visit the county. It's also likely that visitors in general will value broadband more each year moving into the future as broadband become more of a daily necessity. This makes it likely that the demand for discounts will increase over time.

One strategy that has been considered, but never implemented is to make sure that the business is on a secure financial footing through selling to full-time residents before offering a discount to part-time residents.

Pricing Strategy

We assumed that the products would be as simple as possible. For example, our analysis includes only three broadband speed tiers for residential or business customers.

There are a number of different pricing strategies used around the country by ISPs selling broadband. Following is a discussion of some of the more common models and a discussion of the pros and cons of the various approaches to pricing.

- Competition. When building broadband into a market that already has existing competition, it's important to consider the prices of the competition as well as predicting how they might react to competition. In rural areas with little or no existing broadband, this is usually not a factor.
- Market Rates. This asks the important question of what people are willing to pay for broadband. We see ISPs that set prices low based upon the assumption that nobody will change providers with prices near to existing market rates. However, CCG has many clients that charge market rates for broadband and get similar penetration rates to ISPs with lower rates.
- General Pricing Philosophy. ISPs often come to the market with predetermined notions of how prices ought to work. A pricing philosophy is often based upon the overall goals for the business and the way that an ISP thinks about business. For example, some ISPs have a goal of maximizing cash flow or of maximizing profits (not the same thing). Other ISPs are more community-oriented and want to bring fast broadband to as many households as possible. These basic philosophies are often the driving force behind a pricing strategy.

  For example, some ISPs believe in simplicity and only offer a few products. Other ISPs stress bundles and price accordingly. Some ISPs think that the way to sell a lot of services is by having low prices. Other ISPs think it's better to have higher prices and fewer customers. Some ISPs think it's important to the community to have a low-priced product for low-income households. Some ISPs charge the same prices to residents and businesses—others charge businesses a lot more.

Those various philosophies result in a couple of different pricing strategies that we manifested into market rates. A few key examples include:

- One Broadband Product. A few ISPs like Google Fiber, Ting and a handful of smaller ISPs have one broadband product. They sell a gigabit of speed for a set price. Google Fiber had gone to a 2-product offering in 2020 returned to offering only the flat-rate $70 gigabit. Any ISP with this philosophy is likely not trying to capture a huge share of the market but is content to sell a high-margin product to a smaller number of homes. Interestingly, Google Fiber added a 2-gigabit product in some markets priced at $100.

- Low Basic Price. Some ISPs set the price for the basic product low. This is done more often by municipal ISPs, but there are small commercial ISPs with the same philosophy. As an example, an ISP might set the price of the basic broadband product at something like 50 Mbps for $40.

  CCG Consulting has access to the prices and the resulting customer counts from nearly 200 ISPs and what we have learned is that most customers will buy the basic broadband product if the speed is okay. A basic product set at 5 Mbps likely won't sell, but in today's market, a product with a decent speed like 50 Mbps or greater will be perceived as acceptable to most households.

  As mentioned above, it's debatable if an ISP with low rates captures more of a market – but it's obvious that low rates leave a lot of margin on the table. In setting rates, we began by considering existing market rates in Door County. These are "permanent" rates, and we don't consider special advertising rates that last for a year before reverting to full price. ISPs often make the mistake of setting their permanent rates to compete with existing provider special rates.

  Following are the basic product residential rates in the market today:
    - AT&T has a simple DSL pricing. Most speeds are $60 per month plus $10 for the DSL modem.
    - CenturyLink DSL starts with a list price of $47 for 7 Mbps DSL. The price for 12 Mbps DSL is $52, and 20 Mbps is $62. From what we see around Door County, few customers are seeing speeds even as fast as 12 Mbps on CenturyLink. CenturyLink models add up to $6.95 per month.
    - Frontier charges $44.95 for 6/1 Mbps, $54.95 for 12/1 Mbps, and $59.95 for 18/1.5 Mbps. For all products, a modem is $10 extra.
    - Charter/Spectrum's basic broadband product is $69.99 per month for up to 200 Mbps, with an optional $9.99 for a WiFi router.
    - Door County broadband prices start at $54.95 for 4/1 Mbps, $64.95 for 6/2 Mbps, $74.95 for 8/2.5 Mbps, and $84.95 for 10/2 Mbps.
    - SonicNet charges $52.95 for 5 Mbps and $73.85 for 12 Mbps.
    - Other wireless ISPs don't quote rates online.

  A new ISP with a fiber network will be able to offer significantly faster download speeds than all of the ISPs other than Charter/Spectrum. Fiber would bring significantly faster upload speeds than Charter/Spectrum. In our experience, ISPs don't have a big problem selling a superior product. A customer with a slow DSL product is usually willing to pay a little more for service that is twenty times faster.

  In the models for this assessment, we used $60 as the starting price for broadband. That's the same as AT&T but higher than Frontier and CenturyLink. It's $10 less than Charter/Spectrum's basic product. We also could justify setting the starting rate at $65 but think that setting rates at Charter/Spectrum's $70 rate might be a challenge.

- Price Steps or Tiers. Most ISPs price with tiers (like the above examples for incumbents). Probably the key attribute to tier pricing is the price differential between tiers. Consider three different pricing structures that begin with a $60 broadband product:

	Rate 1	Penetration	Rate 2	Penetration	Rate 3	Penetration
100 Mbps	$ 60.00	95%	$60.00	70%	$60.00	60%
250 Mbps	$ 90.00	4%	$75.00	25%	$70.00	30%
Gigabit	$120.00	1%	$90.00	5%	$80.00	10%

For 1,000 Customers:			
Revenue	$61,800	$65,250	$65,000
Increase		5.5%	5%

The difference in the steps or tiers is that "Rate 1" prices are set $30 between products, "Rate 2" is at $15, and "Rate 3" is at $10. The impact of smaller tiers is that it's easier to upsell a customer to faster products. The above penetration rates are typical for some CCG clients using the different price tiers. Customers might voluntarily choose a fast product when the step between tiers is small, and they are more likely in the future to upgrade anytime they feel their speed is bogging down or inadequate. Conversely, when the steps are too large, customers buy and then stick with the lowest-priced tier rather than increase the monthly bill too much.

We have seen that having too many price tiers confuses customers. The above examples have tiers with three prices. We know of ISPs with seven to ten price tiers, and in looking at their penetration rates, we see that this confuses customers. We have seen the most effective rate structures having no more than four tiers, which can be explained to customers on a fiber network as fast, faster, and fastest, and gigabit.

- Setting Business Rates. Philosophies vary widely on business rates. The incumbent telephone companies and cable companies generally charge a lot more to business than to residential customers. At one time, the philosophy behind this was that businesses consume more resources and cost more to serve than residential customers. While that might still be true for medium and large businesses, ISPs will tell you that the average home today uses considerably more bandwidth than the average small retail store. The exception might be a coffee shop supporting a public hotspot or a business that deals in large files like photographers or engineers.

  We know a few ISPs that charge the same rates to businesses and residences, although that is rare. Most ISPs follow the incumbent pricing practices and charge more for businesses.

  One thing that a first-time ISP learns quickly is that incumbents don't have standard rates for businesses, but rather they negotiate with them. It's not unusual to find two similar small businesses in the same neighborhood paying drastically different rates for the same products. This creates a challenge for ISPs. Some ISPs set standard business rates that apply to all businesses, while others set rates on a custom basis compared to what a business is currently paying.

  The other thing that a new ISP learns quickly is that most businesses care more about reliability than price. They want their broadband and telephones to always work during business hours. They don't want to pay more than they can afford, but they are not afraid to pay for a quality connection. While a new fiber provider might see good appreciation for a fiber-based ISP saving them money, the chances are that they decided to change ISPs due to outages they have had in the past with their current provider – if they perceive fiber to be a more stable technology. One of CCG's clients recently did a survey of businesses in a new market, and over half of them had experienced a half-day or longer broadband outage during the last year. For most businesses, such outages are the deciding factor they cited when they talked about the willingness to talk to a new network provider.

- Rate Bundles. The large cable companies are well-known for having bundles of products where they provide a discount to customers buying more than one product. Charter/Spectrum offers a dizzying array of cable, telephone, and broadband combinations. Generally, customers have no idea which products the discount applies to. No more than 15% of the small ISPs that CCG works with provides a similar bundling discount. Most smaller ISPs set prices at rates at a competitive level and don't discount them further.

  We caution that we've seen ISPs that built a business plan and forecasts upon list prices and then found themselves in financial stress when a marketing person at the company decided they could sell more by offering discounts that weren't in the business plan. Interestingly, Verizon announced in 2020 that it is doing away with bundled rates for new customers. It will take a few years for customers with older plans to migrate to unbundled rates. Verizon describes the new rates structure as more open and honest and says that this is what customers want.

- Introductory Rates. The big telcos and cable companies are also well-known for advertising low introductory rates that increase dramatically after a term contract of 1 to 3 years. Most of the rates you'll see from these companies on the web or in advertising are the introductory rates, and the real rates of these companies are generally buried in the small print if shown anywhere.

  Customers dislike the introductory rate process because they invariably get socked with an unexpected rate increase when rates jump back to list prices. The time of big introductory discounts might be starting to end. AT&T decided in 2019 to stop renegotiating customers with low introductory rates and moved customers to list rates. This cost AT&T nearly two million customers on DirecTV, but the company said they would rather have fewer customers that are profitable than keeping customers that don't contribute to the bottom line of the company. A few medium-sized cable companies have made this same change.

  Most small ISPs do not offer introductory rates. They've found that introductory rates are a lot of work since it requires getting customers to 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 Section I.C. of this report. Some ISPs offer low-priced products to low-income households. Most try to set rates to make it affordable, and most have some criteria for how customers qualify for the low rates, such as having students using the free lunch program. Most ISPs try to set the rates at a level that at least covers costs and that hopefully returns a tiny margin.

Rates Used in This Assessment

Telephone Rates

The studies assume a single residential telephone product – a telephone line with unlimited long distance for $25.00. 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 unlimited long distance will be welcome in households that have poor cellular coverage since the telephone companies charge long distance rates for calling outside of the county. The unlimited calling plans today often include Canada, Mexico, and even some other international locations.

The studies assume three telephone products for businesses:

Basic Line	$30
Basic Line with Unlimited Long Distance	$35
Trunk Line	$45

Trunk lines are lines used to bring telephone service to a business that owns its own telephone system. It's worth noting that most ISPs charge residential rates to home-based businesses, including farms.

Cable TV Products

We did not include cable TV in the feasibility assessment. Millions of households with good broadband have been dropping traditional cable every year and instead using some combination of streaming video services. None of the rural ISPs in the county offer cable TV today. Even should you find a wholesale TV option, there is little margin on the product, so adding cable TV would make little difference to the financial analysis. Finally, it's nearly impossible for a small ISP to compete on price with the satellite TV providers and small ISPs that offer TV generally have significantly higher prices. That makes it hard to attract customers to the product, even if it's delivered on fiber.

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.

	Price	**Percentage**
Residential Fiber Broadband		
100 Mbps	$ 60.00	70%
250 Mbps	$ 75.00	25%
Gigabit	$ 90.00	5%

Business Fiber Broadband		
100 Mbps	$ 75.00	50%
25- Mbps	$ 90.00	35%
Gigabit	$105.00	15%

Most ISPs charge more to businesses for broadband, and the studies assume a $15 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 exceeded those caps would be charged more than the basic prices. AT&T has a data cap on some DSL products. A few of the wireless ISPs have data caps. Charter/Spectrum does not have data caps but asked the FCC permission last year to impose them. The company had agreed to not bill for data caps as a condition for buying Time Warner Cable. The FCC denied the request, but the Charter/Spectrum will almost certainly impose data caps when the FCC agreement ends in 2024.

Managed WiFi

This is a relatively new product that's been around for a few years. ISPs have found that one of the biggest problems with home broadband is 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 a 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 $7.00 for residences and $10.00 for businesses. It's further assumed that 60% of residents would buy this product and 50% of businesses.

Large Broadband Products

There are entities in Door County that buy larger bandwidth products. The studies are conservative and do not predict a new ISP winning this business. In the county, the fast broadband products would likely be sold to cellular towers, schools, and a handful of large businesses. Over time, a new fiber provider would likely win some of this business, but we didn't want to overinflate the financial outlook of a new ISP by overinflating these revenues.

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. The cellular carriers like to buy large volumes of connections from a single regional provider, and they often already have a long-term contract for an area much larger than the county.

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. We are already seeing small cell sites popping up in towns the size of Sturgeon Bay, and over time this could be a growing market opportunity. There may never be many small cell sites in rural areas.

Network Capital Costs

The telecom industry uses the term capital costs to describe is the industry term for 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, electronics for FTTP, huts and buildings, and customer devices like cable settop boxes and 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.

The Supply Chain Issue. We really struggled with setting capital costs due to the current wild pressure on the industry due to supply chain issues. The pandemic has wreaked havoc with the supply chain for telecom assets.

The biggest current concern in the supply chain is fiber cables. 2021 is already shaping up as the biggest year we've ever had for building fiber. As busy as it is now, we are just warming up when looking out at the massive amounts of fiber that might be built as the result of the ARPA grants, aggressive state grant programs, and the possibility of a massive federal infrastructure program. Additionally, all of the big telcos have announced aggressive plans to finally build fiber.

AT&T reported recently at an investor conference that supply chain issues will likely mean that the company will only achieve 2.5 million of the 3 million planned new passings for 2021. AT&T didn't name the vendor that was the primary reason for the slowdown, but it's likely that it's either Corning or CommScope.

This news must be sounding loud alarms in boardrooms everywhere in the industry because if AT&T has supply chain issues, then everybody else is likely to have worse ones. It's hard to imagine that every manufacturer in the industry isn't giving AT&T the highest priority in its queue. If AT&T can't buy everything they want, then how will smaller telcos meet fiber expansion goals? How will new fiber overbuilders like cities using ARPA funds be able to break into an overloaded supply chain?

Supply chain issues are arising for a variety of reasons, all of which might come together to create a perfect storm for the industry. One reason for shortages is manufacturing capacity. For example, Corning, which makes fiber cables, saw revenues jump by 21% in the recently ended second quarter compared to a year earlier. Factories that are already working at or near capacity can't flip a switch to produce 20% more product. Demand is going to grow a lot more. The consulting firm

> RVA LLC recently predicted that the industry has plans to build fiber past 61 million homes between 2021 and 2025 – that's far more fiber than has ever been built.
>
> Supply chain issues are also still suffering from the lack of the raw ingredients needed to manufacture key components. This is one of the key issues behind the chip shortage and the shortage of electronics cases that are made from resin. Much of the global supply chain has not recovered from the impacts of the pandemic and this issue is far from behind us.
>
> There are also more mundane supply chain issues. There is still a shortage of truck drivers and port capacity to deliver the glut of materials and products hitting the market as the economy is rapidly improving. Apparently, during the pandemic, many truckers decided they were tired of life on the road and are pursuing other lines of work. The trucking industry can't train new truckers at the needed pace, and truck driving schools are working overtime.
>
> There are also more subtle changes behind the scenes. For example, many manufacturers have quietly looked for sources other than China during the pandemic. Many companies have come to realize that their own success was tied too closely to supply chains that were wholly within specific regions of China. Switching supply sources to other countries is not something that happens overnight, and many of these new relationships are still growing and maturing.
>
> Some of these issues will get solved over time. But the bigger issue of unprecedented demand is likely going to plague us for much of the next decade. AT&T is not going to give up on the half-million homes it won't reach this year and will just shove that into next year.

