Broadband Plan Report

Champaign County, Illinois

March 9, 2022

Finley Engineering
CCG Consulting

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EXECUTIVE SUMMARY

Finley Engineering and CCG Consulting submit this Broadband Plan Report for Champaign County, Illinois. Our firms were hired in response to RFQ 2021-008. The scope of the project was to create *a sustainable broadband master plan for the entire county to address existing digital inequities and barriers to access, adoption, and utilization of robust broadband by all residents, businesses, and institutions*. The scope of work changed somewhat during the course of our work to address the large amounts of broadband grant monies that are coming available at both the federal and state level. So rather than just document the various broadband gaps, this report is an actionable plan for seeking the funding to solve the identified broadband shortfalls.

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 a big disparity in the county between broadband speeds in towns and cities and speeds in rural areas. The best visual demonstration of this is the map created from the survey conducted by the Farm Bureau that shows broadband speeds dropping at the outskirts of every city. This study verified the speed issue using several other sources of data.
- The study also highlighted problems throughout the county with broadband upload speeds. In the rural areas, the upload speeds are so slow as to be nearly non-functional. But speed tests, surveys, and other data show that there are a lot of homes in the cities that also don't have adequate upload broadband to enable multiple people to use upload bandwidth at the same time.
- Our financial analysis shows there is a need for significant grant funding to build the networks needed to bring broadband to the rural areas. The good news is that 2022 and 2023 will see the awards of unprecedented large amounts of broadband grants. That's a great opportunity for finding a solution for areas with poor broadband. But it also creates a sense of urgency because if the county doesn't find a solution now, there may not be an additional opportunity for a long time.
- The FCC offered subsidies to ISPs to serve a significant portion of the rural areas with the Rural Digital Opportunity Fund (RDOF) reverse auction in December 2020. The FCC has not yet made any of these awards to the three ISPs that tentatively won the reverse auctions. These awards present several dilemmas for solving the broadband needs in the county. Most of the RDOF award areas are to be built using wireless technology – this may not provide the long-term broadband solution the county is hoping for. We are also concerned that the FCC hasn't decided about making these awards. No other grant funding can be used in these areas while the FCC funding is pending, and the clock is ticking to look for solutions for the RDOF areas if the FCC decides not to make the RDOF awards.
- Any broadband solution needs to be built for the future and not for today. The requirements for broadband have been growing at a steady rate since the 1980s. OpenVault recently showed that the average broadband usage for homes in the U.S. has grown from 215 gigabytes per month in the first quarter of 2018 to 536 gigabits at the end of 2021. That growth is slightly higher than historical averages due to the pandemic – but not by much.

Our first phase of the investigation was market research to understand availability broadband in the county today. We communicated with residents and businesses through surveys and interviews to understand the

broadband needs throughout the county. We interviewed the existing ISPs. 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 many of the rural residents have access to 25/3 Mbps broadband that we know doesn't exist. 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 also heard from residents who can't afford broadband, meaning the county also has a broadband affordability gap.

The next phase of the assessment quantified the cost of bringing better broadband to the county. We studied three different geographic footprints. First, we studied everything outside of Champaign and Urbana. We also studied what we called the rural areas, which is every place in the county that isn't served today by a cable company network. Finally, we subdivided the rural area to look at the areas with and without the pending RDOF funding. Finley recommends building a fiber network using XGS-PON technology that is capable of delivering 10-gigabit symmetrical broadband to every home and business in the study area. Finley quantified the cost of the needed investments for a fiber network to by $164.4 million for the whole study area, $71.8 million for the entire rural area, and $54.4 million for the rural areas that are not already covered by tentative RDOF funding.

We knew before we started that any fiber built in the rural areas would require grant funding. We still don't know the rules for the large upcoming federal grants, but we know they may provide up to 75% of the funding for grant-eligible assets. If the final grant rules allow that level of funding there will be up to $53 million of grants available for the whole rural area and $39 million for the areas not covered by RDOF. Our analysis shows that the amount of grant funding needed to make a project work is likely smaller than that but is highly dependent upon the projected number of customers that an ISP expects to get.

The report concludes with two sections discussing what the County needs to consider doing next after getting this report. In a section of the report titled Strategic Considerations we discuss the big decision that the County must make in moving forward. We find it likely that large ISPs will propose to get grant funding to serve the rural parts of the county, although there is no guarantee of that. But this might mean that broadband grant funding might go to support technologies you don't prefer or to support large ISPs you might not want. We think the County can play a big role in choosing the ISP(s) to serve the rural parts of the county, particularly if you provide some matching funding. We are also convinced that a coalition of all of the major stakeholders in the county is needed to get the grant funding you want.

We also provide a list of concrete next steps you should consider after digesting this report. That includes identifying the staffing needed this year to pursue a broadband solution, finding and partnering with ISPs to pursue grants, gathering more facts such as conducting statistically valid surveys, educating elected officials and the public on broadband issues, reviewing local policies that might be a barrier to constructing a broadband network, and tackling the other broadband issues like digital literacy.

FINDINGS

Following are our primary findings:

Existing ISPs. The county has a wide array of ISPs today. AT&T and Frontier are the incumbent telephone companies serving rural parts of the county, and for the most part, provide broadband using DSL technology using copper telephone wires. Comcast and Mediacom are the incumbent cable television providers in the cities and villages. There are a few fiber overbuilders in the county, including I3 Broadband and Campus Communications Group. Several fixed wireless providers claim coverage in the county, including AgPro Wireless, Volo Internet + Tech, Rising Wireless, Rise Broadband, WATCH Communications, and Wireless Data Net. Some rural customers are using broadband provided by cellular companies with cellular hotspots or the more recent fixed cellular products. Most rural homes and businesses can buy satellite broadband from Viasat and HughesNet. We encountered county residents who are participating in the beta test for Starlink, the low earth orbit satellite company.

Existing Broadband Prices. As might be expected with so many different ISPs, broadband prices vary widely. Following is a summary of the prices charged by most commonly used residential ISPs. Note that prices are not always directly comparable since ISPs differ on charges for things like modems. ISPs often offer promotional prices for new customers and sometimes bundle products together. 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.
- 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.
- Comcast's basic broadband product is $76 per month for up to 200 Mbps, with a mandatory fee of $14 for the modem. Comcast offers faster speed tiers up to 1.2 Gbps.
- Mediacom offers a 60 Mbps broadband product with data caps. It charges $49.99 with a 200 GB cap and $69.99 with a 400 GB cap. The standard starting product is $79.99 for 100/10 Mbps and a 1 terabyte data cap. The modem is $10.
- Campus Communications group (CCG) charge $69.99 for a symmetrical 1 gigabit connection.
- I3 Broadband charges $54.99 for 250 Mbps, $64.99 for 500 Mbps, and $89.99 for a gigabit connection, all symmetrical speeds. A router is $7 per month.
- Volo Internet charges by the gigabyte of usage for fiber. A customer can get 10 gigabytes per day for $49.95, 20 gigabytes per day for $59.95, 40 gigabytes per day for $69.95, and unlimited use for $89.95.
- Rise Broadband has speeds from $42 to $57 for wireless speeds between 5 Mbps and 50 Mbps. All plans have a 250-gigabyte data cap, with additional data sold at $5 per ten gigabytes.
- Watch Communications pricing starts at $59.99 for 10 Mbps and climb to $120 for 100 Mbps.
- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds vary by distance from a cell tower and usage is unlimited.

The Study Areas. The study looks at the cost of bringing fiber broadband to three different study areas.

- We first looked at everything outside of Urbana and Champaign. This includes the rural parts of the county, but also all of the other cities and villages in the county.
- We then looked at the rural parts of the county where we don't believe residents have the option today to buy a broadband product that delivers a speed of at least 25/3 Mbps.

- Finally, we excluded areas from the rural footprint to account for tentative federal awards to bring better broadband from the Rural Digital Opportunity Fund (RDOF) awards made in a reverse auction in December 2021. These awards have not yet been awarded to auction winners.

Market Demand Assessment

Residential Survey. We conducted an online residential survey that attracted 362 responses. 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 responses 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:

- 90% of survey respondents buy broadband at home from an ISP. Another 4% get broadband using cell phones.
- Residents use a wide variety of broadband technologies today. 43% of survey respondents buy broadband from a cable company. 17% of respondents use DSL technology from a telephone company. 13% of respondents have fiber to the home. 11% use fixed wireless. 3% use satellite broadband, and 3% use a fixed cellular data product.
- There is a moderate level of dissatisfaction with ISPs 28% of respondents are unhappy with download speeds. 36% are unhappy with ISP customer service. 47% of respondents are unhappy with the value received for the price paid for broadband.
- 70% of respondents said that somebody is working from home at least part-time. This includes 19% of households that have somebody working from home full-time. 38% of respondents said they would work from home more with better broadband.
- 32% of respondents have school-age children at home. 32% of these households said that home Internet was not good enough to support the students during the pandemic.
- 14% of respondents don't have good cellular coverage at home.
- The average price being paid for broadband is $68 per month.
- 73% of respondents support the idea of funding a better broadband solution. Another 26% might support better broadband but need more information. Only 1% of respondents do not support the idea.
- 46% of respondents said they would buy broadband and pay the same price as today from a new network if it was faster. Another 31% said they would probably buy from a new network.

Business Survey and Interviews. We reached out to businesses through an online survey and by interviewing some businesses in depth. The surveys and interviews focused on businesses located in rural areas or a few businesses that serve rural residents like the local hospital and the Housing Authority.

To summarize what we heard, rural businesses have several common problems with broadband. Broadband is inconsistent and often slows down during the daytime. ISPs have occasional major outages that can last days, but the more common problems are shorter outages that happen with regularity. Most businesses told us that an Internet outage largely shuts down the business. A common complaint was from business owners who drastically different broadband situations at home and the office.

We heard some specific stories of interest. We heard from a rural real estate agency that rural homeowners are having a hard tell time selling homes without broadband. We heard there was a lot of interest from

people wanting to move to the county and live in the country, but 95% of them will only consider homes with good broadband.

We also heard from a number of farmers. Some farmers struggle with the combination of poor broadband and poor cellular coverage. Most farms are still using fixed wireless broadband, and a common complaint is that the speeds are still the same as a decade ago while the broadband needs for farmers have grown exponentially. Every farmer has a list of things they could do more efficiently with faster broadband.

Speed Tests. As part of the study, we solicited speed tests from residents using the Ookla speed test (speetest.net). While none of the following samples is large enough to make any definitive statement about any specific ISP, the difference in speeds by technology is interesting and for the most part is what we expected to see. The following table summarizes the speed tests by technology:

	Technology	Latency (ms)	Download (Mbps)	Upload (Mbps)
Fiber	Fiber	12	232.7	180.3
DSL	DSL	39	11.5	2.2
Cable	Cable	19	200.3	23.9
Fixed Wireless	Wireless	44	28.7	8.5
GEO Satellite	Satellite	637	26.1	3.1
LEO Satellite	Satellite	35	95.5	11.5
Fixed Cellular	Cellular	53	43.2	8.9

Broadband Gaps. Champaign County has a significant broadband availability gap, and the county is a story of broadband haves and have-nots. The cities are served by cable companies, and most are also starting to be overbuilt by fiber ISPs. The rural areas have a really mixed situation. Except for some pockets, landline broadband speeds are not good. There is widespread coverage by wireless ISPs, but the speeds seem to vary widely, with some speeds as slow as DSL.

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.

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	Full Study Area	Rural Only	Without RDOF
Residential	32,363	5,406	6,643
Large Apartment Units	2,745	68	68
Business Customers	5,107	1,127	919

Total	12,716	6,601	4,630

Fiber Design. Finley Engineering invested the technology option for bringing broadband and selected fiber technology using XGS-PON technology which can deliver symmetrical 10-gigabit broadband to residents and businesses. The network was designed using the following primary assumptions:

- The network was designed to pass every home and business in each scenario.
- After examining the poles in the county, Finley determined that the most cost-effective solution is to bury all fiber construction.
- 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 network was designed with redundancy and route diversity so that if a main fiber is cut, a neighborhood node will continue to operate.

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

	Miles	Cost	Cost / Mile
Total County	1,956 miles	$133,669,758	$68,338
Rural Study Area	1,332 miles	$ 61,133,570	$45,896
Rural No RDOF	920 miles	$ 47,232,678	$51,340

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.

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.

	Total Study Area	Rural County	Without RDOF
Fiber	$133,669,758	$61,133,570	$47,232,678
Drops	$ 14,551,173	$ 5,962,110	$ 3,983,360
Electronics	$ 14,848,896	$ 3,888,042	$ 2,453,748
Huts	$ 270,000	$ 270,000	$ 202,500
Operational Assets	$ 1,072,962	$ 511,454	$ 504,704
Total	$164,412,788	$71,765,175	$54,376,990
Passings	40,215	6,601	4,630
Cost per Passing	$ 4,088	$10,872	$11,744

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 40% for residents and businesses in the cities and 65% in the rural areas. We don't know how many customers a new fiber business might attract, and we picked these penetration rate as slightly conservative but typical of what we see in other markets.
- The base models assumed financing with loans with a 20-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>All Scenarios Require Substantial Grant Funding</u>. We expected when we started the assessment that grant funding would be required to help fund fiber to rural parts of the county. 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. The following tables represent the breakeven grant scenarios for a commercial ISP. Breakeven means an ISP would need to get the grants shown in order for the business to always be cash positive. No ISP is interested in operating a business that never

generates any profit, so the actual amounts or grants needed by an ISP would be higher – with how much higher determined by the profitability goals of a given ISP.

	Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
Full Study Area	35% / 60%	$161.6 M	$34.0 M	21%
	40% / 65%	$164.5 M	$22.0 M	13%
	45% / 70%	$169.5 M	$ 0.0 M	N/A
Rural Study Area	60%	$71.0 M	$41.0 M	58%
	65%	$71.7 M	$38.0 M	53%
	70%	$72.4 M	$35.0 M	48%
No RDOF	60%	$53.9 M	$38.0 M	71%
	65%	$54.4 M	$37.0 M	68%
	70%	$54.8 M	$32.5 M	59%

There are several observations to make about the need for grant funding:

- In the full study area, grant funding is needed at lower penetration rates, but with enough customers, the project wouldn't need any grant funding. This is due to economy of scale – at some point, the customer revenues become large enough to cover the costs of the business, including the rural areas.
- It's also clear that the urban areas are a lot more profitable than the rural areas. This can be seen by seeing the amount of needed grant funding increase significantly to build to only the rural areas. Effectively, the cities would help to subsidize the rural areas.
- There are federal grants that might be able to fund up to 75% of the assets in the rural areas. These tables show that the needed grants are below that level, so ISPs might look at this table and see reasonable opportunities to pursue grant funding.