Our goal is to always be realistic but still be a little conservative in our estimates. For the past decade, the prices for components in the industry have been stable, and we've been able to make estimates that get within 5% of the cost of building a network. Right now, we are as lost as everybody else in the industry in that we don't have a crystal ball that tells us where prices might peak from the supply chain problems.

We started our analysis by using the most current component costs we know about. Some of these costs are already 15% to 20% higher than costs for a year ago. Everything we read and hear about say that the cost increases due to supply chain issues have not peaked. We decided for purposes of the assessment to increase material costs by 20% over today's prices. Hopefully, that will mean a conservative and achievable capital budget.

Below is a summary of the cost of the needed assets to support each primary option that was studied. The estimates below represent the assumption that a new fiber ISP would eventually gain a 50% market share in the county. Since there is an incremental cost to add a customer to a fiber network, the investments would be higher if the penetration rate is higher.

	Whole County	Rural Only
Fiber	$ 99,571,592	$60,298,125
Drops	$ 15,476,075	$ 7,435,255
Electronics	$ 12,360,410	$ 5,889,393
Huts	$ 1,248,328	$ 1,191,328

Operational Assets	$ 1,816,915	$ 1,330,596
Total	$130,473,319	$76,144,696
Passings	27,685	12,716
Cost per Passing	$ 4,713	$5,988

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the average electronics for an ONT cost $577, which includes the cost of the labor for installation at the home. In the projections, it was assumed that the installation would be done by external contractors. It might be less expensive to do installations using company personnel or local contractors who can install at a lower cost. We've also assumed 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 the service provider will supply a WiFi router for customers that want one. We've assumed these routers cost $159. There are more expensive options available.

Fiber Drops: Fiber drops are the fiber that connects from the street to the customer premises. 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 five 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 are much larger than what company personnel could handle. We've estimated the cost per drop at $1,638 for buried drops. The buried drops are largely only found in the towns. We've estimated that the average price for aerial drops for the whole county are $846, with average rural drops slightly more at $855.

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 Door 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 50% to begin our analysis. We think this is a likely conservative penetration rate for several reasons. In the rural areas a fiber provider would likely win a large majority of customers over time. It would be a challenge to win 50% of the customers in the towns, but the countywide average represents the composite penetration rate for the towns and rural areas combined. As an example, the 50% composite penetration rate could be achieved by getting 65% of customers in the rural areas and 35% of residents in the towns.

The only way to get a better estimate of the penetration rates would be through a statistically valid survey. However, it's difficult to conduct a reliable survey for a whole county, and an ISP might want to do regional surveys to better understand demand. We think any ISP will have to do a survey before tackling any large portion of the county.

Expense Assumptions

As a reminder, unless otherwise noted, all scenarios are created from the perspective of a small ISP offering the services. We know the county is not interested in being an ISP, but we show a few scenarios using bond financing, mostly to compare to commercial financing. The majority of scenarios assume that the ISP owns and operates the network.

Expenses are the recurring costs of operating the business once it's built. We strive when building financial projections to have conservatively high expense estimates. It's often less costly for an existing service provider to add a new market than what is shown in these projections.

As mentioned earlier, expenses are estimated on an incremental basis, meaning that the models only consider new expenses that would be needed to open the new market for an existing ISP. In an incremental analysis, it's assumed, for example, that the existing ISP is already paying for positions like an accountant, etc., and the incremental models only hire employees needed to open a new market and add additional customers.

The primary expense assumptions are as follows:

Employees: Labor is generally 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 38% 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 would require the following additional types of employees:

<u>Customer Service Representative.</u> Takes new orders, answers customer questions about billing, services, etc. We've assumed the business will require the following new positions:

Rural Only	4 new CSRs
Total County	6 new CSR
Total County	1 CSR manager
Total County	1 provisioner

<u>Install/Repair Technician.</u> 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:

Rural Only	4 new outside technicians
Whole County	6 new outside technicians
Rural Only	1 new inside technicians
Whole County	1 new inside technicians

Sales and Marketing. A new ISP of this size will require staff to handle sales and marketing. Some ISPs outsource the marketing function, but that would cost at least as much as hiring somebody. The role of the salespeople is to sell to businesses. ISPs have found that the only effective way to sell is with a live one-on-one sales model of a salesperson visiting businesses.

Rural Only	1 marketing analyst
Whole County	1 salesperson
Rural Only	1 marketing analyst
Whole County	2 salespeople

Administrative. A business of this size would likely require some sort of overall manager unless the ISP tackling the business already has a large presence in the county.

Rural Only	1 local market manager
Whole County	1 office manager
Whole County	1 local market manager

The total county scenario grows to twenty new employees. The rural scenario grows to twelve new employees.

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 the first few years thereafter. However, once the bulk of customers has been added, the forecasts assume that future installations will be done by company technicians.

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 list 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 (instead of the word-of-mouth that often happens in rural markets). It would be too risky to spend the money to build a network without knowing for sure that there are enough interested customers to allow the business to pay for itself. Marketing expenses shown in the models are likely going to be for that effort. It's possible that such money would be spent earlier than shown in the model. There have been rural start-ups that have been able to sign up customers using community volunteers, so it's possible that the marketing costs could be lower than assumed in the models.

The advertising budget for the first five years of operations for the three scenarios are as follows:

Rural Only	$ 650,000
Whole County	$1,460,000

Delivery of Products: The projections assume that the new business will not construct a headend to provide the services. It's likely that any ISP tackling Door County is already buying and providing triple-play products to customers.

The studies assume that a wholesale basic telephone line can be purchased wholesale at $6.00 per month. A line with unlimited long distance is assumed to be $9.50. 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. If this business were served by a new ISP, then the cost of bandwidth would be higher to also cover the cost of transport to reach the Internet.
- Internet Help Desk. The monthly fee for this service covers several distinct functions. This fee would cover those functions used to deliver broadband such as spam monitoring and security. This also includes network monitoring. The fee includes the help desk function, which is the function of assisting customers with broadband and network issues. The models assume a monthly cost of $5 per customer. That is a conservatively high number and anticipates buying a whole suite of outsourced services. This could be done for less, and some of these functions can also be done by ISP employees.

Software Maintenance: Triple-play providers 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 of customer equipment, tracking of inventory, creation of customer bills, tracking of 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, of charging bills to credit cards, and of charging bills directly as debits to bank accounts.

Taxes: The model assumes that the business that operates the business will pay state and federal income taxes. These taxes would not apply if this were operated as a municipal business or as a nonprofit.

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 that are assessed to customers. For example, this business would be expected to charge and collect various telephone taxes. These kinds of fees are normally added to the customer bill, and thus customers pay these 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. They are not shown as revenue or expense of the forecasts, but rather are just a passthrough.

Overhead Expenses: The forecasts include various overhead expenses. Again, since this is an incremental model, it does not include allocated expenses such as an allocation of the general manager's salary. But 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 (is written off over five years). The cost of a new vehicle is then depreciated monthly to write off the asset over the 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 instead amortized, using the same process as depreciation.

D. Financial Results

The primary purpose of creating the financial forecasts is to determine if it might be profitable for an ISP to profitably operate each scenario. We have found that the combination of the quantification of the capital costs along with the financial projections is useful when talking to ISPs about serving the market. Each ISP will obviously make its own estimate of the cost of operating in the market, but we think our analysis is a decent generic representation of how most ISPs will view the opportunity.

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 we are projecting. Following are some of the conservative assumptions used in the business plan:

- Our model assumes a regular replacement of electronics. However, it is possible that upgrades will be needed less often than we have shown. Further, our assumption is that the cost of electronics at the time of each upgrade would cost as much as the equipment that is being retired. The experience of the electronics industry is that electronics get cheaper and more efficient over time, so the cost of upgrades is probably going to be less than is shown in the model. The vendors in the industry have also gotten better at having phased upgrades that allow for keeping older equipment in place and not having to replace everything at once, making upgrades less expensive than we have projected.
- There are steps that the new business could take to improve upon these projections.

- Preselling. We've seen ISPs that can achieve earlier revenues than shown in this model through preselling to customers. This gives them the opportunity to begin connecting the network to the homes of presold customers while the network is being built. This would allow customers to be turned on in "nodes" or neighborhood-by-neighborhood as construction to specific neighborhoods are completed – at a faster pace than is shown in these projections.
- Adding Customers Sooner. These models assume that most customers will be gained by the end of the fifth year. There is a significant cash boost from selling faster and adding customers sooner.
- More Concentrated Build Schedule. It's always possible to build faster than shown in these forecasts if the ISP can execute on a faster construction schedule. The amount of network that can be constructed in a given time can be increased by adding more construction crews.

It is never easy to summarize the results of complicated business plans to make them understandable to the nonfinancial layperson. The following summary shows a few key results of each scenario that we think best allows 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.

Fiber to All of Door County

This scenario looks at the feasibility of bringing fiber to all parts of Door County. The first two scenarios assume that an existing commercial ISP funds the network using commercial debt. In contrast, the last scenario shows the network instead built and operated by the local government.

Base Study

	Breakeven	
	No Grant	Grant
Asset Costs	$130.5 M	$130.5 M
Grant	$ 0.00 M	$ 14.0 M
Equity	$ 17.8 M	$ 15.6 M
Bank Debt / Bond	$118.8 M	$104.1 M
Total Financing	$136.6 M	$133.7 M
Penetration Rate	50%	50%
Cash after 10 Years	$ 0.18 M	$ 4.44 M
Cash after 20 Years	(-$13.26 M)	$ 0.19 M

This shows that building fiber everywhere in the county is not feasible without substantial grant funding. In this case, the grant required is not large compared to many other projects we've considered, and the $14 million grant represents only 10% of the total cost of financing the project.

Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the amount of grant funding needed for the project to always be cash positive.

Probably the most significant number in the above numbers is the amount of equity that would be required for a commercial ISP to build the market. It's normal for banks to expect about 15% equity so that an ISP has 'skin in the game' and isn't borrowing 100% of the cost of a project. There are not a lot of ISPs around that will have more than $15 million in free cash available. The need for significant equity is one of the biggest reasons why small ISPs have trouble expanding – they don't fit the desired borrower profile for banks.

Municipal Financing

We know that the county has no desire to be an ISP. However, there is a lot of pressure across the country for local governments to step into this role when there is no apparent ISP willing to serve a market. The following results show the impact of financing with bond financing instead of commercial bank financing.

	GO Bond No Grant	GO Bond Breakeven	Rev Bond No Grant	Rev Bond Breakeven
Asset Costs	$130.5 M	$130.5 M	$130.5 M	$130.5 M
Grant	$ 0.0 M	$ 40.2 M	$ 0.0 M	$ 45.0 M
Equity	$ 0.0 M	$ 0.0 M	$ 0.0 M	$ 0.0 M
Bank Debt / Bond	$153.2 M	$106.2 M	$165.3 M	$108.5 M
Total Financing	$153.2 M	$146.4 M	$165.3 M	$153.5 M
Penetration Rate	50%	50%	50%	50%
Cash after 10 Years	(-$ 9.46 M)	$ 8.93 M	(-$12.07 M)	$ 9.39 M
Cash after 20 Years	(-$48.14 M)	$ 0.15 M	(-$56.17 M)	$ 0.55 M

The nuances of bond and bank financing are discussed later in this section of the report. The biggest difference between bond financing and commercial financing is that a municipality can borrow 100% of the funding, and rarely would have to put any equity into a project. That greatly increases the size of the borrowing, which greatly increases interest expense. In this case, the higher financing costs are reflected by a much larger grant required to break even – over $40 million with muni financing versus $14 million with commercial financing.

Customer Penetration Rate

The most significant variable affecting the success of a fiber project is almost invariably the customer penetration rate – the percentage of customers in a market that buy service. The base scenario studies above assumed a 55% penetration rate – and that is the first scenario shown again below. To the right is the impact of changing the penetration rate to 45% or 55%. In a scenario where grant funding is needed to make a project work, the penetration rate has a big impact on the amount of grant funding needed – and this is shown for the 45% and 55% penetration rates.

	50% Breakeven	45% Base	45% Breakeven	55% Base	55% No Grant
Asset Costs	$130.5 M	$127.9 M	$127.9 M	$133.3 M	$133.3 M
Grant	$ 14.0 M	$ 14.0 M	$ 29.0 M	$ 14.0 M	$ 0.0 M
Equity	$ 15.6 M	$ 15.6 M	$ 13.2 M	$ 15.6 M	$ 17.8 M
Bank Debt / Bond	$104.1 M	$103.8 M	$ 88.1 M	$104.1 M	$118.6 M
Total Financing	$133.7 M	$133.3 M	$130.3 M	$133.7 M	$136.4 M
Penetration Rate	50%	45%	45%	55%	55%
Cash after 10 Years	$ 4.44 M	(-$ 0.23 M)	$ 4.38 M	$ 9.79 M	$ 5.29 M
Cash after 20 Years	$ 0.19 M	(-$13.91 M)	$ 0.49 M	$15.10 M	$ 1.58 M

The above numbers demonstrate several interesting findings about financing fiber:

- This shows on the asset line how the amount of capital required changes according to the number of customers being connected to the network.
- If the customer penetration rate drops, the amount of grants required to make the scenario reach breakeven increases significantly. The grant needed increases from $14 M to $29 M if the penetration rate is 45% instead of 50%.
- This shows that there is no grant required if a 55% penetration rate could be achieved.
- This demonstrates how important it is for a potential ISP to understand the market potential. An ISP that expected a 50% market penetration but only achieved 45% would have a big cash deficit.

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we call a sensitivity analysis.

<u>Changing Broadband Prices</u>

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing a rate from $60 to $65) changed cash flow over 20 years by $13.5 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $2.7 million. This is a significant sensitivity. The cautionary tale about this finding is that an ISP must be careful after launch to stick to target prices. If a future decision is made to cut rates to be more competitive, the impact on the bottom line could be huge. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by over $13.4 million.

One of the biggest impacts we found comes from assuming modest rate increases over time. The base scenario includes no rate increase and still has $60 broadband rates in twenty years. If rates are increased modestly – a 5% increase every fifth year – the impact is to improve cash over twenty years by over $16.3 million. That is less than a 1% rate increase every year – far smaller than the assumed rate of inflation for expenses.

Seasonality. The ISP will collect less revenue if it provides a discount to seasonal residents for the months they aren't in Door County. It is difficult to estimate the percentage of customers that might use a seasonal discount. A scenario was created that assumed that 30% of all customers are seasonal and the discount provided is that rates drop to half the normal rate when they aren't in the market. This discount reduced cash flow over twenty years by $11.8 million. Obviously, many other assumptions are possible, and this topic was discussed in more detail earlier in this section of the report.

Changing Financing Terms

We looked at the impact of changing the various financing parameters.

Interest Rate. We looked at a scenario that lowered the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 3.5% to 3.0%). This increased cash flow by almost $5.8 million over 20 years. The impact from increasing the interest rate was similar, where increasing the rate by 50 basis points lowered cash flow by $6.0 million.

This provides a warning that anybody planning a new fiber network during a time of financial uncertainty must keep a close eye on interest rates and be ready to not proceed with financing if interest rates move too high. We've been lucky for the last decade that interest rates have held steady for years at a time, but over history, it's more normal for interest rates to fluctuate. As we write this report, the interest rates are extraordinarily low, but this can change quickly.

Loan Term. The base scenario assumed a 25-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 25 years to 30 years. This increased cash over 20 years by $11.8 million.

We also looked at decreasing the loan term from 25 years to 20 years. This decreased cash flow by $19.0 million.

In both cases, the change in long-term cash flow is due to the changes in annual debt payment required for loans of various lengths. This provides a great incentive to consider the longest loan maturity that can be achieved. Longer loans mean lower annual debt payments (just like with a home mortgage). Most loans can be repaid earlier or refinanced, but the longer the loan term, the smaller the annual required debt payments and the less the pressure on cash.

Changing the Cost of the Network

We examined the impact of changing the cost of the network. In one scenario, we increased the cost of fiber by 5%. This lowered cash flows over 20 years by $4.7 million. Decreasing the cost of fiber had nearly the same impact and increased cash flow by $4.7 million. The change in cash flow is due to higher or lower debt payments.

We also looked at the impact of pricing the full fiber network and electronics at today's cost. Earlier I mentioned that the base scenario assumes a 20% increase in material costs due to supply chain issues. This increased capital costs by $7.5 million which lowered cash flow over twenty years by over $6.0 million.

The Additive Nature of the Variables

The impacts cited for the various variables are somewhat additive. For example, the above discussion describes an improvement to cash generated by the business from finding a lower interest rate on debt than shown in the models and for spending less on the network. These improvements are roughly additive, meaning that you can add the results above together and will come close to the impact of making both changes in the projections.

Rural Areas Only

This scenario looks at the feasibility of the rural parts of Door County outside of the areas served by Charter/Spectrum. The first two scenarios assume that an existing commercial ISP funds the network using commercial debt. In contrast, the last scenario shows the network instead built and operated by local government.

Base Study

	No Grant	Breakeven Grant
Asset Costs	$ 76.1 M	$ 76.1 M
Grant	$ 0.00 M	$ 33.7 M
Equity	$ 10.9 M	$ 5.7 M
Bank Debt / Bond	$ 73.0 M	$ 38.2 M
Total Financing	$ 83.9 M	$ 77.6 M
Penetration Rate	50%	50%
Cash after 10 Years	(-$ 7.93 M)	$ 2.92 M
Cash after 20 Years	(-$32.31 M)	$ 0.21 M

This shows that the needed grants to just build the rural areas is significantly higher than to build the whole county. That tells is that operating in the towns was profitable in the all-county scenarios above, and that profitability helped to subsidize rural broadband. The cost per customer is higher to build in only the rural parts of the county, and so the needed grant funding is also higher. In the above scenario, with a 50% penetration, grants representing 43% of the project financing just to break even. Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the amount of grant funding needed for the project to always be cash positive.

The amount of equity required for commercial bank loans are a lot lower than when building to the whole county – but it's still significant.

Municipal Financing

We know that the county has no desire to be an ISP. However, there is a lot of pressure across the country for local governments to step into this role when there is no apparent ISP willing to serve a market. The following results show the impact of financing with bond financing instead of commercial bank financing.

	GO Bond No Grant	GO Bond Breakeven	Rev Bond No Grant	Rev Bond Breakeven
Asset Costs	$ 76.1 M	$ 76.1 M	$ 76.1 M	$ 76.1 M
Grant	$ 0.0 M	$ 44.3 M	$ 0.0 M	$ 45.9 M
Equity	$ 0.0 M	$ 0.0 M	$ 0.0 M	$ 0.0 M
Bank Debt / Bond	$ 89.2 M	$ 37.4 M	$ 96.3 M	$ 38.3 M
Total Financing	$ 89.2 M	$ 81.7 M	$ 96.3 M	$ 84.2 M
Penetration Rate	50%	50%	50%	50%
Cash after 10 Years	(-$15.60 M)	$ 4.56 M	(-$17.03 M)	$ 4.67 M
Cash after 20 Years	(-$52.71 M)	$ 0.17 M	(-$57.39 M)	$ 0.20 M

The nuances of bond and bank financing are discussed later in this section of the report. The biggest difference between bond financing and commercial financing is that a municipality can borrow 100% of the funding and rarely would have to put any equity into a project. That greatly increases the size of the financing which increases interest expense. In this case, the higher financing costs are reflected by a much larger grant required to break even – over $44 million with municipal financing.

Customer Penetration Rate

The most significant variable affecting the success of a fiber project is the customer penetration rate – the percentage of customers in a market that buy service. The base scenario studies above assumed a 50% penetration rate – and that is the first scenario shown again below. To the right is the impact of changing the penetration rate to 45% or 55%. In a scenario where grant funding is needed to make a project work, the penetration rate has a significant impact on the amount of grant funding needed – and this is shown for the 45% and 55% penetration rates.

	50% Breakeven	45% Base	45% Breakeven	55% Base	55% Breakeven
Asset Costs	$ 76.1 M	$ 74.9 M	$ 74.9 M	$ 77.4 M	$ 77.4 M
Grant	$ 33.7 M	$ 33.7 M	$ 40.9 M	$ 33.7 M	$ 26.4 M
Equity	$ 5.7 M	$ 5.7 M	$ 4.6 M	$ 5.7 M	$ 6.9 M
Bank Debt / Bond	$ 38.2 M	$ 37.9 M	$ 30.5 M	$ 38.3 M	$ 45.9 M
Total Financing	$ 77.6 M	$ 77.3 M	$ 76.0 M	$ 77.8 M	$ 79.1 M
Penetration Rate	50%	45%	45%	55%	55%
Cash after 10 Years	$ 2.92 M	$ 0.53 M	$ 2.82 M	$ 5.39 M	$ 3.03 M

Cash after 20 Years	$ 0.21 M	(-$ 6.62 M)	$ 0.28 M	$ 7.23 M	$ 0.19 M

If an ISP serves only the rural area, it's possible to get more than a 55% penetration. We know of a handful of rural communities where broadband penetration rates are over 90% - but that is extraordinarily high. To show how the rural-only scenario would work with even higher penetration rates the following shows the impact of 60% and 65% penetration.

	50% Breakeven	60% Base	60% Breakeven	65% Base	65% Breakeven
Asset Costs	$ 76.1 M	$ 78.7 M	$ 78.7 M	$ 80.0 M	$ 80.0 M
Grant	$ 33.7 M	$ 33.7 M	$ 19.2 M	$ 33.7 M	$ 11.8 M
Equity	$ 5.7 M	$ 5.8 M	$ 7.2 M	$ 5.8 M	$ 9.2 M
Bank Debt / Bond	$ 38.2 M	$ 38.5 M	$ 48.0 M	$ 38.5 M	$ 61.1 M
Total Financing	$ 77.6 M	$ 77.9 M	$ 74.3 M	$ 77.9 M	$ 82.0 M
Penetration Rate	50%	60%	60%	65%	65%
Cash after 10 Years	$ 2.92 M	$ 7.80 M	$ 2.92 M	$10.30 M	$ 3.26 M
Cash after 20 Years	$ 0.21 M	$14.18 M	$ 0.14 M	$21.33 M	$ 0.21 M

The above numbers demonstrate several interesting findings about financing fiber:

- This shows on the asset line how the amount of capital required changes according to the number of customers being connected to the network.
- If the customer penetration rate drops, the amount of grants required to make the scenario reach breakeven increases significantly. The grant needed increases from $33.7 M to $40.9 M if the penetration rate is 45% instead of 50%. At a 60% penetration rate, the required grant drops to $19.2 million.
- This demonstrates how important it is for a potential ISP to understand the market potential. An ISP that expects a 50% market penetration but only achieves 45% would have a big cash deficit. On the flip side, these scenarios show the potential upside from achieving a higher penetration rate than expected – but also notice that there is a higher capital cost and increased borrowing needed to add additional customers.

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we call a sensitivity analysis.

Changing Broadband Prices

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing a rate from $60 to $65) changed cash flow over 20 years by $6.6 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $1.32 million. This is a significant sensitivity. The cautionary tale about this finding is that an ISP must be careful after launch to stick to target prices. If a future decision is made to cut rates to be more competitive, the impact on the bottom line could be huge. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by almost $6.2 million.

One of the biggest impacts we found comes from assuming modest rate increases over time. The base scenario includes no rate increase and still has $60 broadband rates in twenty years. If rates are increased modestly – a 5% increase every fifth year – the impact is to improve cash over twenty years by over $7.9 million. That is less than a 1% rate increase every year – far less than the assumed rate of inflation assumed for expenses.

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We looked at the impact of changing the various financing parameters.

> Interest Rate. We looked at a scenario that lowered the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 3.5% to 3.0%). This increased cash flow by over $2.1 million over 20 years. The impact from increasing the interest rate was similar, where increasing the rate by 50 basis points lowered cash flow by over $2.2 million.
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> This provides a warning that anybody planning a new fiber network during a time of financial uncertainty must keep a close eye on interest rates and be ready to not proceed with financing if interest rates move too high. We've been lucky for the last decade that interest rates have held steady for years at a time, but over history, it's more normal for interest rates to fluctuate. As we write this report, the interest rates are extraordinarily low, but this can change quickly. To put this into context, if interest rates went up 2 full percent (from 3.5% to 5.5%), the cash flow of the project would go down by almost $9 million over twenty years.
>
> Loan Term. The base scenario assumed a 25-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 25 years to 30 years. This increased cash over 20 years by over $4.3 million.
>
> We also looked at decreasing the loan term from 25 years to 20 years. This decreased cash flow by almost $7.0 million.
>
> In both cases, the change in long-term cash flow is due to the changes in annual debt payment required for loans of various lengths. This provides a great incentive to consider the longest loan maturity that can be achieved. Longer loans mean lower annual debt payments (just like with a home mortgage). Most loans can be repaid earlier or refinanced,

but the longer the loan term, the smaller the annual required debt payments and the less the pressure on cash in the early years of a project.

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We examined the impact of changing the cost of the network.

In one scenario, we increased the cost of fiber by 5%. This lowered cash flows over 20 years by almost $2.9 million. Decreasing the cost of fiber had nearly the same impact and increased cash flow by almost $2.9 million. The change in cash flow is due to higher or lower debt payments.

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What Conclusions Can We Draw from the Financial Results?

There are a number of conclusions we can draw from the results of the business plan analysis:

Building Broadband in Rural Door County Will Require Significant Grants

We expected when we started the assessment that grant funding would be required to help fund broadband in the rural parts of the county. This was expected due to the low housing density in rural areas. Our analysis allowed us to quantify the amount of grant needed. It turns out that the amount of grant required varies significantly depending upon the expected customer penetration rate.

Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
45%	$68.9 M	$40.9 M	59%
50%	$70.1 M	$33.7 M	48%
55%	$71.3 M	$26.4 M	37%
60%	$72.5 M	$19.2 M	26%
65%	$73.7 M	$11.8 M	16%

Note that the amounts of grants shown above allow the business to reach breakeven. No ISP wants to operate a broadband business that barely breaks even, so the amount of grant sought by an ISP would be at least a little higher than the amounts shown above.

The table demonstrates how the ISP business is an economy-of-scale business, meaning the larger the business in terms of customers, the more profitable the business can be. The amount of grants needed at higher penetration levels is due to the fact that more customers generate more revenue and profits, which lowers the need for grant funding. Just eyeing the above table, it looks like the business might not need any grant if the expected level of customers is higher than 75% of all households. While that outcome is not impossible, very few ISPs would be willing to tackle a business where a 75% penetration rate is needed just to break even.

We know that clients want to know the amount of grant funding needed to make broadband work. The above table provides the answer of, "It depends." It depends on how well the business will ultimately perform in terms of landing customers.

The above table should lead any ISP interested in serving the county to first conduct a statistically valid survey of any area they plan to serve. Surveys are a reliable way to measure customer interest in buying broadband from a new network. The only alternative to a survey is a canvass – where the ISP would ask customers to pledge to take service. Pledges can work well when serving small communities, but the logistics of asking every customer in an area is a lot of work.

Grants Would be Smaller for Somebody Willing to Build to the Whole County

Consider the following table that shows the amount of grant required for somebody willing to build fiber to the whole county.

Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
45%	$127.9 M	$29.0 M	23%
50%	$130.5 M	$14.0 M	11%
55%	$133.3 M	$ 0.0 M	0%

This shows the amount of grants needed to build to the whole county would be smaller. This comes from two reasons. First, serving the whole county means more customers, so there is more revenue and margin driven from customer revenues. But more importantly, the lower housing density in the towns results in a lower investment per customer, and it is more profitable to serve the towns. The lower grants from this second table are mostly due to profits from the towns subsidizing the rural areas.

An ISP Business is Sensitive to Changes in Other Key Variables.

While customer penetration rate seems to be the most important variable, all scenarios are sensitive to variations in other key variables. The above discussion shows that cash flow generated can be impacted by changes in variables like interest rates, loan term, prices, and the cost of building the network. The report above describes these impacts for building to the whole county or to just the rural areas.

The Importance of the Breakeven Calculations - and the Important of Expected Returns

Several tables above discuss the amount of grant funding needed just to achieve breakeven. Breakeven in this case refers to the business always maintain positive cash after the initial financing.

We want to caution that breakeven is not the same thing as being profitable. Each ISP will have a different definition of profitable. Commercial ISPs typically expect a higher profit or return than municipal ISPs, but there is a wide range of the way that commercial ISP calculate profitability. If you talk to a dozen ISPs and you might find a dozen different methods for calculating profitability.

Most commercial ISPs measures 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 upon operating margin, while another ISP may expect a return on equity based upon free cash flow. Those are two very different numbers for asset-heavy businesses, because free cash flow includes the cost of annual capital for maintenance and growth. Other ISPs use a metric of return on assets. Other ISPs measure success based upon internal rate of return (IRR), which is the net present value into today's dollars for future expected earnings.

This can get really complicated, and so anytime an ISP talks to a municipality about a desire to make a return, it's vital to see the formula they are using to calculate that return. A return of 20% on equity might actually be lower than somebody expected in IRR of 6%.

Municipalities may also expect a return. For example, many municipal electric utilities are required by law to make a return in order to build up a rainy-day fund to pay for catastrophic weather events. Some cities expect all utilities to contribute to the city coffers and would expect a fiber business to make a return. The calculations above that consider the amount of grant needed to breakeven use the simplest definition of cash flow breakeven – the business never runs out of money. A business that breaks even on cash flow over twenty years will actually have lost money if there was equity inserted into the business – because the business would not even have earned back the initial investment.

The expected return can be a huge deal for commercial ISPs and is one reason that a lot of ISPs won't build rural networks even if they get a lot of grant funding. 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 making a commercially acceptable return. This is one of the primary reasons why the ISPs that tend to partner with communities for rural fiber businesses tend to be entities that have relatively low earnings goals.

IV. OTHER ISSUES

A. Funding for Broadband Networks

For a sizable percentage of broadband projects, the biggest challenge is finding the funding. This section of the report looks at the several ways that other communities have been able to fund broadband networks. If a community wants fiber badly enough, there probably is a way to pay for it.