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 the three study scenarios.

Other Operating Models Don't Look Easily Feasible. The analysis shows that it looks to not be feasible financially to offer open access where the County would build the network and invite multiple ISPs to use the network to provide broadband. It also looks challenging to have a scenario where the County would build the network and would lease it to a single ISP – although there are probably a few scenarios where this might work.

There may be scenarios where the County and an ISP could jointly invest in a network. Any profitable scenario showing the County as an ISP would be a candidate for a partnership with the right ISP.

The Size of the Needed Funding. The report discusses the upcoming federal BEAD grant and other grant programs that might fund up to 75% of the needed assets to bring a broadband solution. This might imply

that an ISP must come up with 25% of the cost of the assets to make a project work. The math is not that simple, and the actual matching funds needed are larger.

- Not all assets are eligible for grant funding. Grants are generally used to build networks and connect customers. Grants generally don't cover assets like vehicles, computers, office furniture, spare inventory, and operating software. The grants can cover up to 75% of network assets.
- Until the details are out from the way that states will administer the grants, we can't assume that the 75% will apply to all assets. For example, a state might decide that it will finance up to 75% of the investment in unserved areas, but something smaller, perhaps 50% in underserved areas.
- Grants also don't cover operational losses that are inevitable from opening a new ISP market. There is significant effort required to build and launch a new market and an ISP must spend the labor and marketing money needed to launch a market. Grants do not cover operating expenses, and so the ISP will have to cover all expenses until the new market generates enough revenues to cover costs.
- To use two examples from the financial analysis, let's assume that the base case for both rural scenarios which can be summarized as follows:

	Total Rural	Rural Without RDOF
Total Cost of Financing	$76 M	$57 M
Eligible Grant Assets	$70 M	$52 M
Broadband Grant	$53 M	$39 M
Matching Required	$24 M	$18 M
Percent Matching	31%	32%

This simple math shows that the actual amount of matching funding needed for these two scenarios is a little about 30% - not the 25% that might be assumed when somebody hears there will be a 75% federal grant. Of course, if the grant doesn't cover 75% of all eligible assets, then the percentage of matching would be much higher.

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 later this year. The biggest upcoming grant is the BEAD grant program that is distributing $42.5 billion through states to build broadband infrastructure. There should also be additional money funning into state grants from other federal sources. There are numerous smaller grant programs that support a wide range of stakeholders like schools, libraries, electric companies, and others.

One of the more interesting upcoming grans will provide $2.5 billion in grants to tackle digital literacy and to get more computers into households.

Community Engagement Plan. Section IV.A discusses how other communities have engaged the public in working towards finding broadband solutions.

Finding an ISP Partner. Section IV.B. of the report discusses the process for identifying and creating partnerships with ISPs to bring better broadband.

Regulatory Hurdles. Section IV.C. of the report examines possible regulatory hurdles in Illinois 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 Illinois. 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.

STRATEGIC CONSIDERATIONS

The creation of the $42.5 billion BEAD grant program has changed the process moving forward for most of rural America. Before the big federal grants, the big challenge for most counties was where to find the money needed to bring broadband. We don't know if the BEAD grant program is large enough to solve the broadband problems in all of rural Illinois, but it's going to solve a significant percentage of the issue.

The focus for communities has shifted the focus from wondering where to find the needed funding to bring broadband to instead positioning the community to be at the forefront of those that get the needed broadband funding. We believe that the County can play a key role in making sure that you receive the needed grant funding to bring broadband to the rural parts of the county.

We think there is a significant possibility that multiple ISPs will pursue grant funding in some or all of the rural areas of the county. We find it likely that one or more of the companies that already won RDOF funding in the county will pursue the larger grants to create a larger and more coherent serving area. Note that the two biggest tentative RDOF winners are proposing to bring a wireless solution and not fiber. We think there is a chance that one or more of the big ISPs like AT&T, Frontier, Windstream, and likely others will pursue the big granting funding. We can't know for sure that any of them will pursue a grant in the county, but they've all announced aggressive plans to seek grants. There is also a chance that an ISP you've never heard of will pursue grants to serve the area. In the RDOF awards, a fiber overbuilder from Georgia won the majority of the RDOF awards in rural Michigan – we think there will be investor backed ISPs that might go after the grants across gigantic geographic areas – and those awarding grants might find that attractive.

The challenge facing the County is that none of these may be the ISP you want. A lot of rural areas are highly leery of seeing grant money going to ISPs that are promising superfast wireless solutions. Such technologies are new and unproven, and wireless is probably not the technology to carry the county into the next fifty years.

Most counties are leery of the grants going to the big telephone companies. The big telephone companies carry a lot of the blame for the poor condition of broadband in the rural areas. The companies slowly abandoned rural America starting in the 1980s. They closed local customer service offices. They cut back on technician staff to the point where it is nearly impossible to get a problem fixed quickly, if at all. They stopped making any investments in rural areas, so technology came to a standstill at a time when technology everywhere else was being modernized – including rural areas operated by smaller telephone companies and cooperatives. The question that communities are wrestling with is if they should trust these big companies again? What's to stop the big companies from taking federal grants, building just enough to meet the letter of the law, and then underfunding maintenance going forward and starting the cycle all over again. If a new fiber network is not properly maintained, it will begin to show problems in a decade and could become a paperweight in two decades.

Finally, there is no obvious local ISP that is able and ready to tackle serving the whole rural area. It's possible that one of the local ISPs could take that role, but there are a few things for the County to consider before backing a local ISP. First, grants tend to be given to ISPs with strong balance sheets. As this study shows, a grant winner will need to raise substantial matching funds – and that is going to be a challenge

for any ISP who has not raised a lot of money before or one that has already reached its natural credit limit.

The purpose of this discussion is to point out that the County can play a significant role in influencing the ISP that can win a grant to serve the rural areas. For example, if the County partners with an ISP and pledges some ARPA or other money as matching funds, that ISP will be viewed favorably by those making the big grant awards. Current grants are going to encourage and reward local collaboration and local skin in the game.

This is not to say that an ISP the county backs will be an automatic grant winner. If some large, well-financed ISP promises to serve a seven-county areas that includes Champaign County, that ISP may still win instead of the County and a chosen partner. But we think it's likely that the County and a strong ISP partner will have a strong case for winning grant funding.

Why is this important? If the County does nothing, it's likely that one or more entities will ask for grants to serve the rural areas. It's possible that an ISP you don't want, or a technology you don't want could get funded. There is also no assurance that anybody will win grant funding for the county - especially if none were endorsed by the County with a local financial pledge. There are many who think the $42.5 billion is not nearly enough to solve all of the rural broadband needs in the country. If you don't find a broadband solution in the upcoming grants, there might not be another chance for a long time.

A final option would be for the County to pursue the funding directly, with the County acting as the ISP. From what we've seen with recent grant funding, we don't think that is a good idea. The NTIA awarded a lot of money in 2009 to entities that had never been an ISP, and many of them failed. We think there will be a big emphasis with the upcoming grants to fund entities that have already proven they know how to be as ISP – the NTIA is not going to want to see big grant dollars going to entities with no experience.

The bottom line of this discussion is that the County needs to partner with one or more ISPs to pursue grant funding. That's the only chance for you to influence who will win the grant funding. If you don't do that, you could end up with an ISP you don't trust, a technology that is not future-proof, or even with no broadband solution. The County's biggest strategic decision might be deciding who to partner with to pursue grants.

A lot of the steps needed to move forward will be discussed in the following section that describes specific tactical steps needed to make sure you are ready for the big grant funding. But there are few other strategic decisions to be made before moving forward.

Is the County Willing to Help Fund a Solution?

As the discussion above highlighted, we believe that communities that 'put skin in the game' will have a higher chance of attracting grant funding than those which don't. This boils down to being willing to invest in a broadband solution.

We doubt the County is willing to shoulder the whole financial burden to fund fiber. The analysis shows that the funding needed to bring broadband to the rural areas is roughly $76 million for the whole rural area or around $57 million for the areas that aren't already covered by RDOF. We know counties that are

using ARPA (American Rescue Plan Act) funds to fund a large portion of rural broadband, but it would be extraordinary for the County to pony up enough money that you don't need to rely on grant funds. Considering the federal grants on the horizon, that seems like a drastic solution.

But as the simple analysis in the Finding section above showed, even with federal grant funding, an ISP will need to bring between $18 million and $24 million to the table to make these scenarios work. That's a large investment to make in a rural market that may never generate an acceptable return for an ISP to justify the investment.

One role that the County can play is to bring some matching funds to make it easier for an ISP to be successful. There are a lot of other demands on ARPA funding in every county, but you'd be well advised to set aside some of that funding to help find a broadband solution you like. Funding doesn't only have to come from ARPA monies. Around the country we are seeing rural counties that are willing to float small bond issues to use as matching funds to attract ISPs.

Consider a Collaborative Effort to Get Better Broadband

It's becoming clear that the big federal grant programs are valuing coalitions over an individual ISP or a single local government asking for grants as a standalone entity. Even if the County finds a partner ISP to build the needed broadband, any grant funding is going to have a better chance of success if a lot of other stakeholders in the county take a role in getting that funding.

For past grants, community support was mostly accomplished through letters of support sent with the grants. Those are still going to be needed, but a coalition goes a lot further than that. There are a few different ways that county stakeholders can participate and help to assure that the local grant team wins a grant.

As an example, in the past, the Farm Bureau might have provided a letter of support for a grant. A more proactive step might be to get farmers to pledge to buy broadband if somebody brings fiber to their farm. That way, the grant folks aren't hearing from the Farm Bureau but instead from a long list of farmers who have made a pledge. That's much stronger support than would have been supplied for grant filings in the past.

We think an important strategic step to take in the current grant environment is to recognize that coalitions are important and to figure out how to active coalitions to support a grant request.

What Are You Willing to Tackle?

There are a lot of different ways for the County to get involved. Not only is there an opportunity to build rural broadband infrastructure, but there is an opportunity to find grant funding for digital inclusion that might include such efforts as getting computers into homes, making sure residents take advantage of broadband subsidies, funding training classes in digital literacy, or workforce development by establishing programs to train fiber technicians.

This is all a lot to chew off and tackle, and one of the earliest strategic discussions is to have a frank discussion of what the County and other stakeholders are realistically willing and able to tackle.

RECOMMENDED NEXT STEPS

The section above discussed the strategic decisions that must be made - the County needs to decide how you want to move forward. Once you've made that decision, this section discusses specific steps that we think you'll want to consider.

Note that you might want to undertake some of these steps concurrently with wrestling with the strategic issues.

Who Will Tackle the Next Steps?

One of the first things to consider after getting this public is to determine who specifically needs to get involved in the next steps. For example, there may be things that your broadband committee is authorized to tackle. But many of the next steps will require approval and funding from County staff or elected officials. There may be tasks that other stakeholders or volunteers might best be able to tackle. And after considering all of that, it may become obvious that the County needs to hire or dedicate an existing resource to get this done this year. This is the year to get ready for the giant grants, and you'll have to find all of the solutions and identify the needed funding before the end of the year, and possibly sooner.

We've seen many efforts to get broadband that fizzled when nobody was dedicated to the community engagement tasks. We've seen the following ways that communities have identified the needed resources.

- Dedicate Staff. 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. A lot of communities are funding this effort this year through the ARPA funding. The staff could come from many different places, from existing county staff, from economic development staff, or a new hire.

  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.

  We worked with a county in Minnesota that 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 top 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. You already have the broadband committee, but you all have other jobs. It might be possible to recruit volunteers to help this year. 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 Champaign-to-Champaign 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.

- ISPs. Any ISP partners will do a lot of the technical and grant preparation work, but they are going to be of little help for the community side of the effort.

Reach out to Potential ISP Partners

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

- We've created maps showing the areas that we think are eligible for federal broadband grants. This is something that ISPs don't have at their fingertips.
- The study quantifies the cost of building a new fiber network. The engineering was also done in such a way that Finley Engineering can supply an ISP with a subset of the costs if an ISP only wants to tackle bringing broadband to a portion of the county.
- We've demonstrated the financial viability of an ISP being able to make work in several ways. For example, this study estimated broadband revenues. It wouldn't be hard for an ISP that has different rates than the ones assumed in our analysis to update our estimate for their purposes. We've also quantified the amount of grant funding that we think is needed to make this work. An ISP can now look at the potential grant funding and decide if that creates a viable business plan.
- We've made some high-level estimates of customer penetration rates based upon your surveys and our experience in working in other similar rural areas.

We think one of your first steps should be to reach out to potential ISP partners. That begins by sharing the results of this report with local ISPs. We warn that you must be careful in interpreting the reactions of ISPs. Most ISPs will say they are interested in looking at grants. What some of them won't tell you is that they are only interested if they can find almost all of the needed funds through grants. Your challenge will be to find out if any local ISPs are really interested. As mentioned elsewhere in the report, the biggest barrier for most ISPs is the ability to raise the needed matching funds.

If there are no local ISPs interested, you should widen the search. This is discussed in more detail in section IV.B. of the report. This is also the time to start seriously thinking of alternate plans, such as the County funding the network and partnering with an ISP to operate it.

You also might find that no single ISP is willing to tackle the entire rural parts of the county. There might be different ISPs interested in different geographic areas. You'll have to be flexible because that might mean working to support multiple grant applications.

Educate the Public

The surveys and interviews indicate a lot of interest from the general public for getting better broadband. You should determine the best way to inform the public of the results of this report and begin gathering 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.

- Publish This Feasibility Report. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson.
- Hold Public Meetings. Meetings can be held to explain the results of this report, or meetings could be more generic and be aimed at explaining the broadband issues. 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 – even if they are virtual.
- Broadband Website.[1] 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.

Define Potential Customers Better

The surveys conducted for this study were online and not statistically valid. That means that the surveys contributed a lot of insight into how the community feels about existing broadband and what they would like in the future. But online surveys do predict hard statistics like possible customer penetration rates. The primary reason for this is that the surveys are not random – the people who elect to take the survey online are already those who are interested in broadband. In survey lingo, these folks are self-selected. To understand customer penetration rates, it's important to hear equally from folks who don't want broadband than only those who do.

There are two ways to gather data about possible customer penetration rates – statistically valid surveys and canvasses. We find it likely that an ISP partner will want more assurance about the level of customer interest in buying broadband – and they might hope that the County can either pay for that effort or head up the required work.

Statistically Valid Survey. A statistically valid 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

[1] Here is a good example of a community broadband website. https://falmouthnet.org/

that if a survey is conducted 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, getting between 365 and 380 completed surveys will produce this desired accuracy.

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 common methods used to conduct a statistically valid survey of a whole community – either by knocking on doors or by telephone. There are challenges in a rural area for both of these methodologies. The effort required to knock on doors requires a lot of effort since it means going to homes randomly and hitting all the corners of the rural areas. You'd have to knock on doors of all types, from the smallest to the largest homes. There are survey methodologies to make sure such a survey is random. The primary issue is the number of people needed to give the surveys. We found that this is only affordable if done using volunteers.

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.

The challenge of conducting a telephone survey is obtaining a list of the rural telephone numbers. That is sometimes impossible.

Canvass. An alternative to a survey would be to conduct a canvass. This is often referred to in the industry as a pledge card drive. This requires an effort to ask as many of the rural folks in the county if they will buy service if somebody brings a new fiber network to their location.

Ideally, you don't do a pledge card drive until you know the prices and speeds of the future broadband, which are the two facts people want to know. Pledge card drives are generally tackled in several ways. It often starts with a postcard mailing where folks just check a yes or no box and return the postcard. If that doesn't get enough responses, many communities then get volunteers to call folks to try to get an answer. You'll never get 100% of people to respond, but if you can get north of a 40% response this starts to be

even more accurate than a survey.

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.

Champaign 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 possible that the rules are the same everywhere, but they also might differ around the county. The goal would be to eliminate rules that would hinder fiber construction.

Tackle the Other Broadband Gaps

Section I.E. of the report discusses ways to tackle the other broadband gaps such as the homework gap, the computer ownership gap, and the digital literacy gap.

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

As a note, this study is looking at the rural parts of the county. There are some ISPs that only serve in towns that we have no included below. We include the cable companies because we think they are an important price point to consider for anybody setting rates.

AT&T and Frontier are the incumbent telephone companies serving rural parts of the county, and for the most part, provide broadband using DSL technology using copper telephone wires. The telephone companies serve some businesses with fiber, but fiber is not widespread. Comcast and Mediacom are the incumbent cable television providers in the cities and villages. There are a few fiber overbuilders in the county, including I3 Broadband and Campus Communications Group. Several fixed wireless providers claim coverage in the county, including AgPro Wireless, Volo Internet + Tech, Rising Wireless, Rise Broadband, WATCH Communications, and Wireless Data Net. Some rural customers use broadband provided by cellular companies with cellular hotspots or the newer fixed cellular products. Most rural homes and businesses can buy satellite broadband from Viasat and HughesNet. We saw some county residents participating in the beta test for Starlink, the low earth orbit satellite company.

Following is an analysis of the prices being charged in Champaign County today. We know from experience that prices vary widely by customer for many ISPs. Some ISPs include products in bundles that can be unique by customer. Many ISPs have special rates for new customers or customer rates for customers willing to negotiate rates. Some customers are grandfathered into old rates and old products that don't change for as long as they keep the original product. 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 base 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 provides traditional landline 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.

We could see from the speed tests that the company has build some fiber in Champaign, Urbana, and Savoy, and possibly elsewhere. The company has announced plans to build fiber to pass about 30 million homes and businesses by the end of 2025, which would double existing fiber passings. AT&T's philosophy of building fiber is unique. The company builds in small neighborhoods around locations where the company has an existing fiber connection, such as to a school, small cell site, or large business. These small network pockets of fiber are often small, with 50 to 100 passings. AT&T doesn't look to have any intentions of building to whole communities, but rather to build only where it's relatively cheap to reach customers.

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 only six years of owning 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 nets $43 billion in cash to AT&T to pay down debt. 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 third quarter of 2021, the company had over 15.5 million broadband customers and 15 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 a similar loss of DSL customers.

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 broadband 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. There is some evidence of this product in Champaign County.

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.

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 third quarter of 2021, the company had 2.7 million broadband customers and 400,000 cable customers.

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

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 provides broadband using 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 the regulated product rates and includes long-distance, features, and a wide variety of business telephone services.

Cable Companies

Comcast Xfinity[2] is the incumbent cable TV provider in Champaign County. Comcast markets and bills using the Xfinity brand name. The company offers the traditional triple play of cable TV, internet, and voice services. Comcast is the largest cable TV company in the U.S. with 2020 revenues of nearly $104 billion and is the second-largest cable company in the world. They are headquartered in Philadelphia. At the end of the third quarter of 2021, the company had 31.6 million broadband customers and 18.5 million cable customers.

In addition to providing triple-play services, the company owns assets like NBC, Telemundo, MSNBC, CNBC, U.S.A Network, The Golf Channel, Syfy, numerous regional sports networks, Universal Picture (and theme parks), Dream Works, and the Philadelphia Flyers hockey team and arena. The company now sells cellular phone service. They are also probably the largest seller of smart home services in the country.

Standalone Internet

Comcast offers significant discounts to some new customers. Promotional products eventually revert back to list price, generally within one or two years. Following are the most recent list prices for standalone broadband.

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

Performance Starter	50/2 Mbps	$56.00
Performance Plus	100/5 Mbps	$76.00
Blast! Pro	200/5 Mbps	$86.00
Extreme	400/10 Mbps	$96.00
Extreme Pro	800/15 Mbps	$106.00
Gigabit	1,200/35 Mbps	$116.00
WiFi Modem (for all products)		$14.00

Comcast has announced in some markets, mostly where there is competition, that the basic speed of broadband is now 200 Mbps download. It's worth noting that Comcast does not use standard nationwide pricing. The company might lower rates to match the competition in heavily competitive markets – but not always. The company also doesn't offer identical speeds everywhere, and we know of markets where the basic speed product is sold as 100 Mbps, 150 Mbps or 200 Mbps – all of these are typically up to marketing speeds, which might differ from actual speeds.

Comcast makes it hard for customers to buy the Performance Starter product, so the minimal Comcast product is now priced at $76 after the end of any promotional discounts, plus the $14 modem – a total of $90.

Comcast raised all broadband rates by $3 in December 2020, with an identical price increase a year earlier. Industry analysts expect prices to increase annually. The company announced a 3% rate increase for 2022, but we haven't been able to verify the new rates as of the date of writing this report.

Comcast has data caps. Most broadband products are capped at 1 terabyte of download data per month (1,000 gigabytes). There are lower caps that apply to grandfathered legacy products. When customers exceed the cap for a given month (the usage adds together both download and upload data usage), Comcast bills $10 for each additional 50 gigabytes of data used, with a maximum of $50 extra.

Comcast also offers discounts to new customers, meaning customers that move from DSL or another fiber provider. These are advertised special promotional prices that change from time to time. As this paper was being finalized the price for Comcast special pricing for standalone internet was:

200 Mbps	$49.99
400 Mbps	$69.99
600 Mbps	$74.99
Gigabit	$84.99

Note that the fee for a WiFi modem is still $14 for these special products and must be added to the prices above to get total customer prices. These products revert to list prices after a one or two-year term. In markets where there is a significant fiber provider, Comcast will sometimes offer special prices to existing customers who are willing to negotiate.

Telephone

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

Basic	$30.00
Additional Line	$9.95

The basic line is a telephone line with standard features but no long-distance option. Comcast used to offer a telephone line with unlimited long distance, but that's no longer listed on the web site. Perhaps the company will start directing customers to buy Comcast cellular service.

The Comcast Bundle

It is important for anybody that wants to compete against Comcast to understand the power of its bundles. The most obvious reason for giving bundles is to entice customers to buy more than one service from the company, and Comcast provides increasing discounts for customers that buy multiple products. Because the company has so many products, it offers a dizzying array of bundles, with prices that change often as inducements to get customers to buy additional products. Comcast has learned that customers that buy multiple products – particularly products in addition to the triple play – rarely churn and become loyal customers.

One of the most important aspects of bundles is that they punish customers for dropping a bundled service. Consider the following simplified example of how this works. Suppose that a customer purchased the $76 broadband product and the $70 cable product and is given a $20 bundling discount and charged $126 for the bundle. If a customer drops either product, the customer loses the entire $20 discount, and the remaining product reverts to the list price.

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

This is one of the primary reasons that some competitors to Comcast offer cable TV. Otherwise, if a customer tries to change just their broadband to a new provider but leaves cable TV with Comcast, they are charged a "penalty" for breaking the bundle. Once customers understand the financial consequences of breaking the bundle, many won't change to a competitor since they might not see any net savings.

Comcast has expanded the bundle in the last few years. Their newest offering is cellular service which is only available for customers buying Comcast broadband. The pricing is simple and inexpensive. Customers pay by the amount of data used, at $12 per gigabyte. A customer using less than 1 GB of data pays only $12 per month for the connection. For $45 per month customers get unlimited data. Comcast uses the Verizon network to carry the traffic, but the company recently purchased spectrum and is planning on providing the service directly to customers in some markets.

Comcast also provides smart home products under the brand name Xfinity Home. The company is now supporting the home automation devices of nine major manufacturers: August (smart locks), Automatic (automobile), Cuff (fitness tracking), Lutron (smart lighting) Leeo (alarms), Nest (thermostat), Rachio (sprinkler system), Skybell (doorbell), and Whistle (pet tracking). It's an impressive suite of products and is all integrated through the Comcast portal.

Comcast also offers traditional home security with hardware developed at Comcast Labs. This includes the traditional suite of burglar, fire, and other alarms that are monitored and reported to authorities when there is a problem.

Mediacom provides service in Mahomet, Rantoul, and a few other smaller communities. The company is a large cable company with corporate headquarters in New York City. They are an interesting company that serves some large markets like parts of the New York City metropolitan area but mostly serves smaller rural markets. At the end of the third quarter of 2021, the company had 1.46 million broadband customers and 590,000 cable customers.

Residential Broadband		
60/5 Mbps	$ 49.99	200 GB Data Cap
60/5 Mbps	$ 69.99	400 GB Data Cap
100/10 Mbps	$ 79.99	1 TB Data Cap
200/20 Mbps	$ 99.99	2 TB Data Cap
500/30 Mbps	$119.99	4 TB Data Cap
1 GB/ 50 Mbps	$139.99	6 TB Data Cap
Modem w/WiFi	$ 10.00	
Internet Fee	$ 15.00	This is added for standalone broadband.

Telephone Rates: Mediacom offers a phone line with unlimited long-distance calling and 17 features.

Standalone Telephone	$49.95
Bundled with one other product	$39.95
Bundled with TV and Broadband	$29.95
Voicemail	$4.95
Sells Long-Distance Packages at	$0.05 per minute

Fiber Overbuilders

Campus Communications Group (CCG)[3] is a fiber optic internet provider with headquarters in Champaign. CCG builds fiber-optic networks for businesses, apartment buildings, and single-family homes. CCG uses a 100 Gigabit national backbone to provide speeds up to 10 Gbps to its customers. In Champaign County, CCG also provides service in the villages of Mahomet and Savoy.

As an aside, This company is not related to CCG Consulting who authored this report.

Residential Internet

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

1 Gbps	$69.99

Business Internet

Lite	150/50 Mbps
Basic	250/100 Mbps
1 Gig	1000/500 Mbps
Enterprise Connections	2000/2000 Mbps

Businesses must contact CCG for pricing for business internet.

I3 Broadband[4] is a fiber optic internet provider founded in 2003 with headquarters in East Peoria, Illinois. I3 provides fiber optic internet, television, and voice services throughout Greater-Peoria, Champaign-Urbana, Springfield, and Jacksonville, Illinois. I3 also provides fiber optic internet, television, and voice services in Barrington, Warren, and Bristol, Rhode Island. In Champaign County, I3 Broadband provides service in the city of Champaign.

Residential Broadband

250 Mbps	$54.99
500 Mbps	$64.99
1 Gbps	$89.99
Router	$ 7.00
Installation	$49.99

Business Internet

Potential customers must contact I3 Broadband for business pricing and speed quotes.

Telephone

Unlimited Local and Long-distance U.S. and Canada Calling	$9.99
Battery Back-up	$2.99

Pavlov Media[5] is an ISP that specializes in providing the triple play to off-campus housing and luxury apartments. The company works nationwide and is in forty-four states, serves in 170 university communities, and connects to 800 large apartment buildings and complexes. The company claims to be the largest provider of off-campus housing broadband. The company doesn't publish prices in many cases isn't the named ISP, with services sold to the landlord rather than to tenants. It's unlikely that the company owns any fiber in the area, and most typically would buy fiber transport from another ISP.

Volo Internet + Tech[6] is a fiber and fixed wireless internet provider founded in 2001 and headquartered in Urbana. Volo provides both fixed wireless and fiber in the Champaign-Urbana, IL areas. Volo provides residential fiber in Urbana, Thomasboro, Mahomet, St. Joseph, Rantoul, and surrounding areas. Volo provides fixed wireless in Champaign, St. Joseph, Wilbur Heights, Thomasboro, and surrounding areas.

[4] https://i3broadband.com/

[5] https://pavlovmedia.com/

[6] https://volo.net/

Residential Fixed Wireless		
Streaming	Unlimited Media Streaming	$75.00
Basic Broadband	Includes 250 Mb/24 Hours	$39.95

Basic Broadband Additional	
3 Free 5,000 MB/day blocks of priority bandwidth	
Additional 250MB/day blocks of priority bandwidth	$10.00

Additional	
IP Address Change	$5.00 per change/reset
Custom Network Setup and Consulting	$75.00/hour
Wireless Router and Setup	$85.00
Wireless Router Setup	$35.00

Residential Fiber		
Basic	10 Gigabytes/Day	$49.95
Enhanced	20 Gigabytes/Day	$59.95
Power	40 Gigabytes/Day	$69.95
Ultimate	Unlimited	$89.95

Additional	
Installation	$150
Router	$125 - $350 + Installation
Managed Router	$15/month per 1000 sq ft in home.

WISPs (Wireless ISPs)

AgPro Wireless[7] is a fixed wireless provider with headquarters in Chrisman, Illinois. AgPro Wireless provides fixed wireless service in east-central Illinois and west-central Indiana. In Champaign County, the company provides service in the county's southeastern corner.

Potential customers must contact AgPro Wireless for speeds and pricing quotes.