There are a number of different financing options to consider. Below we look at the following:
- Private Financing (loans)
- Public Financing
- Grants
  - Federal Programs
  - State Programs
- Loan Guarantees
- Customer Financed
- Public-Private Partnerships

<u>Private Financing Options</u>

When commercial ISPs build networks, they must rely on traditional private financing, meaning loans. Following are the key elements that determine the cost of 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 required.
>
> Equity can take a number of different forms:
> - <u>Cash</u>: Cash is the preferred kind of equity and lenders like to see cash infused into a new business that can't be taken back out or that doesn't earn interest.
> - <u>Preferred Equity</u>: For a stock organization (like an LLC or other type of corporation) the business can issue some form of preferred stock that then acts as equity. Preferred equity usually gets some sort of interest rate return, but the payments are not usually guaranteed like they are for bank loans. If the business gets into a cash crunch, they must pay bank loans and other forms of debt before they pay preferred equity interest.
> - <u>Assets</u>: 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 by an independent appraiser.
> - <u>Non-recourse Cash</u>: Non-recourse cash means accepting a contribution to the business that is not guaranteed to be paid back. To give an example, in Sibley and Renville counties in Minnesota, a fiber business was launched in the form of a cooperative. The local government provided an economic development bond to the business as a non-recourse loan. This means that the new fiber business will make their best effort to make the bond

payments, but if they are short of cash then the government entities that issued the bonds would have to make the bond payments. The banks involved in that project looked at the contributions from the bonds to be the same as equity.

Bank Loans: The banking industry as a whole does not like to finance long-term infrastructure projects. This is the primary reason why the country has such an infrastructure deficit. Fifty or more years ago, banks would fund things like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. But various changes in banking laws have required 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 want to earn higher interest rates. 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 from earning more on its equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and many telecom projects can't generate enough cash in that time period to repay the loans.

There are exceptions. A few of the large banks like Key Bank and Bank of America have divisions that will make bank loans to municipal ventures that look a lot like bonds. These loans will have long payment terms of 20 years or more and reasonable interest rates. However, most of these loans go for things like power generation plants and other projects that have a strong guaranteed revenue stream. These banks have done a tiny handful of telecom projects, but they view most broadband projects to be too risky.

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 telecom project.

There is one unique banking resource available to companies who want to build fiber projects. This is CoBank, a boutique bank, and a cooperative. This bank has financed hundreds of telecom projects, mostly for independent telephone companies and electric cooperatives. CoBank is a relatively small bank and has strict requirements for financing a project. It is leery of start-ups, and we can't think of a start-up they have financed recently. It also expects significant equity to be infused into a new venture. They tend to have somewhat high interest rates and somewhat short loan terms of 10–12 years.

Cooperatives also have another bank that lends only to cooperatives. This is RTFC (Rural Telephone Financing Cooperative) that is owned by cooperatives.

One interesting source of bank financing is local banks. Historically local banks were the source in many communities for car and home loans. But over the last few decades, those loan portfolios have migrated to other lenders, and local banks have been struggling for a decade to find worthwhile projects in their regions. We know of many commercial projects for small telcos that have been financed by local banks.

The biggest challenge of borrowing from a local bank is that they typically have a relatively small lending limit. Most local banks won't make an individual loan for more than a few million dollars. That obviously doesn't go far in a fiber project. However, local banks have become adept at working in consortiums of multiple banks to make larger loans. This spreads the risk of a single loan across many banks. A banking consortium usually begins with a local bank in the area of the project, with the local bank taking the role of finding other banking partners and of servicing the loan. This approach requires a lot of extra effort from a local bank, but the approach has been used to finance good telecom projects.

Collateral. The biggest issue that banks have in lending to broadband projects is the lack of collateral, which is the assets they inherit if the project should fail. 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 networks are sometimes sold for pennies on the dollar.

It's important to understand the importance of collateral. Communities often ask a nearby ISP to build fiber in their town. What the community generally fails to realize is that the ISP likely would have to pledge their entire business as collateral in order to secure the loans to finance a new market – meaning that if the new venture fails, they could lose the whole 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 default. A bank will look at a dozen financial parameters before making an offer of interest rate and term – all based up their analysis of 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 of the 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 to 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 greater than 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 their 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).
- 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. Pre-loan expenses may be reimbursed only if incurred prior to the date on which notification of a complete application is issued.

RUS is allowed to make loans to a wide range of entities. Borrowers can be either nonprofit 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. We note that the loan application requires a lot of work, including such things as pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things which make the application expensive to get prepared 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.

In practical terms, here is how the RUS loans have been administered over the past few decades:

- The rules say that a project needs at least 10% equity, but in reality, 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 requires enough equity that the project can adequately cover debt payments.
- The loan terms are generally in the range of 12 years, sometimes up to 15 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under a 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 the more successful the existing company, the easier to meet their 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. This is generally not possible.

This makes the RUS a very unlikely funding source for a municipal venture or for any start-up venture.

The other big drawback of these loans is that they take a long time to process. They often have a backlog of loan applications at the RUS of 12–18 months, meaning you have to wait a long time after application to find out if they will fund your project. Very few existing companies are willing to wait that long unless they are certain they will be funded. If a borrower wants to coordinate these loans with other forms of financing, this delay is not practical. The loans are granted by using a detailed checklist and rating system. This system gives a big preference to making new loans to existing RUS borrowers.

However, the loan fund is quite large and currently sits at more than $1 billion. Congress generally has been adding additional funds to the RUS pot each year. The RUS also has some discretion, and it has the power to make a grant as part of the loan. 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 interest rates can be lower than market in some cases, but for the last several years, with low interest rates everywhere, the RUS loan rates were not much cheaper than commercial loans.

These loans also require a significant paperwork process to draw down funds along with significant annual reporting requirements.

Public Financing Options

The two primary mechanisms used for public financing are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. 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 out for 25 or 30 years. It's also possible to finance a project completely with bonds, meaning that no cash or equity is needed. The primary historical source of public money used to finance telecom projects comes through the issuance of municipal tax-exempt bonds, meaning the buyers of the bonds don't have to pay federal and/or state income taxes on the revenue from the bonds.

> **BCPL Loans**.[17] The State of Wisconsin makes infrastructure loans to communities through the Board of Commissioners of Public Lands (BCPL). From the ten years between 2009 and 2019 this program loaned almost $1.3 billion to local governments. BCPL interest rates are similar and competitive with bond interest rates. The main benefit of this loan package is that local governments can gain access to the same interest rates and terms as with highly rated municipal bonds without having to go through the expensive process of getting a rating for a bond issue.
>
> **Revenue Bonds**: Most of the municipal fiber networks that have been built have been financed through revenue bonds. Revenue bonds are backed by the revenues and the assets of the fiber network and the associated business. With a pure revenue bond, a local government will not have to repay the bonds if the project fails. With that said, having a bond default is a financial black eye that might make it hard for a community to finance future projects. So, to some degree, most governments would feel obligated to pay back revenue bonds, since there is a big cost for not doing so.
>
> It has gotten harder to finance broadband projects with pure revenue bonds due to some failures on the part of other municipal networks. Among these are Monticello, MN; Crawfordsville, IN;

[17] https://bcpl.wisconsin.gov/Pages/LoanProgramHomePage.aspx

and Alameda, CA. These kinds of failures have made investors leery about buying bonds that are only backed by the business. This reluctance has made financing with revenue bonds more expensive.

The cost of a bond issue cannot be judged only by the interest paid. The other financing costs can outweigh the interest rate in the effect on the bottom-line. Because of higher perceived risk, revenue bonds often have higher interest rates than general obligation bonds. Revenue bonds may also be layered with extra costs like the following:

> Debt Service Reserve Fund (DSRF): Many revenue bonds require borrowing additional funds to be kept in escrow as a hedge against missing future payments. The DSRF is often set to equal a year's worth of principal and interest payments. This money is put into escrow and is not available to operate the business.
>
> Capitalized Interest: Bonds begin accruing interest from the day the money is borrowed. Since fiber businesses take a number of years to generate enough cash to make bond payments, the bondholders require capitalized interest that is used to make the interest payments for up to the first 5 years of the project. Basically, the project must borrow the amounts needed to make debt payments which can add a significant amount to the size of the bond issue.
>
> Bond Insurance: Bond insurance is an up-front fee paid to an insurance company that will then pay one year of bond payments to bondholders in case of a default. We've seen bonds issued that have required both a debt service reserve fund and bond insurance.

For the last decade, the interest rates charged to bonds have been lower than the interest rate on commercial loans. But that has not always historically been the case. The difference between bond interest rates and commercial interest rates both change over time; that difference is referred to in the industry as the "spread." Sometimes the spread favors bonds, and at other times, it favors commercial borrowing. In our financial analysis, we assumed that the interest rates are lower on bonds. Interest rates are also not the same for all kinds of bonds. For instance, the interest rate for revenue bonds can be considerably higher than general obligation bonds due to the perceived higher risk.

General Obligation Bonds (GO Bonds): If revenue bonds aren't an option, then the next typical alternative is general obligation bonds. General obligation bonds are backed by the tax revenues of the entity issuing the bonds. This backing can be in the form of various government revenues such as sales taxes, property taxes, or the general coffers of a government doing the borrowing.

What these pledges mean is that if the broadband project fails and can't make the bond payments, then the backing, then the pledge revenue source, such as property or sales tax, would have to be used to make the bond payments.

Many states or local governments require a referendum to approve general obligation bond. Most states have a few exceptions for things like economic development bonds that don't require a referendum. Local governments sometimes hold a referendum for major infrastructure projects to make sure the public supports the initiative being financed.

There are other financing mechanisms that have been used by other municipalities to fund revenue-generating projects. These include:

Variable Rate Demand Obligations (VRDOs): A VRDOs is a bond where the principal is paid in a lump sum at maturity. However, the borrower has the right to repay the bonds in whole or in part at any time (upon an agreed-upon notice). VRDOs are effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system, this type of financing provides the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated, principal payments do not need to be made. If revenues come in faster than anticipated, repayment of the bonds can be accelerated without penalty. We can recall having only ever seen this used once for a municipal telecom system by the city of Alameda, California. This kind of financing is used fairly routinely for other kinds of municipal needs.

VRDOs are most commonly structured as 7-day floating rate bonds. Interest rates are reset each week, and this adds a lot of risk to this type of financing. Unlike fixed-rate bonds, the borrower doesn't know what the interest rate will be on the VRDOs over the life of the issue. Interest rates on VRDOs are on the short end of the yield curve and have therefore historically been lower than interest rates on fixed-rate bonds, even with the additional ongoing costs for a liquidity provider and a remarketing agent. There is typically a maximum rate stated that the VRDOs cannot exceed. But in a market where there is a significant increase in overall interest rates, this kind of financing could end up being significantly more expensive.

Capital Appreciation (Zero Coupon) Bonds (CABs): CABs are bonds that are issued at a deep discount which do not bear any stated interest rate. Like a Series E savings bond, CABs are bought at a price that implies a stated return calculated on a basis of the bond being payable at par at maturity. With no stated interest rate, there is no interest paid until maturity, at which time all the compounded accreted interest is paid. With no interest payments required in the beginning years of the bonds, this would enhance the cash flow in the beginning years of the business.

CABs do, however, have several drawbacks over other types of available financing. First, the interest rates on CABs are typically higher than both the fixed-rate and VRDOs. Second, investors prefer not to have a prepayment option on CABs, which limits the flexibility of the government to call the bonds early if revenue collections are better than anticipated or if a restructuring of the debt is needed. This structure is used frequently for various government borrowings, but we've not ever heard of this being used for telecom—although there is no reason why it could not be used.

Comparing Bond and Bank Financing

Benefits of Bond Financing: There are several major benefits for using bond financing:

- 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 out for 25 to 30 years. It's difficult to finance a commercial loan longer than 15 years. The longer the length of the loan, the lower the annual bond payments.
- Bonds can be used to 100% finance a project, meaning there is no need for cash or equity to fund the new business. Lack of cash equity is generally the requirement that creates a challenge for traditional commercial financing.
- Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the credit worthiness (bond rating) of the borrower as well as the perceived risk of the project.
- It's generally easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved, there is generally a ready market for buying the bonds and raising the needed funds.

Benefits of Commercial Financing: There are also a few benefits for commercial financing.

- Generally, the amount that must be borrowed from commercial financing is lower, sometimes significantly lower. This is due to several issues associated with bond financing. Bond financing often contains the following extra costs that are not included with commercial loans:
    - Surety: Bonds often require a pledge of surety to protect against a default of the bonds. The two most common kinds of surety are the use of a debt service reserve fund and bond insurance. A debt service reserve fund (DSRF) borrows some amount of money, perhaps the equivalent of one year of bond payments and puts it into escrow for the term of the bond. The money sits for the term of the bond to make bond payments should the project have troubles. Bond insurance works the same way, and a borrower will pre-pay an insurance policy at the beginning of the bond that will cover some defined amount of payments in case of a default.
    - Capitalized Interest: Bonds typically borrow the interest payments to cover bond payments for some period of time, up to 5 years.
- Construction Loans: Another reason that commercial financing usually results in smaller debt is through the use of construction financing. A commercial loan will forward the cash needed each month as construction is done, and interest is not paid on funds until those funds have been used. However, bonds borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also mean that a borrower will only draw funds they need, while bond financing is often padded with a construction contingency in case the project costs more than expected.
- Deferred Payment: Commercial financing often will be structured so that there are no payments due for the first year or two. This contrasts with bonds that borrow the money required to make these payments. Fiber projects, by definition, require several years to generate revenue, and deferring payments significantly reduces the size of the borrowing.
- Retirement of Debt: It's generally easy to retire commercial debt, which might be done in order to pay a project off early or to refinance the debt. This contrasts to bonds that often

require that the original borrowing be held for a fixed number of years before it can be retired or refinanced.

Grants

It currently feels like it's almost raining grants because there currently is a lot of grant programs all hitting the street at the same time.

Federal Broadband Grants: There are several permanent federal broadband grant programs that might benefit this project.

<u>e-Connectivity Grant Program</u>. In March 2017, Congress passed a one-time $600 million grant/loan program to build rural broadband. The project was labeled as the e-Connectivity Pilot. There is a lot of hope that Congress will continue this program.

<u>ReConnect Grants</u>.[18] In the 2017 Farm Bill, Congress created a grant program called ReConnect. The program awarded $200 million in grants, $200 million in loans, and $200 million in a combination of grants and loans in 2019. The program awarded $661 million in grants from the 2020 grant program. There will be an even larger amount of funding in the program, with the grant amounts to be announced later this year.

<u>Community Connect Grants</u>.[19] This program specifically targets the poorest parts of the country. This program awarded $34 million in 2018 and $30 million in 2019. Grant awards for the program are generally between $100,000 and $3 million and require at least a 15% matching from the grant recipient.

<u>BroadbandUSA Program</u>.[20] This program is part of the Department of Commerce's National Telecommunications and Information Administration (NTIA). The agency provides an annual database of grants that can sometimes be used for broadband (and are often used for other purposes). Examples include the Appalachian Regional Commission and the Community Development Block Grant (CDBG) Program.

The NTIA is also currently overseeing a grant program for $288 million that is aimed at rural partnerships. The NTIA is also currently overseeing a $1 billion grant program for Tribes.

<u>EDA Grants</u>. The Economic Development Agency awards grants for counties in the U.S. that are economically challenged. EDA grants can be used for a variety of purposes, and for the last decade, many rural communities got grants to fund broadband. The agency was recently given $3 billion in funding for grants, and the rules and grant deadlines should be announced sometime this fall.

2021 Grants. There are a lot of new grant opportunities for grants that are funded by the $1.9 trillion American Rescue Plan Act (ARPA).