Rising Wireless[8] is a fixed wireless provider founded in 2012. Rising Wireless provides engineering, maintenance, and support for their customers in addition to the fixed wireless internet. Rising Wireless provides internet service in the eastern part of the county.

Residential Internet		
Typical Speeds	25-30 Mbps	$65.00
Installation	$150	
Service	$75/hour	

[7] http://www.agprowireless.com/

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

Rise Broadband[9]. In 2015, Skybeam, Digis, T6, Prairie Net, and Rhino Communications were rebranded under one name, Rise Broadband. Rise Broadband was founded in Englewood, Colorado, in 2005 and provides fixed wireless internet and telephone services. The company claims to have coverage throughout the county.

Residential Internet

Up to 5 Mbps	$42.00	250 GB Data Cap
Up to 10 Mbps	$42.00	250 GB Data Cap
Up to 15 Mbps	$42.00	250 GB Data Cap
Up to 20 Mbps	$47.00	250 GB Data Cap
Up to 25 Mbps	$47.00	250 GB Data Cap
Up to 50 Mbps	$57.00	250 GB Data Cap

Additional Data is $5 for 10 GB.
Rise Broadband does not charge an installation or modem rental fee.

Telephone

ActivePhone (Broadband phone)	$25.00

Wireless Data Net[10] is a fixed wireless provider founded in 2005. Wireless Data Net provides fixed wireless broadband service in over 18 local and rural communities throughout Central Illinois. In Champaign County, Wireless Data Net provides service in the northwestern part of the county.

Residential Internet

Basic Plan	2 Mbps/250 Kbps	70 GB data cap	$39.95
Standard Plan	4/1 Mbps	Unlimited	$49.95
Standard Max Plan	10/2 Mbps	Unlimited	$49.95
SoHo Plan	15/4 Mbps	Unlimited	$60.00
Installation $100			

WATCH Communications[11] was founded in 1991 and is a subsidiary of the Benton Ridge Telephone Company of Lima, Ohio. WATCH Communications offers fixed wireless and fiber optic internet, TV, hosting, and VoIP phone services throughout Illinois, Indiana, Kentucky, and Ohio. WATCH Communications offers fiber TV in Indiana and parts of Ohio and has partnered with DISH to provide satellite television in its other service territories. In Champaign County, WATCH Communications provides fixed wireless service throughout the county.

Residential Internet

Watch Essentials	10 Mbps	$59.99
Watch Choice	15 Mbps	$69.99
Watch Preferred	25 Mbps	$79.99

[9] https://www.risebroadband.com/

[10] https://wirelessdatanet.net/

[11] https://watchcomm.net/

Watch Premium	50 Mbps	$99.99
Watch Elite	100 Mbps	$120.00
Additional		
Equipment Maintenance Plan	$ 5.00	
Voice		
VoIP	$24.99	

Cellular Broadband

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

Fixed LTE Products. The traditional cellular plan using 4G LTE broadband has been labeled as hotspots. These plans have data caps similar to traditional cellular plans.

More recently, the cellular companies have introduced fixed cellular plans that use the new spectrum each company is labeling as 5G. These plans are still only available in places where each carrier would have upgraded cellular cell sites to use the new spectrum, but also where the new product is open for marketing. It's unlikely today that all of these products are available in the county, but over the next year, these products should be available in some parts of the rural county.

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

4G Hotspots		
15 GB of data	$35	
100 GB of data	$55.	
Additional 1 GB	$10	
5G Fixed Wireless		
25/1 Mbps	$60	350 GB Data Cap
Additional 50 GB	$10	

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

4G Hotspots	
15 GB o data	$ 20
50 GB of data	$ 40

100 GB of data	$ 90
150 GB of data	$110

Once the data cap for the plan has been met, the speeds revert to 3G speeds.

5G Fixed Wireless	
With Verizon cellphone Plan	$55
Standalone	$75
Discount for autopay	$ 5

Unlimited usage.

Reviews have said that speeds generally vary between 25 and 50 Mbps download, although speeds aren't guaranteed.

T-Mobile has historically offered hotspot plans. More recently, it is offering fixed wireless plans that use the new bands of spectrum labeled as 5G. T-Mobile says that it is shooting for 100 Mbps for this product, but speeds are not likely to be that fast in rural areas.

4G Hotspots	
5 GB of data	$20
10 GB of data	$30
30 GB of data	$40
50 GB of data	$50
Discount for autopay	$ 5

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

5G Fixed Wireless	
Up to 100 Mbps	$65
Discount for autopay	$ 5

Unlimited usage

Satellite Broadband

There are two geostationary satellite broadband providers available across the county. Both Viasat and HughesNet use satellites that are parked at a stationary orbit over 22,000 miles above the earth.

There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much (Viasat claimed in their most recent financial report for May 2021 that the average residential broadband bill is $93.06). 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 server 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 can be seen by the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault

announced recently that the average U.S. home used 434 gigabytes of data per month in the second quarter of 2021, up from 380 gigabytes in 2020 and 344 gigabytes in 2019. The small data caps on satellite broadband make it impractical to use for a household with school students or for a household that wants to use broadband to work from home.

Viasat (formerly marketed as Exede or Wildblue). Viasat satellite broadband has gotten better over time. The broadband on the ViaSat-1 satellite launched in 2011 was relatively slow, with speeds as fast as 25 Mbps. The company advertises speeds as fast as 100 Mbps download on the ViaSat-2 satellite launched in 2017. The company plans three new ViaSat-3 satellites with even higher capacity, with the first to launch sometime in 2022.

Prices are high compared 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
Equipment Fee	$ 12.99		

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 to 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. These packages are severely throttled after meeting the data caps. The packages are as follows:

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

Low Orbit Satellites. There has been a lot of recent news concerning the three new satellite companies that will be offering broadband. First is Starlink, owned by Elon Musk. The company is in beta test mode and has been selling broadband across the U.S. for $99 per month, including a $500 price for the receiver. The company has taken over 500,000 deposits of $99 on a waiting list. The company has over 1,900 satellites in orbit but needs 11,000 for the completed 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.

OneWeb, owned by the British government and various large private investors, says it will begin testing broadband in the far northern hemisphere in early 2022 and plans to cover the world by the end of the year. There is no news yet of speeds, prices, or actual availability.

Project Kuiper, owned by Jeff Bezos, says it will be in service within a few years, although it has yet to launch any satellites. But the company is being fully funded by Bezos and Amazon and is expected to catch up to the other two providers.

B. Surveys / Interviews / Speed Tests

Residential Survey Results

As part of the study, 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. For a survey to be statistically valid, it must be conducted randomly, and in an online survey, the respondents elect to take the survey, meaning the survey is biased toward respondents who are interested in broadband. Since an online survey isn't random, it won't connect to a representative sample of homes with no broadband – it's as important to count them as it is to count homes with broadband.

With that said, an online survey is useful for measuring sentiment. For instance, we can learn a lot about how residents feel about current broadband and existing ISPs.

The survey was conducted online using Survey Monkey from December 2021 through January 2022. The survey was posted on Champaign County's website and was advertised on social media. The survey was well-received by the public, and we got 362 responses.

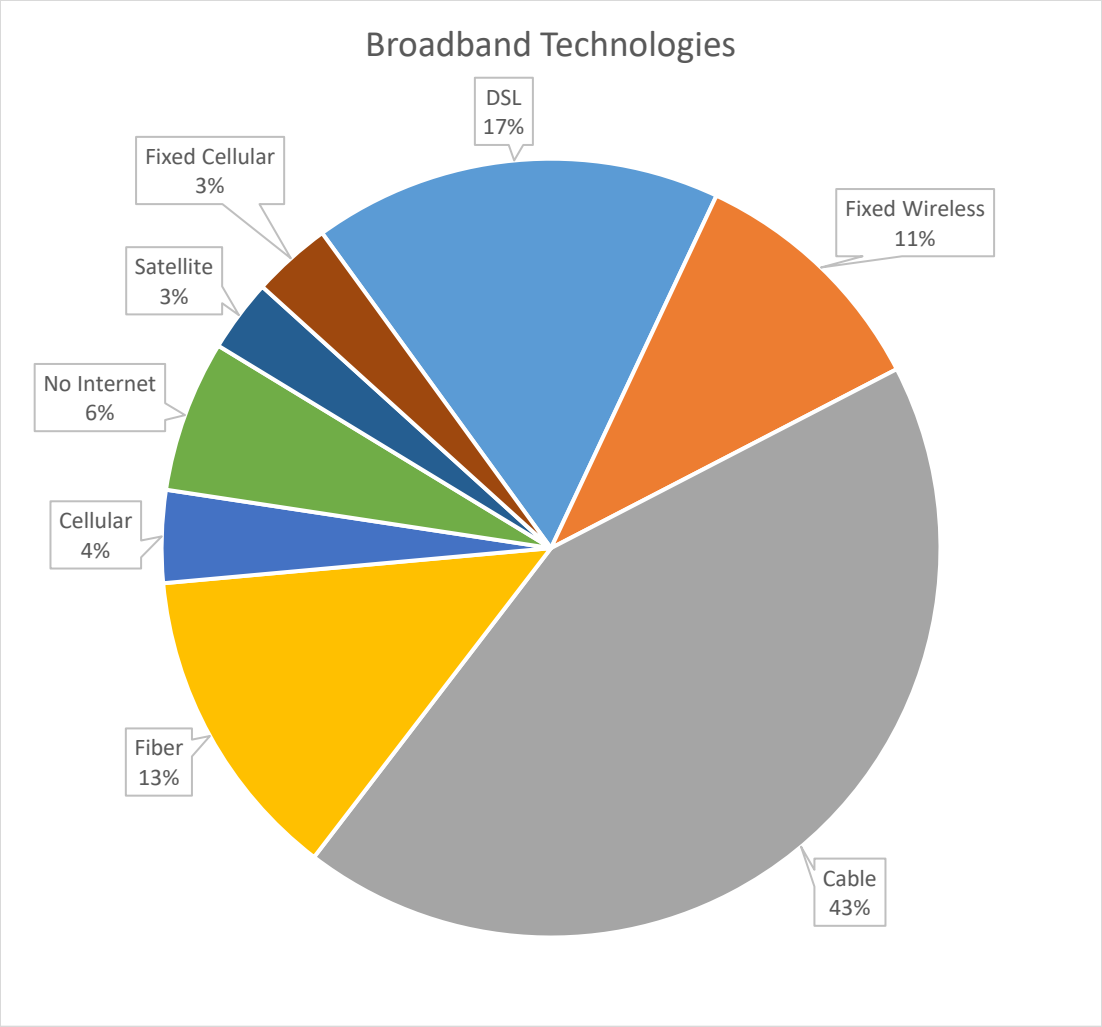
Survey Results

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

94% of all respondents use broadband at home today. That includes 4% of respondents that get broadband only from their cellphones, so the percentage of homes with a broadband connection is 90%. That is slightly higher than the nationwide penetration rate of 87% as reported by the FCC.

The following pie chart shows the technologies used by the survey respondents.



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

- 43% of the respondents get broadband from a cable company. 29% of respondents use Comcast, and 15% use Mediacom.
- 17% use DSL from one of the telephone companies. 9% use AT&T, and 8% use Frontier.
- 13% are getting broadband from a fiber ISP. 8% use I3 Broadband, 3% use Volo Broadband, 2% use Pavlov Media, and 1% use Campus Communications Group.
- 11% of respondents use a fixed wireless technology. 2% use Volo Broadband, 6% use Rise Broadband, 1% use Gifford Wireless, and less than 1% use each of the following ISPs: Rising Wireless, WATCH Communications, Cox Wireless, and Netcare Internet Solutions.
- 3% of respondents use satellite broadband.
- 3% use cellular hotspots or fixed cellular broadband connections.
- 4% have no broadband connection but use cellphones for home broadband.
- 6% of respondents do not use home broadband.

We asked why respondents don't have a home broadband connection. 45% said that broadband is not available at their home, 42% said that broadband is too expensive, and 1% said they don't have a computer.

Broadband Not Available. 23 respondents to the survey said that broadband is not available at their home. We know from experience that this means they can't get broadband that works. Many of these homes have probably tried DSL, fixed wireless, satellite broadband, or cellular hot spots in the past and rejected those technologies as not workable.

Cable TV Penetration

54% of survey respondents report the purchase of traditional cable TV, meaning TV from a cable company, telco, or satellite provider. That is in line with the nationwide average, which hit 56% at the end of the third quarter of 2021. Respondents used a variety of cable providers: 16% use Comcast, 6% use Mediacom, 4% use AT&T, 1% use I3 Broadband, and 27% use satellite.

34% 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 we know the percentage of cord-cutters is growing rapidly as a million households are dropping traditional cable each quarter.

Another 6% of respondents use an antenna to get free TV over the air. 3% of homes claimed not to watch TV, while 3% of homes say that TV services are not available at their home.

Telephone Penetration

27% of homes still report having a landline telephone. That's close to the nationwide average landline penetration of about 25%. 10% of residents buy telephone service from AT&T, 1% from Consolidated Communications, 4% from Comcast, 7% from Frontier, 4% from Mediacom, and 1% from I3 Broadband.

Cellular Service

98% of respondents say that they subscribe to cellular service – that's above the national average of 95%. 14% of homes said the cellular coverage is not adequate at their homes. The poor cellular coverage is likely a factor in homes continuing to keep telephone 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 must be taken with a grain of salt because what people say they pay is often different than what they actually pay. For example, a household might cite an introductory price 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 to not know how much they pay. With that said, here is what customers say they are spending:

Customers buying a bundle of service	$171
Customers buying standalone broadband	$71
Customers buying standalone cable TV	$117
Customers buying standalone telephone	$68

We note that the $171 average for bundles is pretty typical of what we see in other communities. The average price for standalone broadband is typical for 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

We asked respondents with broadband how often they use the Internet at home. 82% said they use it for more than a few hours daily, 14% said they use it for a few hours daily, 1% only use it a few hours a week, and 3% use it only occasionally.

70% 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 (19%), those working several days per week (28%), those working a few times a month (10%), and those working from home occasionally (13%). 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.