[18] https://www.usda.gov/reconnect
[19] https://www.rd.usda.gov/programs-services/community-connect-grants
[20] https://www.broadbandusa.ntia.doc.gov/new-fund-search

Emergency Connectivity Fund. This is $7.171 billion in E-Rate funding to provide funding for expenditures that have already been requested by schools for emergency educational connections and devices for library patrons and school students. This is to provide funding to make sure that schools and libraries have enough laptops, tablets, hotspots, and broadband subscriptions for students to function in the current fall school year. Any funds remaining after accepting all applications for future purchases will be used to reimburse past eligible purchases made during the COVID-19 pandemic.

Coronavirus Capital Projects Fund (CCPF) is intended to fund "capital projects directly enabling work, education, and health monitoring, including remote options, in response to the public health emergency." Wisconsin's share of this program is $189 million. The U.S. Treasury Department is in charge of this funding and has indicated that the money will be predominantly used for broadband. Treasury's goal is to use the money to fund projects that will meet the "continuing need for connectivity in response to the COVID-19 pandemic." There are also opportunities for capital projects that provide other forms of connectivity access, such as community co-working hubs with digital assets.

Coronavirus State and Local Fiscal Recovery Funds provide $370.9 billion to state, local, territorial, and tribal governments. These funds can be used for several major categories of infrastructure, including power, water, and broadband. This is the most interesting and possibly the most useful funding because the local governments have money that can direct be used to build infrastructure. There is still a lot of debate at the policy level about how localities can use the funding. Already it seems like there is a consensus it can be used to bring broadband to low-income parts of the community that are on the wrong side of the digital divide.

Other Grants. The ARPA grant spread money around to a lot of other programs that could benefit parts of the community. There are grants that can be used for broadband training and for digital inclusion programs.

As an example of how widely the funding was dispersed through the government, there are nearly a dozen grants that could be used to assist the libraries. The biggest is a $200 million grant to the Institute of Museum and Library Services. This is an independent federal agency that provides grant funding for libraries and museums. $178 million of the $200 million will be distributed through the states to libraries. Each state is guaranteed to get at least $2 million, with the rest distributed based upon population. This is by far the largest federal grant ever made directly for libraries. There are other grants that can be used to pay for hotspots, modems, routers, and laptops.

FCC E-Rate. This is not a grant program, but it could provide some funding to build infrastructure. This is a program operated by the FCC through the Universal Service Fund. The program is intended to bring affordable broadband to schools and libraries. The funding is used for schools with the highest percentage of students that quality for the federal school lunch program – meaning that not all schools are eligible for the funding.

In past years this funding was used to directly offset the cost for qualifying schools to buy broadband. However, the FCC recently changed the funding mechanism, and schools can currently use the funds to instead build or enter into a long-term lease for fiber transport if that saves money compared to buying bandwidth. Some communities are using this funding to build middle-mile networks between schools, which could act as a middle mile network for a larger last-mile fiber project.

State Grant Programs

Wisconsin Broadband Office.[21] The Wisconsin Broadband Office (WBO) resides as part of the Public Service Commission of Wisconsin. The office has been tasked with the goal of making broadband more accessible, resilient, competitive, and affordable in the state. The WBO has collected data to create Wisconsin-specific broadband maps. The speed test data used in this report was gathered by the WBO.

In July 2020, the Governor created a Task Force for Broadband Access through an executive order. This task force is comprised of representatives from the industry, government, and the key stakeholders in the state. The task force has been asked to prepare an annual report talking about the state of broadband in Wisconsin. Here is a link to the 2021 report.[22]

Wisconsin Broadband Grants.

The Wisconsin Broadband office has been administering the award of broadband grants since 2014. The grant program was initially relatively small, and the awards in 2014 were $500,000. The grants have grown in recent years.

- In March 2021, the WBO awarded $24.8 million to 58 broadband projects around the state.[23]
- The legislature approved a $125 million grant program to be awarded in early 2022. Grant applications were accepted in July of this year. Applications for over $420 million in projects requested funding.
- There have been calls for an even larger grant program next year, but this will require action by the legislature.

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 agencies 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.

[21] https://psc.wi.gov/Pages/Programs/WBO.aspx

[22] https://psc.wi.gov/Documents/broadband/2021%20Governors%20Task%20Force%20on%20Broadband%20Access.pdf

[23] https://psc.wi.gov/Documents/broadband/RptGrantSummary_2021.pdf

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, meaning lots of paperwork. And then the agency making the guarantee will generally 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 the cost of future defaults. The 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 lending 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 tax 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 then designated specific opportunity zones. Unfortunately, there is no Opportunity Zone in Door County.

New Market Tax Credit. 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 is 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 that 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 final four years, for a total of 39%.

The Community Development Financial Institutions (CDFI) Fund and the Department of the Treasury administer the program. The process of how the Treasury allots credits is a complicated one, and we won't cover it, but in essence, there are entities around the country each year that are awarded tax credits, and these entities work as brokers to allocate the credits to specific projects. The credits are often purchased by the large national banks or other firms that invest in infrastructure.

In practice, these funds act as 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 at the end would have a balloon payment for the principal. However, often some or even all of the principal will be excused, making this look almost like a grant.

Because borrowers work with the ever-changing list of entities that hold the credits instead of the federal government, the process for applying for this money is somewhat fluid. However, there are entities and consultants who help find New Market Tax Credits and who can help you through the maze of requirements.

Customer Financing

When no ISP or municipality can finance a broadband project, we've seen citizens to step up and agree to somehow directly fund some or all of a broadband project. There are several examples of places where this has been done in the country:

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. There are some real examples of this kind of financing:

- Lyndon Township, Michigan: 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.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Each town has pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of their fiber network using a federal grant awarded from the Stimulus funding program in 2008. The city held a referendum and used a sales tax increase to pay for the matching funds needed to build the project.

Direct Customer Contributions: It's also possible to pay for some of a broadband project through a direct contribution of possible 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 in the broadband area 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 who agree to contribute $3,500 up-front to cover the cost of construction.

Public-Private Partnerships

A public-private partnership (PPP) is formed when a government entity and commercial entity fund a project together. There is no one model for a PPP, and such an arrangement can be structured in many ways. The main benefit of a PPP is that the commercial operator of a project benefits by getting some bond financing from the municipal partner. This allows the business to blend the benefits of bond and commercial financing and is one of the ways that makes it easier to get through the first few years of the project.

The general benefits of bond financing can make public money attractive to a commercial partner - low interest rates, long repayment term, and small or no payments for the first few years. But the downside is that there are more overall financing costs, and overall, a bond makes a project cost more in terms of cash. The safety of a bond in the first few years, though, can be attractive.

Combining Public and Private Financing. There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes with bonds as the equivalent of equity, meaning that the commercial partner will not require as much, or even no, cash equity.
- In terms of the amount borrowed, the two methods work well together if construction loans are used to cover the construction and bond financing is used for the longer-term financing costs.
- Combining the two methods works to produce a payment term that is longer than a traditional commercial loan.
- Combining the two methods also usually means lower debt payment during the first few critical years while the network is being built.
- Both municipalities and commercial telcos have a natural borrowing limit—meaning that there is always some upward limit on the amount of money they can borrow. Combining both kinds of financing can mean that neither partner has to hit their debt ceiling. Just as an aside, the debt ceiling is often the main impediment to funding a project 100% with bonds. Fiber projects are generally large, and the required funds can easily exceed the ability of a government to fund it 100%.

Following are two examples of this type of PPP, both from Minnesota:

- RS Fiber: RS Fiber is a broadband cooperative that was formed in Renville and Sibley counties. The project was funded from various sources, including a loan for 25% of the project supplied by a bond backed by the cities and counties involved in the project. The Cooperative raised the other money with a combination of bank loans and grants.
- Swift County: The county government contributed a significant percentage of the cost needed to construct a broadband network in the county. The bond proceeds were loaned to Federated Telephone Cooperative and are expected to be paid back over time.

B. Partnering Potential

This section of the report discusses how to find ISP partners to bring broadband to Door County. The following discussion on partnerships assumes a true partnership between Door County and an ISP – meaning one where the county is somehow contributing to the venture.

The Best Characteristics for an ISP Partner

Experience. We know of several investor-driven ISPs looking to invest and operate broadband networks, but which have never built or operated a network. This isn't to say that such a group can't be a good partner, but it's a higher risk to work with an ISP that doesn't already have customers, and that hasn't worked in a partnership before.

There are a few stories in the industry of public-private partnerships that went awry because of lack of experience by the ISP partner. In the following two examples, the ISP management team was made up of a team with industry experience but who had never worked together as a team before.

- The first example is Utopia in Utah. This is a collaboration of small towns that are working together through the Utopia organization to create economy-of-scale for the business. State law in Utah doesn't allow municipalities to be an ISP, so Utopia works as an open-access network where the cities build the network and various ISPs compete for customers.

  Utopia started by hiring an external management team that had not worked in the open-access environment before. Several things went wrong – the networks were late in getting constructed and came in over budget. The ISPs did not sell as aggressively as the business plan had required. Utopia ran out of cash before construction was complete and almost folded, but the business was eventually saved through several rounds of refinancing and is now large enough to be financially stable. It took almost a decade of the business being in financial duress to get to that point.

- Another example is Lake County, Minnesota. The county decided to borrow money to build a county-wide fiber network. This is one of the northernmost counties in the state and quite remote. There are 11,000 residents in 2,100 square miles. They hired an outside firm to construct the network and run the ISP. The project went way over budget and the project ran out of money with a backlog of almost 1,000 customers it couldn't connect to the network.

  The project was funded through a combination of a $10 million federal grant and a low interest government loan for $56 million. The county also bonded over $7 million locally for the project plus floated loans to keep the project afloat. The project went completely underwater financially and didn't make enough money to cover debt payments. In 2019 the county sold the network to an ISP for $8.4 million. The federal government had to write off about $40 million in debt, and the county still must cover the original bonds plus the internal loans made to the project.

Experience Working with Municipalities. It's important to work with an ISP that has worked with local governments before. CCG has witnessed a number of public-private partnerships with the recurring theme that the two parties get frustrated with each other over time. This is due to two factors – frustration with the decision-making process and a difference in goals and expectations.

Commercial ISPs become quickly frustrated with the municipal decision-making process. Most local governments have a specified legal process that must be followed to make certain kinds of decisions. This might mean listing the topic for a public meeting, waiting for a set time, and allowing public comment on the issue. Commercial ISPs are used to making decisions quickly and they don't like the drawn-out processes that government requires. Government entities get frustrated as well since their commercial partners push them to make decisions quickly when they can't.

A more fundamental issue in public-private partnerships is a fundamental difference in goals. The issue commonly arises when the two parties didn't thoroughly discuss their long-term goals for broadband before a partnership began. Commercial ISPs are often most worried about cash flow and profit margins. If they've invested equity in a broadband network, they become unhappy if the business doesn't meet their earnings goals. Governments often have a different set of goals – serving every household, offering low-priced broadband to low-income houses, providing subsidized broadband to nonprofits and anchor institutions. In many cases, these kinds of fundamental differences can't be overcome and eventually ends up in a dissolution of the partnership.

The differences between the two kinds of entities often surface when there is a discussion of rates. Cities often push back against rate increases – particularly in election years. Cities push partners for low rates and often want an ISP to give even lower rates for low-income households.

These kinds of issues are less likely to be a huge problem if the ISP has worked successfully with other municipalities before. A government entity that is working with an ISP that has not partnered in this manner before should have an in-depth discussion upfront about expectations. It's a lot easier if the two parties decide upfront that they aren't compatible instead of getting a divorce after the partnership has been launched.

<u>Financial Strength</u>. Municipal entities often have a tough time judging the financial strength of partners. Unfortunately, most public-private partnerships are not with big, well-financed ISPs. The more typical partnerships are with telephone companies, electric cooperatives, or fiber overbuilders. It's typical for commercial ISPs of this type to overstate their financial security – and they may even believe what they say in doing so. But there are a few fundamental things about ISPs that a city should understand:

- Almost every ISP has a natural borrowing limit. There is only so much debt that bankers and other lenders will allow them to carry. By definition, when an ISP nears that lending limit, it means that bankers think the ISP is pushing its financial limitations. Any ISP that has borrowed to its limit can't afford to make financial mistakes, and that means the partnership and all their other ventures need to perform as expected. It's not unusual to see a budding partnership be dependent upon obtaining financing, and it's not uncommon for the ISP to not get the hoped-for funding.
- The biggest issue with ISPs and borrowing is collateral. Banks don't look at fiber networks as good collateral for loans because there is very little value from repossessing a fiber network. This means the only good collateral that most ISPs have is the value of their existing company. Even surprisingly large ISPs might have to pledge their entire company in order to borrow a sizable amount of money to build an expensive network. It's often necessary for owners of ISPs to make personal guarantees on loans, meaning that both their business and their personal assets are on the line with a new fiber project. ISPs are highly unlikely to disclose to a government partner the details of how they raise money – among other reasons, they fear public disclosure laws and don't want their personal financial position discoverable as a public record.

Capacity to Grow. One of the hardest things to judge is the ability of an ISP to grow quickly. A traditional ISP like a telephone company may have a lot of customers – but they acquired them slowly over decades. ISPs (and all other types of businesses) often get stressed to the breaking point when they try to grow too fast. It's not unusual for an ISP to somehow assume that existing middle and upper management can handle a growth scenario while still somehow handling the existing responsibilities they've always had.

Just because a company is a great ISP doesn't mean that the company is capable of growing quickly. Unfortunately, there is no way to judge this unless the ISP has already been growing prior to the creation of the partnership.

Fair Recognition of Value. One of the important attributes of a good partnership is the full and fair recognition of the value that each party brings to the partnership. Municipalities should be wary of a partner that overvalues what they bring to and undervalues what you bring. A government can create value for a public/private partnership in a number of ways:

- Funding. Any amounts paid towards funding a broadband network are valuable. Governments often don't know how to set a value for cash contributions – something that commercial partners routinely figure out. It's been my experience that ISPs don't value government funding as much as they do other funding sources. This is because government funding doesn't come with the same stringent strings and responsibilities. A local government is not likely (or even able) to require things that a bank might require, such as collateral or a lien on a partner's assets. If an ISP gets into financial trouble, the first entity they will try not to pay is a government partner. This can be dealt with in creating a partnership agreement, but to some degree, this requires a government to think like a bank.
- Anchor Tenant. Government entities often make good anchor tenants – which is pledging to be an early customer of a network and guaranteeing to buy services with a long-term contract. It's not untypical for a government entity to be one of the largest broadband and telecom customers on a network.
- Other Assets. Governments often have other assets that can benefit a partnership. This could be land for placing equipment; It could be a building to create a central office or a storefront. It might mean towers, empty conduit, or spare existing fiber that can be used to defray the cost of constructing a broadband solution. The value of such assets should be set according to what the partnership would pay to get the same thing from a third party.
- Easier Construction Processes. Local governments often take a significant role during the construction process. They might have to approve permits for rights-of-way. They might be the entity that locates existing utilities. They might require inspection of construction worksites, during and after construction. They might require things like traffic management during construction. Before tackling a major fiber construction project with a partner, a government might review these various requirements to see if they can be streamlined to make it easier to build fiber. Note in doing so that this likely means making any relaxed rules available to any other entity that wants to build fiber.
- Contributed Labor. A government can contribute labor. Using the last example above, a government could agree to conduct permits, locating, or some other service for free as a way to contribute to launching a partnership project.
- Tax Abatements. Tax abatements have always been a tool for economic development. Governments often have it within their power to excuse certain taxes to entities that bring

something of economic value to the community. For example, it's common to not charge a large new business any property taxes for some period to lure them to the community. There are numerous taxes and fees that might impact a new broadband network, such as property taxes, sales taxes, right-of-way fees, etc., that a government might be willing to waive to help a new network get established.

The bottom line to this discussion is that a government can bring significant value to a partnership and that contribution should be fairly valued. Even when a government brings tangible value, such as contributing funding, it's not unusual for an ISP to undervalue that contribution. It's even more prevalent for an ISP to not assign a realistic value to the more intangible contributions.

How do You Find Potential Partners?

We've seen almost every partnership we know of come about through the following three processes:

- Request for Information (RFI). It's typical for communities that want broadband to issue an RFI aimed specifically at soliciting potential ISP partners. These RFIs typically describe the situation in the community, typically describe whatever work has already been accomplished (such as this feasibility assessment) and describe the role the municipality wants to take in a partnership.

  The RFI then asks ISPs to describe themselves and their capabilities. The RFI generally doesn't go so far as to request a specific solution but rather asks the ISPs to discuss how they might tackle broadband issues in the community.

  And RFI is generally a first step to determine which ISPs might be interested in partnering. After the RFI the process typically moves to one of the two processes described below.

- Request for Proposal (RFP). And RFP is typically a lot more in depth. In addition to asking ISPs to introduce themselves, an RFP might ask for specific proposed solutions. It might go further in detail asking about the financial strength of the ISP business and details of how they operate in other market.

- Direct and Private Negotiation. It's routine for governments to interact directly with potential ISP partners rather than go through an RFI or RFP. This might involve a local government reaching out to ISPs in the area, or it might be in response to an ISP making an unsolicited proposal to a local government to bring broadband.

Comparing the Three Options.

It's first worth considering the issue from the perspective of an ISP. ISPs are leery of public records laws. They are often highly reluctant to provide financial information, customer lists, or other information that they feel is confidential. They don't trust that local governments will fight to keep such information confidential. ISPs are even leerier of spelling out specific details of their business plan and how they approach a broadband market – they don't want that information to be available to their competitors.

Many ISPs are not willing or able to respond to an RFI or an RFP that asks for lengthy written responses to a lengthy list of questions. Businesses that sell equipment and services are used to the idea of making proposals and usually have a pile of pre-prepared canned responses to the typical questions they are asked by a prospective customer. However, an ISP may never have been asked to make a proposal in writing in the specific and detailed way that might be needed to respond to an RFI or an RFP. There are ISPs that refuse to participate in an RFI or RFP for this and related issues. We know there are ISPs that eliminate cities from consideration if they insist on going through the formal RFP process. They know there are other communities that will talk to them directly without the formal process.

ISPs prefer direct discussions where nothing is put into writing during the negotiation stage. That's the same process that ISPs typically use when they partner with other ISPs – they sit and talk out the pros and cons and mutually decide if there is a potential for a partnership. As often as not, such discussions end up with the realization that a partnership is not a good idea, and the parties amicably go their separate ways, and nothing they discussed is in writing.

For most local governments, the best first step is to invite known ISPs for a high-level discussion about whether any kind of partnership makes sense. This process might involve several meetings where an ISP might come back with ideas and then another meeting where the local government reacts. For smaller cities and for rural governments, this is likely the only approach that will work since small and rural communities are unlikely to attract ISPs from a distance.

Issuing an RFI makes sense when a community can't find or attract local partners. An RFI is more formal and will require ISPs to put at least some of their ideas into writing – which some may balk at doing. If a community issues an RFI, it should ask for basic information only. That might include asking an ISP to provide their history, talking about the products they normally sell, and talking about the management team. While cities might have a hundred questions for a prospective partner, the ISP is going to be a lot more willing to talk if the details of their business are not put into a publicly available document at the early stage of meeting and negotiating.

RFPs only make sense for larger cities – probably those with network costs over $100 million. Such cities are looking for big ISP partners, which will be a little less reluctance to discuss things in writing. An RFP probably should ask for sensitive financial information about the ISP – that can always be provided if the likelihood of a partnership develops.

Establishing Compatible Goals

At some point during the initial stages of the process, it's vital for both sides to thoroughly discuss their goals for the project. Misalignment of goals is the number one issue that plagues any partnership eventually. Both parties need to fully hear, understand, and be fully comfortable with the goals of the other partner.

Goals generally can be stated simply and don't have to be complicated. Goals for a municipality might be things such as serving the entire community, not needing to subsidize the project, keeping rates low, and so forth. Goals for an ISP might be to generate a specific target of cash flows and profits. It wouldn't be unusual for an ISP partner to eventually want the option to buy the business. An ISP also might want just the opposite and might want to capitalize on the success of the business by selling out after some period of time.

It's important to not only see each other's goals, but it's vital for a municipality to understand the ISP's goals. This is one situation where a municipality might want to discuss these goals with a consultant or somebody with broad industry experience. It's not unusual for two partners to be talking a different language when discussing financial issues, and it's vital to fully comprehend what a partner is telling you about their goals.

The alignment of goals is a make-or-break issue in a potential partnership. Many of the differences that a municipality and an ISP might have can be negotiated, but you can't negotiate a difference in philosophy. If an ISP has a goal that a municipality can't live with, such as selling out in 10 years – then our advice is to not pursue the partnership. When an ISP tells you a goal of that nature, they mean it.

How to Rank Potential Partners?

There are hundreds of questions that a local government might ask an ISP that might range from big important questions like, "Can you bring funding to this project?" to questions that are important but have a lesser impact on creating a partnership, such as, "What's your process of disconnecting customers who don't pay?"

CCG has helped to create partnerships of all types and we advise prospective partners (government or otherwise) to place their questions into three categories, 1) make or break questions, 2) questions that might disqualify a potential partner, and 3) all other questions.

Every community will have its own list of make-or-break questions based upon its local priorities for what a partner should bring to the table. Make-or-break questions might be things like 1) "How much funding can you bring to the project?", or 2) "Are you willing to serve everybody in the community?"

The first two categories of questions are the important ones that should be used to qualify and rank potential partners. Other less critical questions are important but probably don't get considered unless it's close between two candidates. You choose a partner based upon the most important aspects of the relationship.

There are several techniques that can be used to compile rankings. Most rankings of this sort are done by compiling the rankings by a team of reviewers. The most important questions might get weighted somehow to have the biggest impact on the composite answer. At the end of this process a numerical value will reflects the composite opinion of those doing the ranking. It's likely that such rankings are not even the final answer, and often the ranking process will send a government back to ask more questions.

Defining the Roles of Each Partner

It's vital to define the specific roles and responsibilities of each partner. Ideally, this should be done before formalizing the partnership arrangement.

CCG has often used a technique that seems to work ideally in defining a partnership. It starts with a list of all of the tasks needed for launching and operating the upcoming broadband business. The level of detail usually becomes readily apparent. For example, it it's clear that the ISP is going to have 100% of the interactions with customers, then having a task called "Interface with customers" would be sufficient rather than listing all of the various ways that somebody might interface with customers.

The items on the list would include financial and other contributions as discussed earlier, issues having to do with constructing the new network, issues having to do with governance, issues having to do with operating the business.

A responsibility must be assigned for each task on the list. The choices for each task are 1) the task is the responsibility of the government, 2) the task is the responsibility of the ISP, 3) the task is a joint responsibility of both parties (in which case that needs to be fully described), or 4) the task is the responsibility of some third party (like an outsourced arrangement). This kind of process quickly shows if the two parties are aligned and agree on all of the responsibilities and if there are tasks where the two sides have a different view. The example used earlier involved the setting of rates – this is a good way to get it in writing from both parties about the roles in rate setting process.

Making this list serves two purposes. It's a great tool for getting both parties to acknowledge the specific roles of each partner. It also then serves as a great template for developing a contract between the partners.

Maintaining Local Control

One of the most challenging aspects of public-private partnerships is the municipality maintaining some control over the business. I always advise a municipality to make a list of items they would like to have some control over. It's likely that a list will include major aspects of operating the business such as rates, installation intervals, business hours, priorities of repairing customers after an outage, etc. I then ask the municipality to change hats and look at these same issues from the perspective of the ISP, which is trying to run a profitable business. This exercise often highlights that some requests for control are unreasonable.

There is a good example of mixing politics and running an ISP from Bristol Virginia Utilities, which was one of the first cities to enter the broadband business. The business was operated by the electric utility, which was a branch of the local government, but which had a full standalone operating authority. The bonds were fully backed by the electric utility, but since the city had to approve any bond issue, the city reserved the right to set and approve rates. A few years after launching the business, and during an election year, the city council voted to slash all the rates by 15%. The utility warned them this would put the business underwater, and surely enough, the business didn't make enough money to meet a bond payment due six months later. The city got the message and ended up raising the rates to a higher level than the original rates to correct the shortfall, and the city also changed the ordinances so that no future city council could change rates.

There are numerous other examples of negative ways that local governments have meddled in a broadband business. Politicians might make promises to constituents on behalf of the ISP. Politicians often press to give special rates to friends or to forgive bad debts for a constituent. It's not unusual for politicians to go further and interfere in things like personnel decisions. It's incredibly important to have clearly defined boundaries and lines so that an ISP can say no to meddling.

ISPs are highly wary of ceding any control to a government entity. ISPs fully comprehend that a partnership with a municipality is always tentative and can change drastically after an election. There are plenty of examples of a council or board that changed from pro-broadband utility to anti after an election. Political changes can put a huge strain on the business relationship even if there are no control issues. ISPs know that the municipality they partner with today may not be the same in the future.

This is not to say that a municipality shouldn't have any control over the business. One of the more obvious aspects of maintaining control depends upon who funds the network. A municipality is going to get little or no say in how to operate a network that includes significant funding from a commercial ISP. If an ISP brings money to a project, they generally will not take the risk of letting a municipality tell them how to operate the business – since the ISP's primary goal will be in getting a good return on their investment.

But even funding doesn't always determine control. Many ISPs will only partner if they can make all the business decisions – even if the government funded the network. This is why potential partners need to ask all of these questions before they create the partnership.

The only sure-fire way for a municipality to have control is to fund and operate the network. It's going to be difficult to find an ISP partner that will want a city to influence business decisions once the business is operating. This is a case where a little authority is a bad thing. If a municipality has any authority to control the business, then eventually somebody at municipality will go too far, either today or in the future as the government changes.

C. Legal and Regulatory Review

The following is a listing of regulations that would apply to any ISP offering service in the county to provide broadband or telephone services. This list does not cover cable TV regulations.

FCC Regulatory Requirements

Generic Regulations

The following regulations apply for any entity undertaking any one of the FCC's regulated business lines (broadband, telephone, cable TV, cellular).

Federal Registration Requirement

All entities that want to do business with the FCC must obtain an FCC Registration Number (FRN). Additionally, entities entering the telecommunication market must receive a Form 499 identification number from the Universal Service Administrative Company (USAC) by filing submitting a signed copy of FCC Form 499-A.

Customer Proprietary Network Information (CPNI) Compliance Certification

Section 222 of the FCC's rules requires that telecommunications carriers and interconnected VoIP providers take specific actions to protect customer data. The FCC rules specify the customer data that must be protected. A telecommunications provider must file an annual certification that states that it is in compliance with the CPNI rules along with a statement each year that summarizes the carrier's CPNI practices and that discloses any customer complaints about violation of customer privacy. The FCC provides a detailed guide outlining the specifics of the CPNI rules.[24]

Infrastructure Access Rights

The FCC, as a result of the Telecommunications Act of 1996, provides carriers with nondiscriminatory access to poles, ducts and conduits. This overall rule applies to any carrier doing business in Wisconsin since the State of Wisconsin still follows the FCC's rules for pole attachments.

Common Carrier Annual Employment Report - Form 395

Common carriers with sixteen or more employees must complete and file FCC Form 395, Annual Employment Report, by May 31 of each year. Data must reflect employment figures from any one payroll period in January, February, or March.

Disability Access and Recordkeeping

Section 255 of the FCC rules requires that telecommunications equipment manufacturers and service providers make their products and services accessible to people with disabilities, if readily achievable. If accessibility for individuals with disabilities is not readily achievable, the provider must ensure that the equipment or service is compatible with existing peripheral devices or specialized customer premises equipment commonly used by individuals with disabilities to achieve access.

In 2010, Congress enacted the Twenty-First Century and Video Accessibility Act (CVAA), which imposed additional recordkeeping and certification requirements relating to disability access. Affected providers must record and maintain information about the accessibility features of its products and services and about the provider's efforts to consult with individuals with disabilities. A service provider must certify annually with the FCC that it meets the accessibility requirements.

Truth-in-Billing Rules

The FCC adopted Truth-in-Billing rules that specify the level of detail that must be included on telecommunications bills. The Truth-in-Billing rules specify a lengthy list of requirements that must be included on customer bills. The rules also outline other ways that carriers must inform customers of their rights for billing issues.

Annual FCC Regulatory Fees – Form 499

Interstate telecommunications service providers, local exchange carriers, and other telecommunications service providers, as well as interconnected VoIP providers, must pay an annual FCC regulatory fee. Carriers subject to the rules must submit Form 499 annually showing revenues. The annual fee is based upon the amount of Interstate revenues.

[24] https://www.fcc.gov/document/customer-proprietary-network-information-cpni.

Government entities and non-profit entities which are exempt under section 501(c) of the IRS Code are also exempt from regulatory fees, but still have to file the 499 form.

Broadband Regulation

The FCC describes its regulation of broadband carriers as 'light-touch' regulation. What this means in practical terms is that the FCC no longer exercises any blanket regulatory authority over broadband providers for big topics like rate regulation. However, the FCC still maintains a few areas of broadband regulation, as discussed below.

Broadband Reporting - Form 477

All ISPs selling retail broadband service or interconnected VoIP must report details of the coverage to the FCC twice each year.[25] This currently involves reporting data like the number of customers, the broadband speeds that can be delivered, and the technology being used by Census block. The FCC is in the process of modifying the method of data collection including the use of mapping tools. This reporting is the most time-consuming regulatory requirement for many ISPs.

Communications Assistance for Law Enforcement Act (CALEA)

Providers of telecommunications service, facilities-based Internet access service, and interconnected VoIP are subject to the Communications Assistance for Law Enforcement Act (CALEA). The CALEA rules are to make certain that carriers have the technical capability to allow law enforcement to conduct electronic surveillance of customers, after a valid subpoena.

Each ISP must create and keep updated a manual that describes how it complies with the CALEA rules, and that describes to law enforcement how to initiate a valid surveillance process.

Digital Millennium Copyright Act (DMCA)

The Digital Millennium Copyright Act of 1998 (DMCA) added several major provisions to the Copyright Act that delineate the rights and protections afforded to copyright owners and users in the digital age. Section 512 to the Copyright Act establishes safe harbors that can limit the type of relief that can be sought by copyright holders can bring against ISPs. The Act largely protects ISPs against copyright violations by the ISP's customers.

Regulatory Treatment of "Broadband Internet Access Service" (BIAS)

In its *Restoring Internet Freedom Order* issued in January 2018, the FCC rolled back portions of the *Open Internet Order* that had established net neutrality. In so doing, the FCC also reclassified broadband Internet access service from a Title II common carrier "telecommunications service" to an unregulated Title I "information service." However, there are a few requirements from the original net neutrality order that are still in effect.