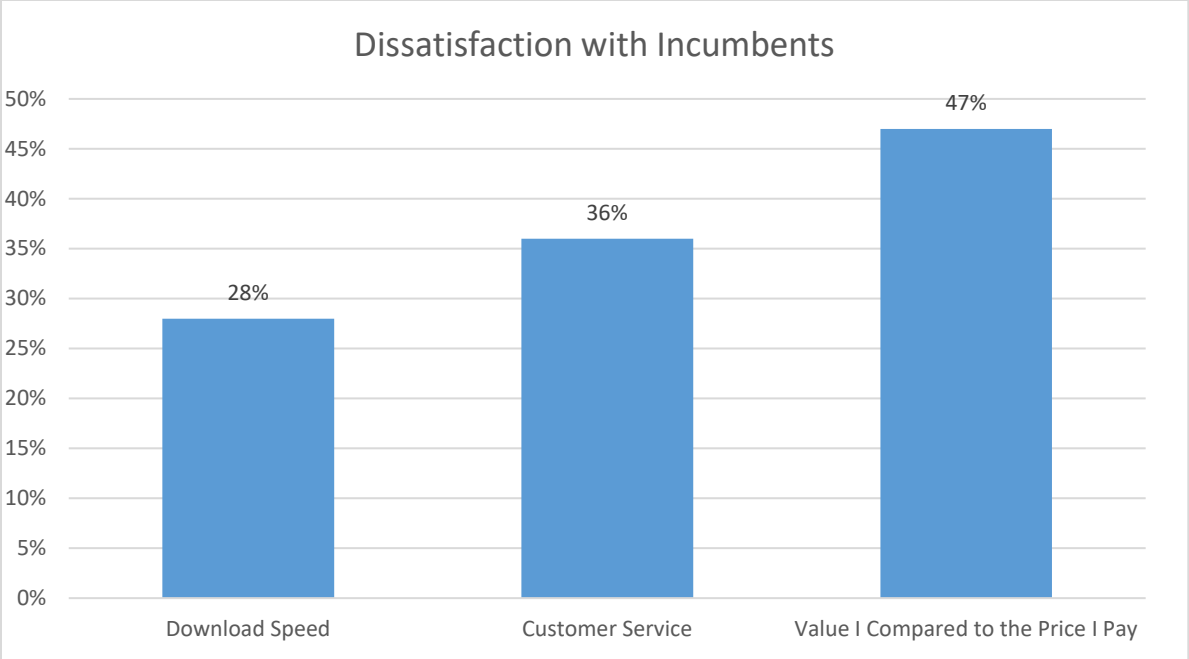
38% of respondents with somebody working from home said they would work from home more often if they had faster Internet.

32% of respondents report having somebody in the home using broadband for schoolwork. 32% 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 when they can't make or maintain an upload connection.

Satisfaction with Existing Broadband

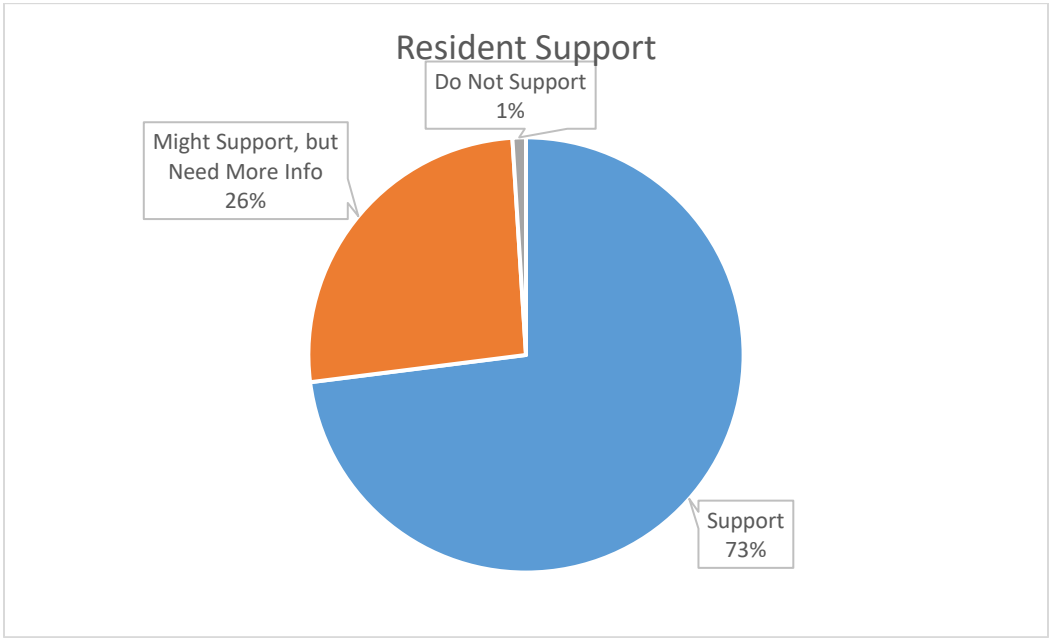
Below is a graph of the survey responses highlighting the dissatisfaction with the current ISPs in the county.



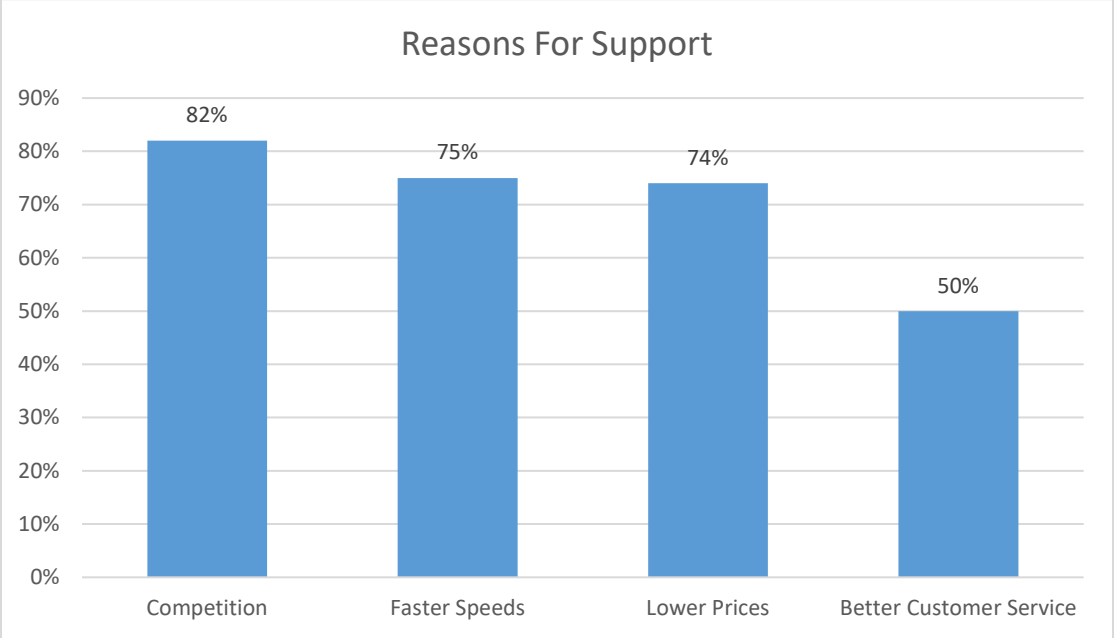
These results show some dissatisfaction with the incumbent ISPs. The highest level of dissatisfaction (47%) comes from the value compared to the price residents pay.

Support for a Fiber Network

One of the key questions asked in the survey is if respondents support the idea of Champaign County trying to get better Internet access.

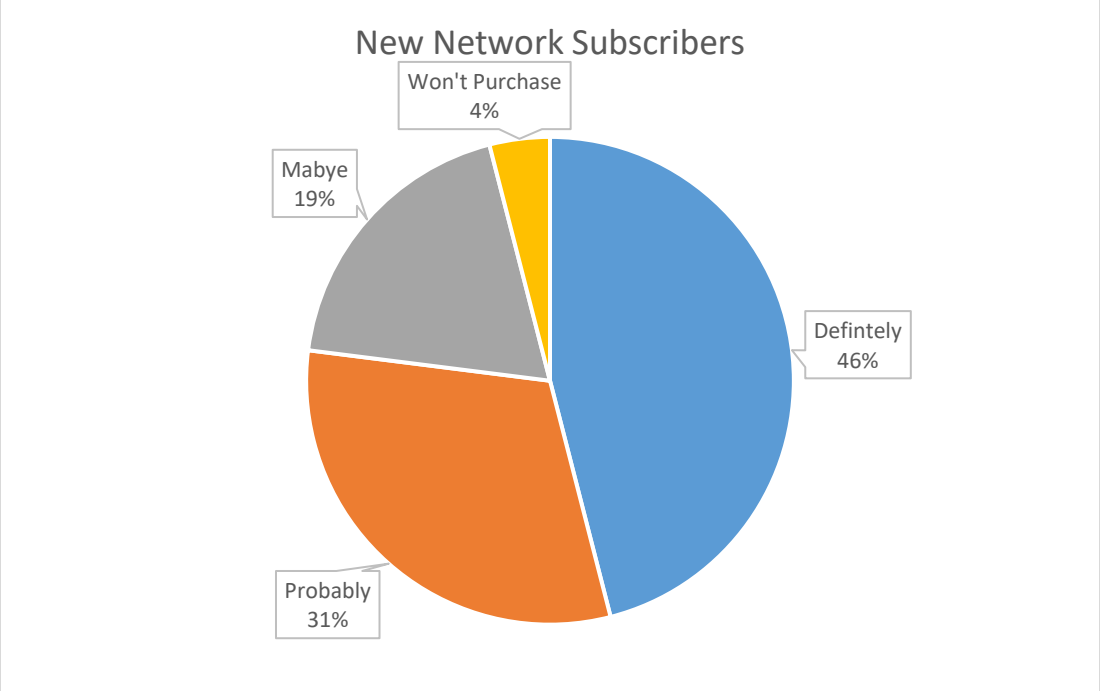


We asked the reasons why respondents support bringing a new network to the county. Below summarizes the reason for support. Interestingly, competition, faster speeds, and lower prices are each important to large percentage of respondents. In most communities we one issue that is more important than the others.



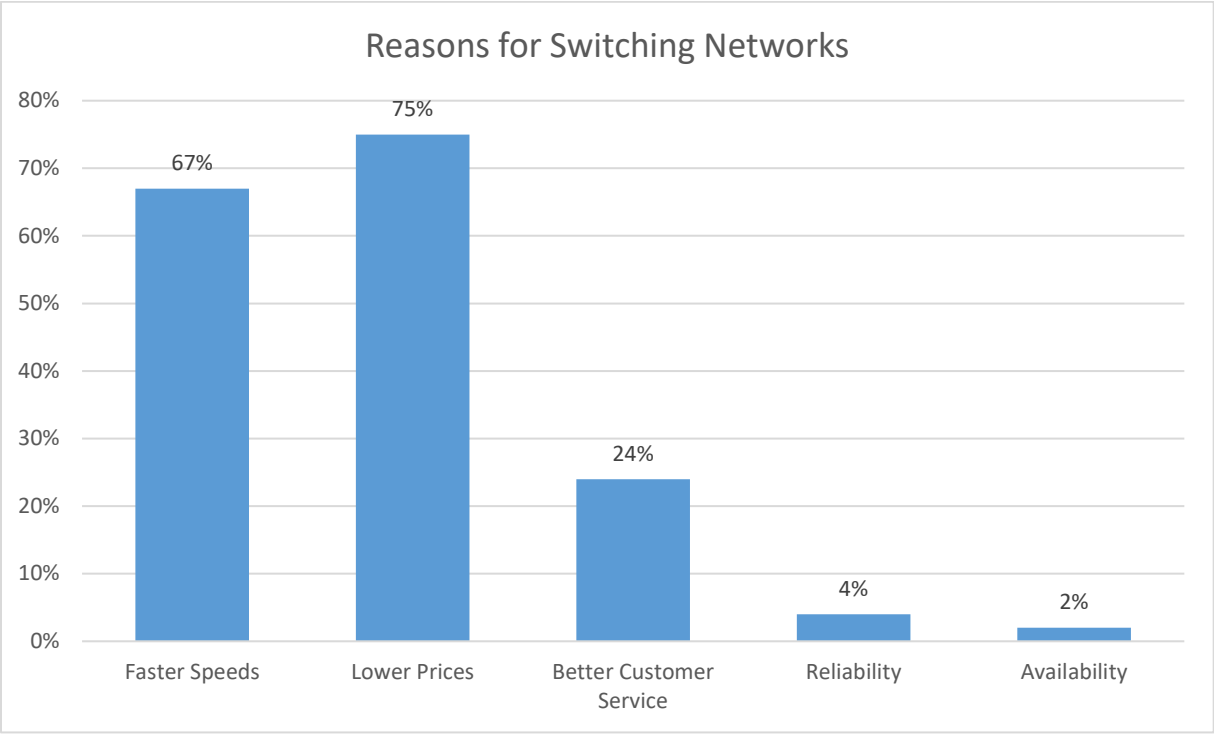
Switching Service to a New Network

In probably the most important question of the survey, we asked respondents if they would buy Internet service from a new fiber network.



As seen in the above graph, 77% of survey respondents have a strong interest in subscribing to the new network (will definitely or probably buy service).

We also asked what factors would lead a respondent to move service to a new network. Below is a graph detailing the reasons why residents would consider moving to a new network.



An overwhelming 75% of respondents said that lower prices are the main reason for switching to a new network.

5% of the respondents said they would buy a landline, with another 11% saying probably, and 21% saying they might buy. 63% 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 Champaign 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. We believe the surveys are telling us the following:

Dissatisfaction with the Incumbents. Almost half of the respondents (47%) are unhappy with the value they get – meaning they think they are paying too much for what they get. The public was less dissatisfied with other issues from their ISP.

Support for a New Network. 73% of respondents support the idea of building a fiber network in the county. This is overwhelmingly positive support, especially since only 1% actively dislike the idea.

The high support is easier to understand when looking at the reasons for the support. The predominant reason for support: 82% of supporters hope for more competition, 74% of respondents hope for lower prices, 75% are hoping for faster speeds, and 50% are hoping for better customer service.

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 (36%) are unhappy with customer service. 50% 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. 82% 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. However, the desire for more competition also seems to be closely linked to a desire for faster speeds and lower prices.

Price Sensitivity. Price sensitivity is an important issue in the county. 74% said that lower prices would be a factor in getting them to change to a new network. However, the signals we get from the survey about pricing are mixed. When we look at what residents say they are spending, many are paying above-average rates. In communities where price is the driving issue, we see many residents buying the lowest cost option available or foregoing buying broadband. It's possible that the price responses in the survey are mostly wishful thinking, and not a loud 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 – because we can't take the results of this survey to be telling us a specific level of interest in broadband in the county.