[25] The 214 forms ask for a lot of information. The forms are found at this link: https://apps2.fcc.gov/form477/login.xhtml.

The Restoring Internet Freedom Order established new transparency requirements that give the FCC insight into current ISPs practices and that are supposed to allow consumers to understand the business practices of their ISP.

The specific transparency obligations include the following:

Network Management Practices. The FCC requires an ISP to disclose its practices for the following:

- *Blocking.* Any practice that blocks or otherwise prevents end user access to lawful content or applications.
- *Throttling*. Any practice that degrades or impairs access to lawful Internet traffic.
- *Affiliated Prioritization.* Any practice that directly or indirectly favors some traffic over other traffic to benefit an affiliate.
- *Paid Prioritization.* Any practice that directly or indirectly favors some traffic over other traffic in exchange for consideration, monetary or otherwise.
- *Congestion Management*. ISPs should describe congestion management practices, if any.
- *Application-Specific Behavior.* ISP should disclose if it blocks or rate-controls specific protocols or protocol ports, modifies protocol fields in ways not prescribed by the protocol standard, or otherwise inhibits or favors certain applications or classes or applications.
- *Device Attachment Rules*. An ISP should disclose of there are any devices that can't be connected to the network.
- *Security.* An ISP should disclose the goals of security practices, including types of triggering conditions that cause a mechanism to be invoked.

Performance Characteristics. The FCC requires an ISP to disclose information about the services it provides.

- *Service Description.* A general description of the service, including the service technology, expected and actual access speed and latency, and the suitability of the service for real-time applications.
- *Impact of Non-Broadband Internet Access Service Data Services.* An ISP should disclose any non-broadband services it provides and describe how any non-broadband service data may affect the last-mile performance of broadband.

Commercial Terms. The FCC requires an ISP to disclose the terms on which they make their services available:

- *Price.* An ISP must disclose monthly prices, usage-based fees, and fees for early termination.
- *Privacy Policies.* An ISP must disclose its privacy practices if any. For example, the ISP must disclose if it uses deep-packet inspection to monitor network traffic, whether traffic is stored or provided to third parties, or if customer traffic is used by the ISP for non-network management purposes.
- *Redress Options.* ISPs must describe how customers can resolve complaints.

Telephone Regulation

Section 214 Certification.

A carrier that wants to sell Interstate or International long-distance must be certified under Section 214 rules by the FCC. The certification is somewhat automatic but is needed to have the authority. It is possible to avoid the need for 214 authority by reselling long-distance from a carrier that already has 214 authority.

A carrier with 214 authority must request permission from the FCC to discontinue service if that means walking away from existing customers.

Kari's Law and RAY BAUM'S Act

Kari's Law became a legal requirement on February 16, 2018, and it applies to multi-line telephone systems (MLTS), which are telephone systems that serve consumers in environments such as office buildings, campuses, or hotels. The law requires that users of MLTS phone systems must be able to dial 911 directly without any additional digits or codes.

On March 23, 2018, the RAY BAUM'S Act was signed into law. This law supplements Kari's law and requires that any call to 911 include 'dispatchable' information, so that first responders can quickly find somebody who dialed 911. If this can't be done as part of caller ID, then locations like campuses, hotels, and large businesses must provide this information directly to local 911 centers.

While these requirements apply to phone systems at MLTS locations, the FCC expects that carriers selling telephone service to such locations make certain that there is compliance.

Local Number Portability

The FCC requires that any carrier that sells telephone service must participate in number portability, which are the rules that means customers can keep a telephone number when switching between providers. In most places in the country (some rural areas are excluded), numbers can also be ported between landline and cellular carriers.

Battery Backup Obligation

The FCC requires that anybody that provides telephone service offer an option for battery backup to customers. Traditionally, telephones served on copper wire continue to work when a home loses power, and the FCC has extended that to all other technologies. Carriers only need to offer the sale of battery backup equipment for sale at cost and are not required to provide battery backup as part of the monthly rate for telephone service

Broadband and Telephone Regulation

Federal Universal Service Program

Contributing to the USP. The FCC requires providers of "interstate" and "international" "telecommunications," "telecommunications service," or "Voice over Internet Protocol" to pay into the Universal Service Fund (USF). These fees can be passed on to end users at an ISP's discretion. All providers of these services must file FCC Form 499-A annually, including carriers that don't owe payments to the USF.

Providers must file FCC Form 499-Q quarterly to report qualifying revenues to the FCC that are subject to the USF fees. Each calendar quarter, the FCC announces the relevant percentage due for that quarter.

Drawing from the Universal Service Fund. Carriers can elect to participate in the programs in the fund that subsidize telecommunications services. Such participation is optional. There are a number of programs that operate under the Universal Service Fund:

- Schools and Libraries Fund. This fund provides subsidies for broadband provided to schools and libraries. Eligible schools and libraries are ranked according to the percentage of students eligible for subsidized school lunches. The program gives discounts to schools for buying broadband or related tasks – these payments are then made to the ISP providing the service.
- Rural Healthcare Fund. This fund provides discounted broadband to rural health care facilities and clinics. Recipients mostly must be non-profit entities, although exemptions exist. The program gives discounts to rural health care facilities for buying broadband or related tasks – these payments are then made to the ISP providing the service.
- Lifeline Program. This program provides a discount of $9.25 per month to customers that can be applied to telephone service, cellular service, or broadband. Households qualify by being eligible for various federal programs. Only one discount can be provided per household. The customer receives the $9.25 discount, and a participating ISP collects this amount from the Lifeline program.
- Various Grant programs. The FCC administers various grant programs through the universal service fund. For example, the current Rural Digital Opportunity Fund (RDOF) grants are being administered through the Universal Service Fund.

Federal Trade Commission Regulation

Red Flag Rules

Since 2003, the FCC has required telecom companies to adopt processes that ensure that customer data, including financial records like credit cards are protected. Telecom carriers must have a manual that describes the compliance to these rules and must hold at least one session per year with employees to review customer data protection.

Broadband Regulation

When the FCC in 2018 reclassified broadband from a Title II telecommunications service to a Title I Information Service, the FCC also gave some of its regulatory authority to the Federal Trade Commission. There are several consequences of this change. First, the FCC will no longer hear complaints about matters that it believes are under FTC jurisdiction. Second, it's worth understanding that the FTC regulates by enforcing specific violations of the law by specific carriers. The practical result of this is that a ruling against a big ISP doesn't necessarily apply to other ISPs – even though ISPs generally will modify practices to stay under the FTC radar.

The FTC is now responsible for the following for broadband providers:

Consumer Protection, Enforcement and Redress

In the *Restoring Internet Freedom Order,* the FCC suggests that consumer protection concerns should primarily be the function of the FTC. The FCC stated that the FTC already had broad authority to protect consumers from unfair or deceptive practices and that the FTC has the ability to apply consumer protection principles to the entire Internet ecosystem as opposed to only certain businesses.

Customer Privacy

In the *Restoring Internet Freedom Order* the FCC designated the FTC as the primary federal agency for ensuring customers' privacy.

Wisconsin Regulations

Overall Regulation

The telecommunications industry in Wisconsin is regulated by the Public Service Commission of Wisconsin (PSCW). The Telecommunications unit of the PSCW is responsible for overseeing the wholesale and provider-to-provider portions of the telecommunications industry in the state. The PSCW no longer regulates most telecom retail offerings. The PSCW jurisdiction is described by state law, and basic laws are codified in Chapter 196 and as modified be several subsequent laws.

<u>The specific focus of the PSCW is as follows, from its website:</u>

- Oversee the providers of wholesale telecommunications services in the state.
- Certify new Wisconsin providers.
- Arbitrate interconnection agreements between providers and approve negotiated agreements.
- Resolve interconnection disputes between service providers.
- Designate Eligible Telecommunications Carriers (ETCs) as defined by the Telecommunications Act of 1996 and Federal Communications Commission rules and regulations.
- Annual Filing Requirements.
- Legal Name Changes.

Specific Powers of the Public Service Commission of Wisconsin – Chapter 196.02

- The PSCW has the authority to regulate any entity it considers as a public utility.
- The PSCW can inspect the books, property, or records of any utility.
- The PSCW may investigate and require hearings on any topic that falls under its jurisdiction.

Jurisdictions over Rates – Chapter 196.03

The PSCW can investigate and determine adequate rates for telecommunications services (it has largely stopped regulating rates, but it still has the authority). PSCW should consider the following issues when investigating rates:

- Promotion and preservation of competition
- Promotion of Consumer Choice
- Impact on the quality of life for the public, including privacy considerations.
- Promotion of universal service
- Promotion of economic development, including telecommunications infrastructure deployment.
- Promotion of efficiency and productivity
- Promotion of telecommunications services in geographical areas with diverse income or racial populations.

Requirements to Share Poles and Conduit – Chapter 196.04

Utilities must allow others to use poles, conduits, and similar facilities. The owners if such facilities can expect to receive fair compensation. The PSCW will adjudicate disputes over connections and fees.

Depreciation Rates – Chapter 196.09

Utilities must annually report the depreciation rates used for each class of assets plus depreciation taken each year.

Public Utility Profit Sharing – Chapter 196.11

Publicly owned utilities must inform the PSCW of the method used to share revenues and profits from a utility with the local government.

Annual Financial Reporting - Chapters 196.07 and 196.12

Utilities must use accounting years ending December 31 and must report balance sheet statements to the PSCW by May 1 each year. Utilities must report details of revenues and expenses to the commission annually in a format specified by the PSCW.

Tariffs – Chapter 196.19

Utilities must file a tariff showing customer rates, tolls, and charges along with the terms and the conditions of products and services. A copy of the tariffs filed must be made available to the public.

Other tariff regulations include:

- Chapter 196.191 defines tariffs for intrastate access service.
- Chapter 196.195 defines tariffs required for rates filed under an alternate regulatory plan.
- Chapter 196.197 defines tariffs for unbundled network elements.
- Chapter 196.198 defines tariffs for local measured service plans
- Chapter 196.199 defines the requirement to file interconnection agreements with the PSCW.

Wholesale Telecommunications Services – Chapter 196.203

This Chapter defines the regulations that apply to wholesale telecommunications services (sales of services to other utilities).

Rates Charged by Government Owned Telecommunications Utilities – Chapter 196.204

Rates for telecommunications taxes, poles, rights-of-way, licenses, and similar costs must be priced at long-run incremental costs.

Discriminatory Rates – Chapters 196.205, 196.28, and 196.37

The PSCW may intervene and change discriminatory rates established by telecommunications cooperatives or small telecommunications utilities.

Voice over IP Not Subject to Regulation – Chapter 196.206

VoIP traffic is deregulated but is still subject to being assessed fees for the state universal service fund and intrastate access charges.

Regulation of Caller ID – Chapter 196.207

Defines the provision and blocking of Caller ID.

Long-Distance Service – Chapter 196.208

Defines long-distance and related blocking services.

Access Service – Chapter 196.212

Defines access charges on Intrastate long-distance.

Long-Distance Rates – Chapter 196.217

Telecommunication utilities must charge the same long-distance rates to residential and business customers.

State Universal Service Fund – Chapter 196.218

Establishes a state universal service fund with the PSCW as the administrator. Defines contributions and uses of the fund. Limits consumer fees for late payments.

Rights of Telecommunications Consumers – Chapter 196.219

Defines obligation to interconnect with other carriers. Defines carrier-of-last-resort obligations for retail service.

Consumer Complaint Process – Chapter 196.26

Defines rights of consumers to make formal complaints and obligates the PSCW to respond.

Regulation of Telecommunications Carriers – Chapter 196.499

Outlines all of the specific areas of regulation. This is a summary of many of the other regulations scattered throughout the rules.

Provider-of-last-resort Obligations – Chapter 196.503

Defines obligations of incumbent local exchange carriers to serve everybody within defined exchange boundaries.

Broadband Expansion Grant Program – Chapter 196.504

Defines a state grant program to promote rural broadband.

Municipal Regulations of Telecommunications – Chapter 196.58

Establishes the ability of a municipality to regulate certain aspects of telecommunications services within municipal boundaries. Most concerns rights-of-ways and uses of streets.

Limitation on Back-billing – Chapter 196.63

A consumer is only liable for unpaid bills within two years of such service.

Approval of Utility Mergers – Chapter 196.80

PSCW must approve mergers of utilities.

Regulation of Video Service – Chapter 66.0420

Defines the regulations for providing video service over wires. This includes a wide range of regulations, including the obligations to carry PEG channels of local programming.

Municipal Broadband Hurdles – Chapter 66.0422

Defines the steps that a municipality must take in order to provide telecommunications or broadband facilities. Before enacting an ordinance or adopting a resolution to offer such services, a municipality must:

- No less than 30 days before considering a service, the municipality must publish a feasibility study that defines the construction costs, expected revenues, and costs of operating the telecommunications r broadband business. The study must include a cost-benefit analysis covering at least three years.
- Hold a public hearing on the proposed service, including giving proper notice to all areas that might be affected by the service.
- A majority of the governing board of the municipality must approve any ordinance or resolution.

There are additional requirements for providing broadband service. At least one of the following three requirements must be met before the municipality can offer broadband:

- The municipality must ask each ISP currently providing service within the community if it already offers the proposed services or if it intends to offer the service proposed by the municipality over the next nine months. The municipality can proceed if nobody says it offers the services or will offer them within nine months.
- If an ISP says it is offering the proposed service, but the municipality demonstrates that the service is not being offered.
- If an ISP says it will offer service within nine months but then fails to do so.

Municipalities do not need to go through this process to provide wholesale service provided directly to ISPs or carriers rather than consumers.

Finally, as soon as practical after starting to provide telecommunications or broadband services, a municipality must demonstrate that it reimbursed the original cost of the feasibility study.

Summary of Regulation

This summary is being written from the perspective of a municipality either becoming an ISP or partnering with an ISP to bring a broadband solution.

<u>Federal Regulation</u>. There are no federal regulations that would disadvantage a municipal ISP or an ISP partnership, including a municipal partner.

Current federal regulation is of broadband is considered light by a historical perspective because the last FCC under Chairman Ajit Pai killed Title II regulation - the primary regulatory tool used to regulate broadband at the federal level. Killing its own authority to regulate broadband means that FCC can't consider things like imposing rules about offering broadband or consider broadband rates. The FCC is still left with some regulations that derive from Congressional orders separate from the Telecommunications Act of 1996. These additional rules dictate the regulations listed above, such as having provide access to customer records in response to an FBI subpoena or having to protect customer credit card records. But for the most part, the FCC no longer performs what would be considered as basic regulatory oversight over broadband.

The FCC still regulates telephone service to some extent since those rules were established by laws that are not tied to Title II regulation. But the FCC has always deferred most telephone regulations to the States. But the agency still sometimes takes new actions, such as a current effort to reduce the number of automated robocalls being sent to the average telephone subscriber.

Wisconsin State Regulation. States all have a dilemma when it comes to broadband regulation, because to some extent, the ability of states to regulate broadband stems from federal authority that is passed on to the states. When the FCC relinquished the ability to regulate basic issues like broadband prices, there is a general consensus that this also killed the state's ability to regulate the same issues.