With that warning in mind, 46% of all respondents said they would definitely buy from a new network. Another 31% said they would probably buy, and 19% 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 response of 46% is extraordinarily high.
- We've always found that most people who say they will 'probably' change will do so. Some won't overcome the effort needed to change providers, 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, 31% of respondents said they would probably change to a new fiber network.
- The 'maybe' respondents are just that. We've always seen that most such respondents won't change. Acquiring any of these respondents requires a significant marketing budget. In your case, 19% 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 46% of respondents to a survey say they would absolutely buy

broadband. We interpret these results to mean that there might be a higher-than-average demand for better broadband.

Champaign County Farm Bureau Survey

The Champaign County Farm Bureau Conducted a simple survey in 2021 that asked four questions. The received 1,516 responses to the survey. They survey identified 487 households that don't have broadband service today. It identified another 233 homes that have broadband where speeds are under 25/3 Mbps.

The responses to the survey are as follows:

Amount willing to pay for customers with existing broadband service (388 responses):

- $30-50 30
- $50-70 49
- $70-90 122
- $90-110 139
- $110+ 48

Average price willing to pay $86.49

Average price paid today for broadband (524 responses):

- $30-50 67
- $50-70 156
- $70-90 126
- $90-110 75
- $110+ 100

Average paid today $79.43

Amount willing to pay for those with no broadband today (283 responses):

- $30-50 71
- $50-70 84
- $70-90 72
- $90-110- 30
- $110+ 26

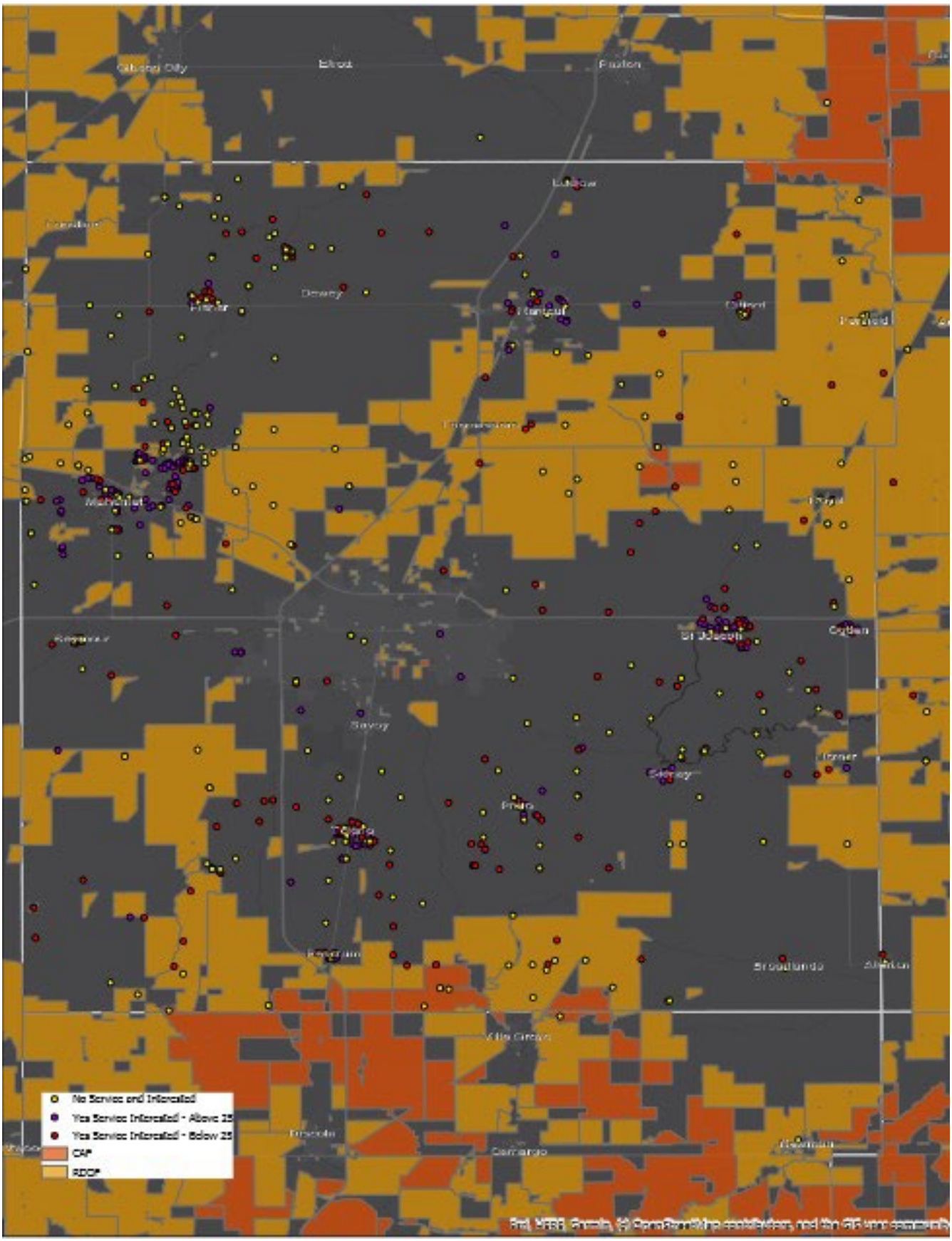
Average price willing to pay $69.82

Amount willing to pay, composite of all respondents (698 responses):

- $30-50 125
- $50-70 212
- $70-90 223
- $90-110 81
- $110+ 57

Average price willing to pay $72.35

The most interesting result of this survey is that the Farm Bureau was able to map the location of respondents. This results in the following map that shows the clusters of homes that don't have available broadband service (the yellow dots).


No Service and Interested
Yes Service Interested - Above 25
Yes Service Interested - Below 25
CAF
RDOF

There are a few interesting results of this survey worth highlighting:

- Many households without broadband today are not willing to pay as much as households with broadband. 25% of such respondents are only willing to pay between $30 and $50 monthly for a broadband subscription. The CCG survey encountered the same issue where many of the homes without broadband today can't afford it.
- However, many of the homeowners without broadband today are willing to pay a substantial price for broadband. 29% of respondents are willing to pay more than $90 per month for broadband, with 9% willing to spend more than $110. These seem to be homes that want broadband but can't buy it today – or at least buy anything that works to their satisfaction.
- The most interesting results come from the map that the Farm Bureau was able to create from the survey results. On the map above, the yellow dots represent homes that don't have broadband today. The red dots are households with broadband that are experiencing speeds today under 25/3 Mbps. The purple dots are those that have broadband speeds today greater than 25/3 Mbps. Examining the map shows the following:
    - There are only a tiny number of purple dots outside of towns. This means that pretty universally that people outside of towns either cannot get broadband, oof if they have broadband aren't seeing speeds greater than 25/3 Mbps.
    - There are clusters at the immediate edge of every town that don't have broadband over 25/3 Mbps (red dots). This is a good presentation of the issue that cable broadband networks have a physical endpoint. On every street leaving a town there is a last customer that can buy cable broadband, and everybody past that point cannot. Customers can live tantalizingly close to a town and still have no broadband option.

Business Survey / Interviews

Interviews and Business Questionnaires

CCG reached out to businesses in two ways. 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 includes what we learned from businesses.

We heard from a good cross-section of businesses and stakeholders involved in the rural part of the county. We talked to two rural school districts. We heard from a large health care provider in the county. We heard from several farmers. We heard from several non-profit agencies and also from the local Housing Authority. We heard from several local politicians from rural villages. We heard from a wide variety of other businesses, including tradesmen, manufacturers, restaurants and hospitality, a construction company, and a rural realtor.

Because of the wide variety of businesses, we heard a wide range of broadband stories. Interestingly, we also got some more depth information about home broadband from the various stakeholders as well. Following are some of the stories we heard.

- As we expected, the schools have great broadband since almost every school in the state is now connected to fiber. The schools told us that they have enough bandwidth to everything that is

needed at the school. The schools also beam WiFi into the parking lots, which provides bandwidth for anybody that wants to use it. The rural schools told us that they think they fared fairly well during the pandemic. There were a lot of students that didn't have hold broadband. The schools made sure that every student had a computer to use at home. They also provided hot spots for those that had decent home cellular coverage. The biggest challenge came from students with no home broadband or cellular coverage. The schools ended up with a hybrid plan where such students were able to attend sparsely populated classrooms while other students participated from home. The schools we talked to thought that they lost very few students during the pandemic but had heard from schools in other counties where a significant number of students gave up during the pandemic.

- The farmers had interesting stories to tell. The big farms in the county grow corn and soybeans. These farmers all rely on smart machinery. Their tractors and other equipment are all connected to broadband. All of the farmers we talked to use John Deere equipment. The farm machinery has multiple options for connecting to the Internet, including cellular, satellite, or WiFi. Farmers prefer a cellular connections, but many of them live in areas without good cellular coverage. A few that use satellite service have had a few outages. They all told us that smart farm equipment might be getting too smart – the machines must have a connection to the cloud to function and cannot be operated manually.

  We heard how farming is becoming a complex business. One farmer said that many days he feels more like an IT guy than a farmer because his farm relies on numerous different software systems that are not compatible. Farming has become a complex business. On top of taking care of crops, farmers have complicated arrangements with equipment vendors, banks, insurance agents, and government agencies. Farms need to deal with finding seasonal labor. The process of selling crops has become a lot more sophisticated for a farmer that wants to get the best price. And all of these various functions include software systems. They now create huge data files when they survey the fields in detail to determine the amount of fertilizer and insecticides to use in each part of the field. This can all be fed into the farm equipment to provide unique solutions to each part of the farm.

  The farmers we spoke to all have used fixed wireless broadband for the last decade – and told us that the majority of farmers use this technology. However, they universally complained that, while the bandwidth delivered a decade ago was adequate, the technology has not been upgraded, and they are receiving the same speeds today, which are now inadequate to their needs. Just in recent months, a few farmers in the county have switched to using the new T-Mobile cellular broadband product. One farmer who lives close to a large cell tower is getting speeds as high as 200 Mbps download – but the product won't work for many other farmers because of their distance from the cell tower. T-Mobile has told some farmers that they only plan to sell a fixed number of customers using the technology because it it's oversold, it won't work for anybody. One farmer said that one of his neighbors was lucky enough to recently get connected to fiber though CCG.

  Almost every farmer we talked to has issues caused by a lack of broadband. One farmer we talked to was unable to buy any adequate broadband solution. The DSL and fixed wireless are too slow at his farm. He has poor cellular coverage and tried and scrapped the T-Mobile fixed cellular product. He often must drive elsewhere to find adequate broadband to get his farm work done. The lack of broadband is a problem for the whole family since they can't stream video or engage in

functions like Zoom calling. Another farmer said that broadband at the farm is so slow that he has to write everything down and then spend evenings at home entering data into his software.

Several farmers said they want to be able to monitor grain bins and corn dryers remotely, but they don't have enough bandwidth to be able to do so. This means they must manually inspect the driers multiple times a day, which ties them to the farm. Many of the farmers have family members who work from home, and we heard from several that upload bandwidth was not adequate for working from home or schooling from home.

- Our conversation with the rural real estate agent was illuminating. We heard that probably 95% of homebuyers now ask about broadband and won't consider buying a home that doesn't have good broadband. This has made it difficult for some rural residents to find any buyers for their homes. We know from nationwide studies by realtors that not having broadband can significantly depress the selling price of a home. Many of the homebuyers who have looked at homes in the county were looking for a home in a more rural setting where they can work from home.

- We heard interesting stories about the contrast between home broadband and work broadband. Several businesses own businesses where there is broadband but go home to poor broadband. Several told us they are unable to work on paperwork and other functions for the business while they are home. We also heard the opposite story where business owners commuted to their rural business from a home that has good broadband. In both situations were told that not having good broadband in both locations was inconvenient.
- One common complaint we got was that there are routine outages for the rural ISPs. One recent outage was reported to last four days. Several businesses told us that outages shut their business completely. Several businesses buy Internet and phone service from the ISP and lose both when broadband goes down. Several businesses told us that they had frequent short outages rather than prolonged outages but that every outage harms their business.
- We also heard stories about Internet slowdowns. It was reported that broadband networks often slow down, making it hard to work. Several businesses told us that slowdowns were so common that it was causing them a lot of extra staff time to complete work. We heard that slowdowns get so bad that Zoom calls won't work. Even low bandwidth functions like banking won't work. We heard from a business where the office broadband got too slow to process DocuSign, meaning that contracts had to be delivered by hand to clients within the community.
- We did hear from a few businesses in the survey who are in a town and have broadband that they say is adequate for their needs. These responses contrasted sharply with the responses from businesses located in rural areas.
- We heard from the Heart of Mary Medical Center that customers in the western part of the county had big problems during the pandemic connecting to telemedicine visits with doctors.
- We heard from the Housing Authority that there was a major lack of computer skills among those using its services. The agency is partnering with the U of I to get a laptop and a hotspot to homes for $11 per month.
    - We also heard numerous complaints about cellular coverage. Businesses often try to revert to cellular broadband when landline broadband is down, and we heard that rural cellular coverage is often slow or completely unavailable.

- Finally, we heard several complaints that broadband is too expensive. This complaint was made about home broadband more than business broadband. Several people reported paying $90 - $100 per month for home broadband.

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

- Communicating with Customers. 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 Champaign 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.
- Communicating with Vendors. Businesses also routinely use the portals of their own vendors to buy whatever they need to operate.
- Communicating with Other Branches of the Company. A number of businesses are part of larger corporations and maintain open data connections to communicate with other parts of the company and with headquarters. For example, the hospital is part of a major chain of hospitals.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, Microsoft, or a private cloud available only to employees of the business. This is the change in the ways that companies operate that has probably created the most recent growth in bandwidth. Much of the routine software that companies use now works in the cloud, meaning that productivity comes to a halt when the Internet connection isn't working. We heard from several businesses in the county that reported that broadband outages crippled them since they work in the cloud.
- Security Systems. Businesses often have their security monitored by offsite firms. Security today also means the use of 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. Farmers reported wanting to have a lot of cameras for security and to check on livestock and equipment.
- 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.
- 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. We heard about a lot of problems connecting to Zoom or similar services.
- 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 Back-up. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that monitors data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function when connected to the Internet.
- Farmer Software Ecosystem. As mentioned earlier, farmers now have a complete ecosystem of smart machinery and devices that must be connected to work. Farmers want to send huge data files to convey the data about soil conditions in each part of their fields. Farmers want WiFi around the farm buildings, which requires a strong Internet signal to the primary broadband location. Farmers want to be able to control devices like grain bins and corn driers remotely.

Speed Tests

As part of the research for this report, we asked the public to take speed tests. Speed tests provide a way to judge the quality of broadband and to provide a different way to judge ISP performance. The speed tests can show if ISPs are delivering the broadband speeds they advertise and show if speeds vary across the market.

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. In this study, we used the speed test from Ookla, which is one of the most popular speed tests. Ookla's algorithm discards the fastest 10% and the slowest 30% of the results obtained. In doing so, the speed test might be masking the problem that drove someone to take the speed test, such as not being able to hold a connection to a VoIP call. Ookla also multithreads, meaning that they open multiple paths between a user and the test site and then average the results together. Ookla connects to a lot of regional servers, which is important because the distance between a customer and the speed test server can make a difference in the results. Another popular speed test is offered by MLabs. This speed test makes only a single connection to the test server and has fewer regional servers.

- Home broadband 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 is 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. For example, some ISP networks bog down and get slower during the busiest times of the day, and a speed test taken when the network is busy might give a different answer than when the network is idle.
- 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.

For any given ISP, one of the biggest influences on an average speed test results is the relative mix of different tiers of service. An average speed of a fiber ISP is not particularly relevant if it includes a mix of customers that subscribe to 100 Mbps, 500 Mbps, and gigabit broadband. That average will be influenced by the mix of customers at the different tiers. What matters more is if there are speed test results that are far different than the published broadband products. As an example, we recently completed a speed test study for a city where two-thirds of customers on a cable company are getting the speeds they had been promised. But this meant that the remaining one-third of residents are getting speeds that are far slower than the base product offered by the cable company. This pointed out the need for more research, and the city gathered additional speed tests by neighborhood. The subsequent research showed that there were a few neighborhoods in the city with poor speeds, meaning that those neighborhoods had network issues that were hampering broadband. This is something the city would never have known without having administered speed tests.

The following table summarizes the speed tests we received by ISP. We received enough speed tests to get a great cross-section of the different ISPs serving the county and also to see the comparative difference between technologies. There were not enough speed tests received for any of these ISPs to make any definitive statements about their average speeds. The main benefit of this exercise was to provide a relative comparison between ISPs. There will be some observations about the speed test details below.

	Technology	Latency (ms)	Download (Mbps)	Upload (Mbps)
AT&T	DSL	37	21.0	4.8
AT&T	Fiber	21	180.6	150.6
CCG	Fiber	2	234.8	430.9
Comcast	Cable	19	228.3	19.5
Consolidated	Fiber	7	300.3	247.6
Cox Wireless	Wireless	44	5.3	3.1
Earthlink	DSL	50	50.0	5.6

Frontier	DSL	40	4.7	0.7
I3	Fiber	11	246.0	167.2
Mediacom	Cable	19	143.3	32.9
Mediacom	Fiber	19	946.0	756.0
Netcare	Wireless	23	8.3	2.7
Pavlov Media	Fiber	12	190.1	161.2
Rise Broadband	Wireless	45	33.5	9.7
Starlink	Satellite	35	95.5	11.5
HughesNet	Satellite	637	26.1	3.1
T-Mobile	Cellular	35	201.4	32.4
Verizon	Cellular	56	16.8	5.0
Volo Broadband	Fiber	9	119.8	89.9

This summary highlights the following:

- As we expected, the average speeds on fiber are spectacular. It's clear that the fiber providers offer fast upload speeds along with fast download speeds. We caution against trying to compare fiber providers, since the difference between them is the relative mix of customers buying different speed tiers - all of the fiber providers offer a gigabit broadband product.
- The download broadband speeds on Comcast and Mediacom, the two cable companies, were as good as fiber. However, the upload speeds for cable companies are a lot slower than the download speeds.
- Download speeds from the telephone companies using DSL are much slower than the speeds offered by fiber and cable companies. The upload speeds for DSL are the slowest compared to the other technologies.
- The speed test attracted two tests from Starlink customers. The results are much in line with what has been reported elsewhere – download speeds are between 50 – 150 Mbps. Upload speeds are slower than the cable companies.
- The speeds for HughesNet, with satellites 22,000 miles above the earth are relatively slow, but faster than DSL.
- It's always a bit tricky comparing wireless ISPs because they use different technologies and network philosophies. The average WISP broadband speed in our survey sample is faster than the FCC's definition of broadband of 25/3 Mbps.
- The speeds reported for cellular companies are for a fixed broadband product for home use – not the same as the cellular delivered to cell phones. With that said, the major companies are in the process of upgrading the networks that deliver these products and speeds are increasing significantly as markets are upgraded. It's likely with the speed shown above that Verizon hasn't upgraded yet but T-Mobile probably has upgraded.

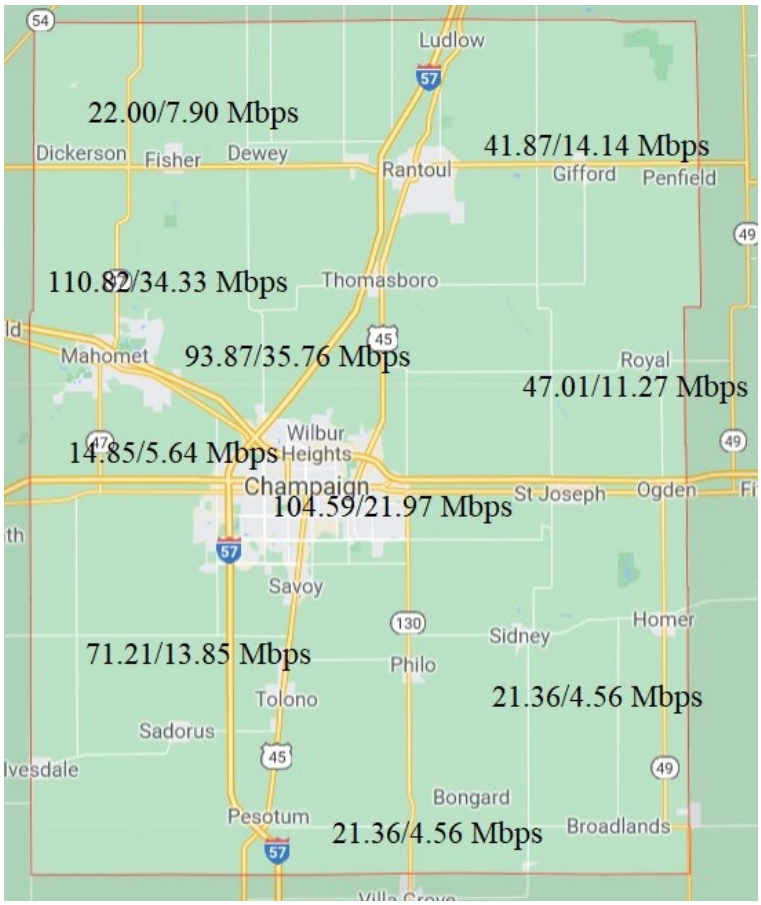
Following is a table of the same results, summarized by technology.

	Technology	Latency (ms)	Download (Mbps)	Upload (Mbps)
Fiber	Fiber	12	232.7	180.3
DSL	DSL	39	11.5	2.2
Cable	Cable	19	200.3	23.9
Wireless	Wireless	44	28.7	8.5
GEO Satellite	Satellite	637	26.1	3.1
LEO Satellite	Satellite	35	95.5	11.5
Cellular	Cellular	53	43.2	8.9

Some Additional Comments About ISPs.

- AT&T DSL speeds are decent compared to what we see elsewhere. However, buried within the averages are rural customers with download speeds under 5 Mbps and upload speeds under 1 Mbps. AT&T's performance is somewhat irrelevant since the company won't sell pr connect new DSL customers.
- We can see that AT&T has built some fiber in Champaign and Savoy. The company typically builds in small neighborhood pockets and does not build to whole communities.
- About 10% of Comcast speed tests were below 50 Mbps download. We look at the overall speeds for Comcast and would judge that the company has largely upgraded their networks. While the average upload speed on Comcast at 19.5 Mbps is still far slower than download speeds – this is a higher average upload speed than we see in many other markets.
- Over a third of Frontier customers have download speeds under 5 Mbps. All Frontier customers have upload speeds at or less than 1 Mbps.
- Mediacom download speeds are not as fast as Comcast. About one-fourth of Mediacom customers reported download speeds under 50 Mbps. However, Mediacom's upload speeds are 50% faster than Comcast. We speculate that Mediacom allocated more bandwidth to upload speeds as a result of the pandemic.
- Rise Broadband speeds vary the most in looking at the detail. This is not untypical for a fixed wireless provider since speeds are influenced significantly by the distance between a customer and the tower. 15% of Rise customers had download speeds under 5 Mbps while 30% reported speeds over 50 Mbps.
- The big news on HughesNet satellite service is the extremely high latency. This will be discussed more below.

Finally, we offer up the following map. This comes from the speed test data collected by the NTIA from Ookla. These results represent the average landline broadband speeds collected by Census tract. These numbers aren't particularly useful since they combine all of the landline broadband technologies into one speed result. However, this map does highlight that the relative broadband speeds are faster in the cities and much slower in the rural areas. But this comes with the caveat that even a small pocket of fiber customers in a rural Census tract can jack up the average speeds shown in this map.



Latency

The two tables above include a column showing average latency. The standard definition of latency is that it's a measure of the time it takes for a data packet to travel from its point of origin to the point of destination. Another way to describe latency is that it measures the delay in the signals between networks. These numbers represent the delay between broadband customers in the county and the speed test site operated by Ookla. Latency is important and is a third primary way to measure the quality of a broadband signal.

There are a lot of underlying causes for delays that increase latency – the following are primary kinds of delays:

- Transmission Delay. This is the time required to push packets out the door at the originating end of a transmission. This is mostly a function of the kind of router and software used at the originating server. This can also be influenced by packet length, and it generally takes longer to create long packets than it does to create multiple short ones. These delays are caused by the originator of an Internet signal (like Netflix).
- Processing Delay. This is the time required to process a packet header, check for bit-level errors and to figure out where the packet is to be sent. These delays are caused by the ISP of the originating party. There are additional processing delays along the way every time a transmission has to 'hop' between ISPs or networks.
- Propagation Delay. This is the delay due to the distance a signal travels. It takes a lot longer for a signal to travel from Tokyo to Baltimore than it takes to travel from Washington DC to Baltimore.

This is why speed tests try to find a nearby router to ping so that they can eliminate latency due to distance. These delays are mostly a function of physics and the speed at which signals can be carried through cables.

- Queueing Delay. This measures the amount of time that a packet waits at the terminating end to be processed. This is a function of both the terminating ISP and also of the customer's computer and software.

Total latency is the combination of all of these delays. You can see by looking at our simple definitions that poor latency can be introduced at multiple points along an Internet transmission path.

The technology used in the last-mile generally has the biggest impact on latency. A few years ago, the FCC did a study of the various last-mile technologies and measured the following ranges of performance of last-mile latency, measured in milliseconds: fiber (10-20 ms), coaxial cable (15-40 ms), and DSL (30-65 ms). These are measures of the average latency between a home and the first node in the ISP network. It is these latency differences that cause people to prefer fiber. The experience on a 30 Mbps download fiber connection "feels" faster than the same speed on a DSL or cable network connection due to the reduced latency.

It is the technology latency that makes wireless connections seem slow. Cellular latencies vary widely depending upon the exact generation of equipment at any given cell site. 4G cellular latency can be as high as 100 milliseconds. In the same FCC test that produced the latencies shown above, satellite latency was almost off the chart with measurements as high as 650 milliseconds

The next biggest factor influencing latency is the network path between the originating and terminating end of a signal. Every time that a signal hits a network node, the new router must examine the packet header to determine the route and may run other checks on the data. The delays of hitting network routers or of changing networks is referred to in the industry as hops, and each hop adds latency.

Slow latencies contribute to poor performance. When latency gets above 100 milliseconds, a customer will begin experiencing trouble with any real-time applications on the web. High latency can make it hard to stream live sports events where the video isn't buffered. High latency makes it hard to connect to a school or work server from home. It can be hard to use the computer for a voice-over-IP call or to participate in Zoom sessions. It can even be hard to shop online and do other web events if the website in use perceives a delay as loss of connection.

A lot of complaints about Internet performance are actually due to latency issues. It's something that's hard to diagnose since latency issues can appear and reappear as Internet traffic between two points uses different routing. But the one thing that is clear is that the lower the latency the better the quality of the broadband connection.

Jitter.

There is one last important aspect of broadband quality that should be mentioned. The above discussion highlights problems caused by high latency, which is a measure of the average delay of data packets on a network. There is another important measure of network quality that is rarely talked about. Jitter is the

variance in the delays of signals being delivered through a broadband network connection. Jitter occurs when the latency increases or decreases over time.

We have a tendency in the industry to oversimplify technical issues. We take a speed test and assume the answer that pops out is our speed. Those same speed tests also measure latency, and even network engineers sometimes get mentally lazy and are satisfied to see an expected latency number on a network test. But in reality, the broadband signal coming into your home is incredibly erratic. From millisecond to millisecond, the amount of data hitting your home network varies widely. Measuring jitter means measuring the degree of network chaos.

Jitter increases when networks get overwhelmed, even temporarily. Delays are caused in any network when the amount of data being delivered exceeds what can be accepted. There are a few common causes of increased jitter:

- Not Enough Bandwidth. Low bandwidth connections experience increased jitter when packets from the outside world exceed the capacity of the broadband connection. This effect can be a double-whammy for somebody with a slow broadband connection because the very slowness causes the network to behave even worse than would be expected.
- Hardware Limitations. Networks can bog down when outdated routers, switches, or modems can't fully handle the volume of packets. Even issues like old or faulty cabling can cause delays and increase jitter.
- Network Handoffs. Jitter can increase at any network bottleneck. The most common bottleneck we all have is the device that converts landline broadband to WiFi. Even the slightest hiccup at a bottleneck can negatively impact the entire network.

All of these factors help to explain why old technology like DSL performs even worse than might be expected. Consider a home that has a 15 Mbps download connection on DSL. If an ISP were to instead deliver a 15 Mbps connection on fiber, the same customer would see a significant improvement in performance even at the same download speed. A fiber connection would avoid the jitter issues caused by antiquated DSL hardware. We tend to focus on speeds, but a 100 Mbps connection on a fiber network will typically have a lot less jitter than a 100 Mbps connection on a cable company network. Customers who try a fiber connection for the first time commonly say that the network 'feels' faster – what they are likely noticing the greatly reduced jitter.