Wisconsin has joined most other states in largely deregulating telephone service. The PSCW still requires companies to create and file tariffs with terms and conditions for customers and to follow rules that protect the public's data, but mostly the state has relinquished this role – although it still has the authority.

There is still one set of regulations concerning municipalities that are still enforced. A municipal ISP must jump through additional hoops before offering broadband – steps that are not required for a new commercial ISP. A municipality would have to hold public hearings, a fairly minor step that would probably be done anyway. The more important restriction is that a municipality must give existing ISPs the opportunity to provide services before it is allowed to do so. ISPs have up to nine months to provide the desired services before a municipal ISP is allowed to do so.

These rules should not stop a municipality from building fiber. But these requirements add time upfront to get into the business.

The law is not at all clear if these restrictions apply to a partnership that includes a municipality. There are a lot of possible ways that a municipality could partner. If it did nothing more than give a grant to a commercial ISP, then this restriction probably wouldn't kick in. But if any partnership is formed such that a municipality has some say in the ongoing business, then it's like that this law would apply. The way that government entities around the country handle these kinds of restrictions is to assume that they apply and act accordingly – it's safest to comply rather than be sued later for not complying.

EXHIBIT I: SUMMARY OF ONLINE RESIDENTIAL SURVEY

Door County
Online Residential Broadband Survey Results
From June 2021

1. Do you have Internet access to your home today?

	Number	Percent
Yes	847	85%
No	148	15%

2. What's the primary reason you don't have home Internet service today?

	Number	Percent
It's not available at my home	124	72%
It's too expensive	39	22%
I don't have a computer	2	1%
I have no need for Internet at home	1	1%
Other	7	4%

3. Who provides Internet service to your home today?

	Number	Percent
Charter/Spectrum/Spectrum	179	25%
CenturyLink	28	4%
AT&T	12	2%
Frontier	147	20%
Door County Broadband	151	21%
Satellite	127	18%
Only use my cellphone data	69	10%

4. Are you receiving the speed you are paying for?

	Number	Percent
Yes	190	27%
No	266	37%
I'm not sure	253	36%

5. What Internet speed are you supposed to be getting today in your home?

	Number	Percent
1 – 10 Mbps	88	38%
11 – 25 Mbps	73	31%
26 – 50 Mbps	12	5%
51 – 100 Mbps	48	20%
101- 200 Mbps	10	4%
200 + Mbps	5	2%

6. What is the actual download speed you are getting in your home?

	Number	Percent
1 – 10 Mbps	142	58%
11 – 25 Mbps	39	16%
26 – 50 Mbps	19	8%
51 – 100 Mbps	28	11%
101 – 200 Mbps	16	6%
200 + Mbps	3	1%

7. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Provider on the following?

DOWNLOAD SPEED	Number	Percent
1 Very Dissatisfied	186	27%
2 Dissatisfied	169	24%
3 Neutral	157	23%
4 Satisfied	104	15%
5 Very Satisfied	81	11%

CUSTOMER SERVICE:	Number	Percent
1 Very Dissatisfied	139	20%
2 Dissatisfied	130	19%
3 Neutral	197	29%
4 Satisfied	126	18%
5 Very Satisfied	97	14%

VALUE I GET COMPARED TO THE PRICE I PAY:

	Number	Percent
1 Very Dissatisfied	233	33%
2 Dissatisfied	197	28%
3 Neutral	139	20%
4 Satisfied	89	13%
5 Very Satisfied	39	6%

8. Who is your current cable provider?

	Number	Percent
Charter/Spectrum/Spectrum	107	13%
CenturyLink	4	< 1%
AT&T	26	3%
Frontier	11	1%
Satellite	335	42%
Watch only online (such as Netflix)	151	19%
Antenna/Over-the-air	76	9%
Do not watch TV	30	4%
No TV service available	63	8%
Other	3	< 1%

9. If you have a telephone landline, who provides your telephone service?

	Number	Percent
Charter/Spectrum/Spectrum	69	9%
CenturyLink	11	1%
AT&T	50	7%
Frontier	125	16%
Don’t have a landline	492	64%
Other	19	3%

10. What do you currently pay for the following?

Standalone Cable TV:	Number	Percent
$25 - $50	9	4%
$51 - $75	21	11%
$76 - $100	42	22%
$101 - $125	54	28%
$126+	67	35%

Standalone Telephone:	Number	Percent
$1 - $20	8	6%
$21 - $50	48	37%
$56 - $75	30	23%
$75+	44	34%

Standalone Internet:	Number	Percent
$26 - $50	54	14%
$51 - $75	136	36%
$76 - $100	115	31%
$101 - $125	24	6%
$126+	47	13%

11. In general how do you feel about the idea of a new broadband network in the County?

	Number	Percent
I support the idea	652	81%
I do not support the idea	9	1%
I need more information.	148	18%

12. What are the reasons for your support?

	Number	Percent
More competition	529	83%
Lower prices	384	60%
Faster Speeds	555	87%
Better Customer Service	274	43%
More reliable service	485	76%

13. What are the reasons you do not support the new fiber network?

	Number	Percent
Cost	1	50%
Broadband in the county is adequate	1	50%

14. What factors would influence your decision to move your services to a new network?

	Number	Percent
Faster Internet speeds for the same price I pay today	602	78%
Lower price than I pay today	441	57%
Same price I pay today but better customer service	180	23%
Availability	51	7%
Reliability	30	4%
Other	12	2%

15. Would you buy Internet service from a new network if it guaranteed faster speeds than the competition at rates similar to what is currently available?

	Number	Percent
Yes, definitely	486	62%
Probably	179	23%
Maybe	92	12%
Probably not	17	2%
Definitely not	4	1%

16. Would you buy a landline telephone service from a new network in the County if they could offer affordable prices?

	Number	Percent
Yes, definitely	151	20%
Probably	81	10%
Maybe	134	17%
Probably not	216	28%
Definitely not	194	25%

17. Do you currently subscribe to cell phone service?

	Number	Percent
Yes	767	99%
No	9	1%

18. Is the cellular coverage at your home adequate?

	Number	Percent
Yes	452	59%
No	320	41%

19. Does anyone in your family ever work at home using Internet access?

	Number	Percent
Yes, full-time	136	18%
Yes, a few times a week	211	27%
Yes, a few times a month	111	14%
Yes, very occasionally	121	16%
No	198	25%

20. Would you or your family member work from home more if you had faster Internet?

	Number	Percent
Yes	407	54%
No	343	46%

21. Do you have school-age children at home who use the Internet to do their homework?

	Number	Percent
Yes	142	18%
No	633	82%

22. If the answer is yes, is your Internet connection good enough to support their homework?

	Number	Percent
Yes	66	36%
No	117	64%

EXHIBIT II: Summary of Financial Results

	Total County	Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 10 Cash	Year 20 Cash
	Commercial ISP								
1	**Base**	$130.5 M	50%	$118.8 M	$17.8 M		$136.6 M	$ 0.18 M	-$13.26 M
2	**Breakeven Grant**	$130.5 M	50%	$104.1 M	$15.6 M	$14.0 M	$133.7 M	$ 4.44 M	$ 0.19 M
3	**Higher Interest Rate**	$130.5 M	50%	$104.9 M	$15.7 M	$14.0 M	$134.7 M	$ 2.44 M	-$ 5.82 M
4	**Lower Interest Rate**	$130.5 M	50%	$103.2 M	$15.5 M	$14.0 M	$132.7 M	$ 6.36 M	$ 5.96 M
5	**20-Year Term**	$130.5 M	50%	$106.2 M	$15.9 M	$14.0 M	$136.1 M	-$ 1.90 M	-$18.82 M
6	**30-Year Term**	$130.5 M	50%	$102.5 M	$15.5 M	$14.0 M	$132.2 M	$ 8.37 M	$11.98 M
7	**55% Penetration**	$133.3 M	55%	$104.1 M	$15.6 M	$14.0 M	$133.7 M	$ 9.79 M	$15.10 M
8	**55% Penetration No Grant**	$133.3 M	55%	$118.6 M	$17.8 M		$136.4 M	$ 5.29 M	$ 1.58 M
9	**45% Penetration**	$127.9 M	45%	$103.8 M	$15.6 M	$14.0 M	$133.3 M	-$ 0.23 M	-$13.91 M
10	**Breakeven Grant**	$127.9 M	45%	$ 88.1 M	$13.2 M	$29.0 M	$130.3 M	$ 4.38 M	$ 0.49 M
11	**Higher Prices**	$130.5 M	50%	$102.6 M	$15.4 M	$14.0 M	$132.0 M	$ 8.93 M	$13.69 M
12	**Lower Prices**	$130.5 M	50%	$105.8 M	$15.9 M	$14.0 M	$135.6 M	$ 0.17 M	-$13.24 M
13	**Rate Increases**	$130.5 M	50%	$104.1 M	$15.6 M	$14.0 M	$133.7 M	$ 7.05 M	$16.54 M
14	**5% Higher Fiber Costs**	$135.2 M	50%	$108.8 M	$16.3 M	$14.0 M	$139.12 M	$ 2.90 M	-$ 4.48 M
15	**5% Lower Fiber Costs**	$125.7 M	50%	$ 99.3 M	$14.9 M	$14.0 M	$128.2 M	$ 5.97 M	$ 4.87 M
16	**With 50% Federal Grant**	$130.5 M	50%	$ 83.0 M	$12.5 M	$34.4 M	$129.9 M	$11.00 M	$19.86 M
17	**With Seasonal Discount**	$130.5 M	50%	$105.6 M	$15.8 M	$14.0 M	$133.7 M	$ 0.59 M	-$11.77 M
	County as ISP								
18	**GO Bond**	$130.5 M	50%	$153.2 M			$153.2 M	-$ 9.46 M	-$48.14 M
19	**GO Bond Breakeven Grant**	$130.5 M	50%	$106.2 M		$40.2 M	$146.4 M	$ 8.93 M	$ 0.15 M
20	**Revenue Bond**	$130.5 M	50%	$165.3 M			$165.3 M	-$12.07 M	-$56.27 M
21	**Revenue Bond Breakeven**	$130.5 M	50%	$108.5 M		$45.0 M	$153.5 M	$ 9.39 M	$ 0.55 M
22	**Operator for Hire Rev Bond**	$130.4 M	50%	$108.5 M		$45.0 M	$153.5 M	$ 4.27 M	($ 8.16 M)
23	**Open Access - Rev Bond**	$127.4 M	50%	$104.1 M		$45.0 M	$149.1 M	($10.62 M)	($46.63 M)

	Rural County	Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 10 Cash	Year 20 Cash
	Commercial ISP								
24	**Base**	$76.1 M	50%	$73.0 M	$10.9 M		$83.9 M	-$ 7.93 M	-$32.31 M
25	**Breakeven Grant**	$76.1 M	50%	$38.2 M	$ 5.7 M	$33.7 M	$77.6 M	$ 2.92 M	$ 0.21 M
26	**Higher Interest Rate**	$76.1 M	50%	$38.5 M	$ 5.8 M	$33.7 M	$77.9 M	$ 2.18 M	-$ 2.01 M
27	**Lower Interest Rate**	$76.1 M	50%	$37.9 M	$ 5.7 M	$33.7 M	$77.2 M	$ 3.63 M	$ 2.33 M
28	**20-Year Term**	$76.1 M	50%	$39.0 M	$ 5.8 M	$33.7 M	$78.5 M	$ 0.59 M	-$ 6.77 M
29	**30-Year Term**	$76.1 M	50%	$37.7 M	$ 5.6 M	$33.7 M	$77.0 M	$ 4.36 M	$ 4.54 M
30	**55% Penetration**	$77.4 M	55%	$38.3 M	$ 5.7 M	$33.7 M	$77.8 M	$ 5.39 M	$ 7.23 M
31	**Breakeven Grant**	$77.4 M	55%	$45.9 M	$ 6.9 M	$26.4 M	$79.1 M	$ 3.03 M	$ 0.19 M
32	**45% Penetration**	$74.9 M	45%	$37.9 M	$ 5.7 M	$33.7 M	$77.3 M	$ 0.53 M	-$ 6.62 M
33	**Breakeven Grant**	$74.9 M	45%	$30.5 M	$ 4.6 M	$40.9 M	$76.0 M	$ 2.82 M	$ 0.28 M
34	**60% Penetration**	$78.7 M	60%	$38.5 M	$ 5.8 M	$33.7 M	$77.9 M	$ 7.80 M	$14.18 M
35	**Breakeven Grant**	$78.7 M	60%	$53.4 M	$ 8.0 M	$19.2 M	$80.6 M	$ 3.13 M	$ 0.19 M
36	**65% Penetration**	$80.0 M	65%	$38.5 M	$ 5.8 M	$33.7 M	$77.9 M	$10.30 M	$21.33 M
37	**Breakeven Grant**	$80.0 M	65%	$61.1 M	$ 9.2 M	$11.8 M	$82.0 M	$ 3.26 M	$ 0.21 M
38	**Higher Prices**	$76.1 M	50%	$37.4 M	$ 5.6 M	$33.7 M	$76.7 M	$ 5.12 M	$ 6.81 M
39	**Lower Prices**	$76.1 M	50%	$38.9 M	$ 5.8 M	$33.7 M	$78.5 M	$ 0.73 M	-$ 6.39 M
40	**Rate Increases**	$76.1 M	50%	$38.2 M	$ 5.7 M	$33.7 M	$77.6 M	$ 4.19 M	$ 8.15 M
41	**5% Higher Fiber Costs**	$79.0 M	50%	$41.1 M	$ 6.2 M	$33.7 M	$80.9 M	$ 1.93 M	-$ 2.68 M
42	**5% Lower Fiber Costs**	$73.3 M	50%	$35.2 M	$ 5.3 M	$33.7 M	$74.2 M	$ 3.87 M	$ 3.09 M
43	**With 50% Federal Grant**	$76.1 M	50%	$34.4 M	$ 5.2 M	$37.4 M	$76.9 M	$ 4.11 M	$ 3.77 M
44	**$1M Alternate for 10 Years**	$76.1 M	50%	$33.3 M	$ 5.0 M	$43.7 M	$82.0 M	$ 9.45 M	$ 9.78 M
45	**$10M One-time Alternate**	$76.1 M	50%	$27.9 M	$ 4.2 M	$43.7 M	$75.8 M	$ 6.12 M	$ 9.79 M
46	**Seasonal Discount**	$76.1 M	50%	$38.8 M	$ 5.8 M	$33.7 M	$78.3 M	$ 0.95 M	-$ 5.69 M
	County as ISP								
47	**GO Bond**	$76.1 M	50%	$89.2 M			$89.2 M	-$15.60 M	-$52.71 M
48	**GO Bond Breakeven Grant**	$76.1 M	50%	$37.4 M		$44.3 M	$81.7 M	$ 4.56 M	$ 0.17 M

49	**Revenue Bond**	$76.1 M	50%	$96.3 M		$96.3 M	-$17.03 M	-$57.39 M
50	**Revenue Bond Breakeven**	$76.1 M	50%	$38.3 M	$45.9 M	$84.2 M	$ 4.67 M	$ 0.20 M
51	**Operator for Hire Rev Bond**	$76.1 M	50%	$38.3 M	$45.9 M	$84.2 M	($ 2.73 M)	($13.83 M)
52	**Open Access - Rev Bond**	$73.9 M	50%	$35.4 M	$45.9 M	$81.3 M	($ 3.98 M)	($19.01 M)