High jitter can be deadly to real-time connections – most people won't care if jitter means it takes a little longer to download a file. But high jitter can play havoc with an important Zoom call or with maintaining a TV signal during a big sports event. It's easiest to notice jitter when a real-time function hesitates or fails. Your home might have plenty of download bandwidth, and yet small problems caused by jitter can accumulate to make the connection fail.

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

Fully understanding the causes of jitter in any specific network is a challenge because the causes can be subtle. It's often hard to pinpoint a jitter problem because it can be here one millisecond and gone the next. But it's something we should be discussing more. A lot of the complaints people have about their broadband connections in the rural areas today are caused by too-high jitter.

C. The Mapping Story

The easiest way to visualize the current state of broadband in a county is through the mapping of broadband speeds. This section of the report will look at broadband speeds in several ways. We'll start with the publicly available data from the FCC. We will then factor in updates that are not reflected in the FCC data, like grants that have been awarded to upgrade broadband speeds. Finally, we'll create maps that we think most accurately reflect broadband available using the information we received from sources like the speed tests. The final map will portray what we think is the real state of broadband in the rural parts of the county.

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.[12] 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 Champaign 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.

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

[12] 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.

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 U.S.. 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 U.S. 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 are no penalties for ISPs that report 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 mean 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. ISPs providing rural DSL or fixed wireless regularly overstate the broadband speeds – these are the two technologies most widely used in rural America and in Champaign County.

FCC to Revise Maps

Congress got involved and passed legislation to require the FCC to fix the maps. In March of 2020, Congress passed S.1822, the Broadband Deployment Accuracy and Technology Availability (DATA) Act. That bill requires the FCC to gather granular service data for wired, fixed wireless, and satellite broadband providers. It requires the FCC to consider using state broadband mapping data where states have tried to create a better picture of broadband. It also requires a crowdsourcing process to allow the public to participate in data collection. The Act provides penalties against ISPs that knowingly or recklessly submit inaccurate mapping data. Finally, the Act requires that all federal agencies begin using the better databases before awarding any major broadband funding – the $42.4 billion BEAD grants require amended mapping data.

As often happens in the government, this bill didn't provide any funding to make the needed changes. The FCC started the process of formulating new rules around the Act but didn't take any action to fix the maps due to lack of funding. Congress finally provided $98 million in funding from the American Rescue Plan Act (ARPA) in December 2020 that included $65 million to create better maps.

In February of 2021, the FCC, under acting chair Jessica Rosenworcel, established the Broadband Data Task Force with the aim of implementing the goals of the DATA Act and fixing the mapping. The FCC kicked off the new Broadband Data Collection (BDC) program in March 2021 to change the way that mapping data is collected from ISPs. The federal procurement process is slow, and the FCC finally released the RFP to hire a vendor to fix the mapping and awarded a $45 million contract to CostQuest Associates. In November 2021, LightBox challenged that RFP award. According to federal procurement rules, it will take at least one hundred days for the FCC to deal with that challenge. The bottom line is that as this report is being written that there are still no changes to the FCC mapping, almost two years after Congress required better maps.

Meanwhile, it is raining federal broadband grant monies. There was a huge amount of potential grant funding in the ARPA legislation that gave some grant monies to federal agencies like the NTIA and the RUS. But that legislation gave far more money directly to cities, counties, and states – much of it directed at broadband. In November 2021, Congress added another $42.5 billion in BEAD grants to the pile of federal money that is on the way. All of these grants have some sort of speed test threshold to define what is eligible for grant funding. Communities all over the country are already making plans for applying for the BEAD grants and are being hindered by not having the new maps.

It's not clear to us that the FCC will fully fix the maps. For example, 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 city and still be unable to draw an accurate polygon of the coverage area. We foresee governments undertaking these challenges, but the process looks 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.

Consequences of Inaccurate FCC Maps

Unfortunately, the speeds reported by the FCC maps have 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 poor 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 can be excluded from being eligible for federal grant money. In Champaign County, we think that many of the speeds claimed by Frontier, AT&T, and several of the wireless ISPs are overstated. We also think the FCC maps exaggerate the Comcast and Mediacom coverage and exclude homes that are close to the cities from being eligible for grant funding.

FCC Data for the ISPs in Champaign County

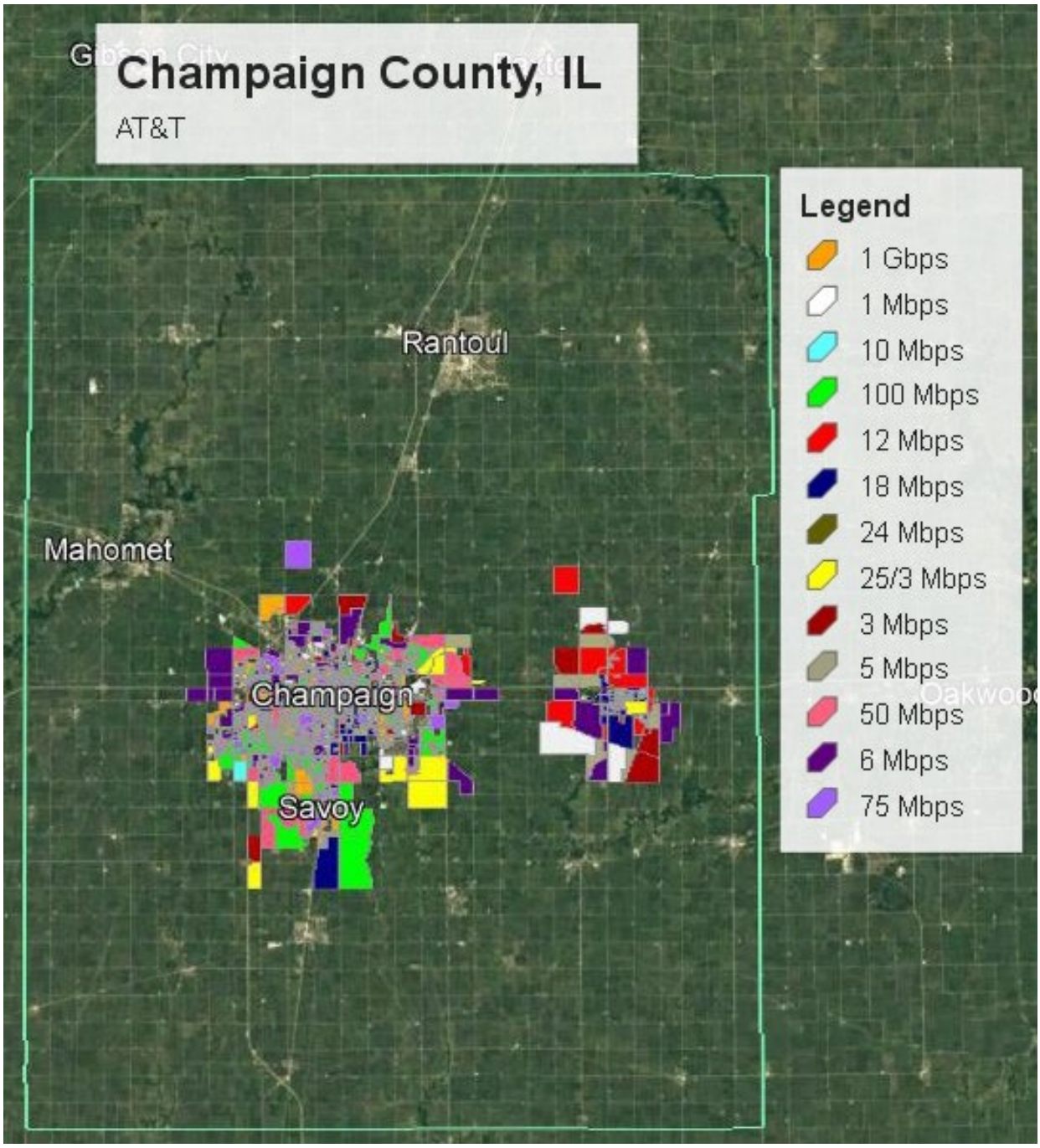
Even with the many faults, there is still some good information in the FCC broadband data. If nothing else, the FCC 477 maps are a starting point for trying to define the ISPs that serve any given area and the speeds they claim to be providing. The following series of maps look at coverage areas claimed by ISPs using the FCC 477 data for each of the primary ISPs in the county. In cases where an ISP reports multiple speeds, we've color-coded the data by speed.

AT&T

AT&T has historically offered DSL in the rural parts of the county. 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 offer fixed cellular wireless instead of broadband, but we have seen no evidence that they've launched that product yet in the county.

The map below shows the speeds that AT&T reports to the FCC on the 477 forms. The company shows speeds between 1 Mbps to 1 Gbps. In the map below, different colors represent different speeds.

Map 1 - AT&T FCC 477 Data

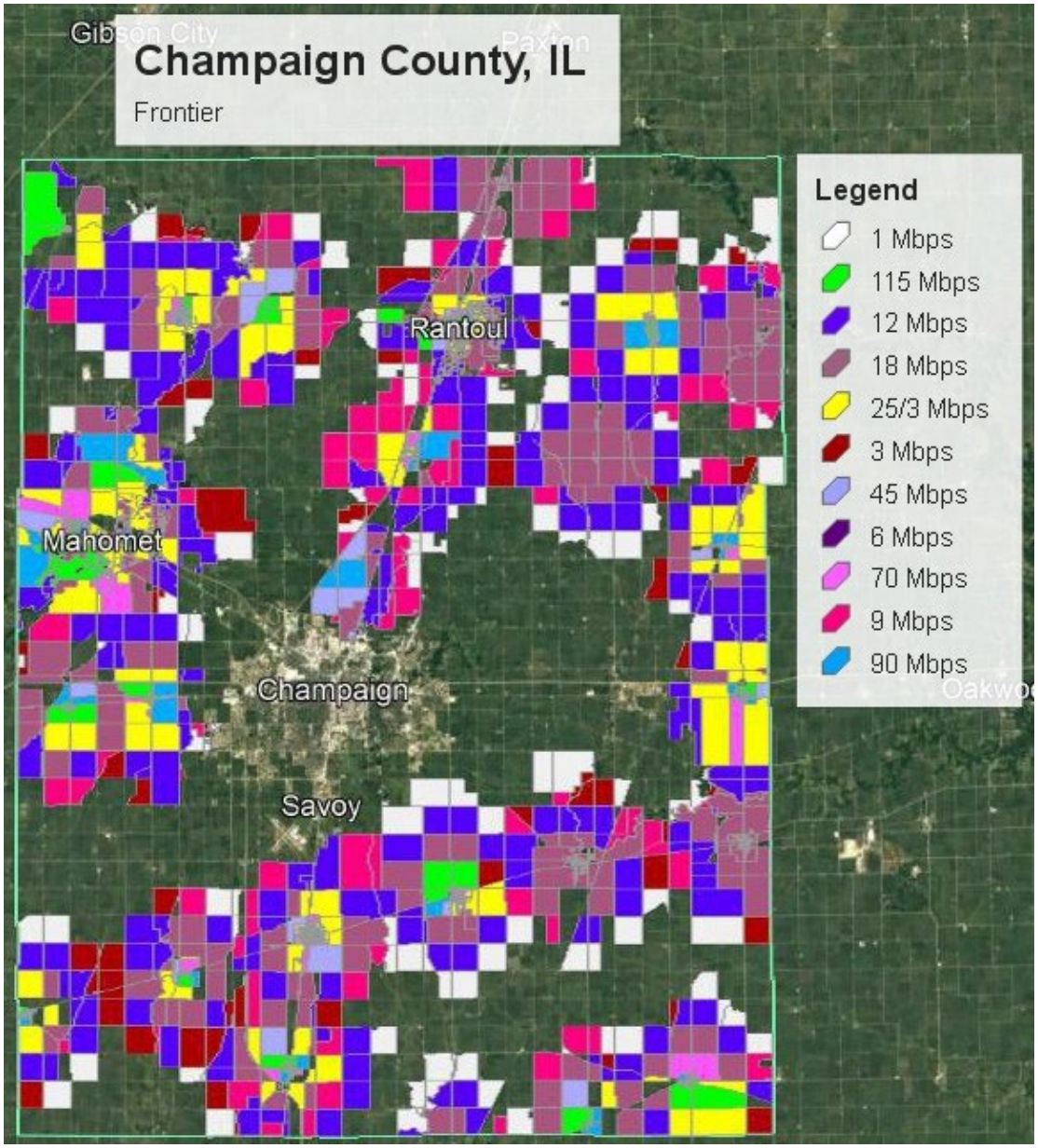


Frontier Communications

Frontier is the incumbent telephone company for most of Champaign County. The following map is one of the best examples we've ever seen of the confusing nature of broadband being reported by telephone companies to the FCC. As can be seen by the map legend, Frontier is reporting 11 different tiers of speeds in different parts of the county, with reported download speeds ranging from 1 Mbps to 115 Mbps.

- Frontier has two options for providing DSL. The primary DSL technology uses one copper pair and delivers speeds under 25 Mbps download even under ideal conditions – and there are no ideal conditions in older copper networks. The speed bands showing speeds under 25 Mbps or less are deploying one-pair DSL. Frontier is reporting speeds of 1 Mbps, 3 Mbps, 6 Mbps, 9 Mbps, 12 Mbps, and 18 Mbps. This is unusual for Frontier, which often reports marketing speeds and not actual speeds. When Frontier reports a top speed to the FCC of 1 Mbps or 3 Mbps, we must believe that's the fastest speed available in those areas.
- Frontier also deploys DSL using two copper pairs, which effectively doubles the speed. The maximum speed available with this technology is 48 Mbps download. One of the problems with the FCC reporting is that there is no way to tell how much of this technology is being deployed. If Frontier serves even one customer in a Census block using the faster technology, the FCC mapping rules allow Frontier to claim that capability for the whole Census block. It's likely that most of these DSL speeds in these areas are far slower than implied by the FCC reporting.
- Frontier shows some speeds faster than 48 Mbps – with Census blocks shown at 70 Mbps, 90 Mbps, and 115 Mbps. It's likely that these speeds represent fiber. Again, due to the rules for reporting speeds to the FCC, Frontier might be serving one business customer with fiber in a Census block and yet is allowed to show the whole Census block as capable of the faster speeds. It's likely that most of the customers in these blocks are served by much slower DSL. There are larger cities where Frontier is deploying widespread residential fiber - but not in places like rural Champaign County.

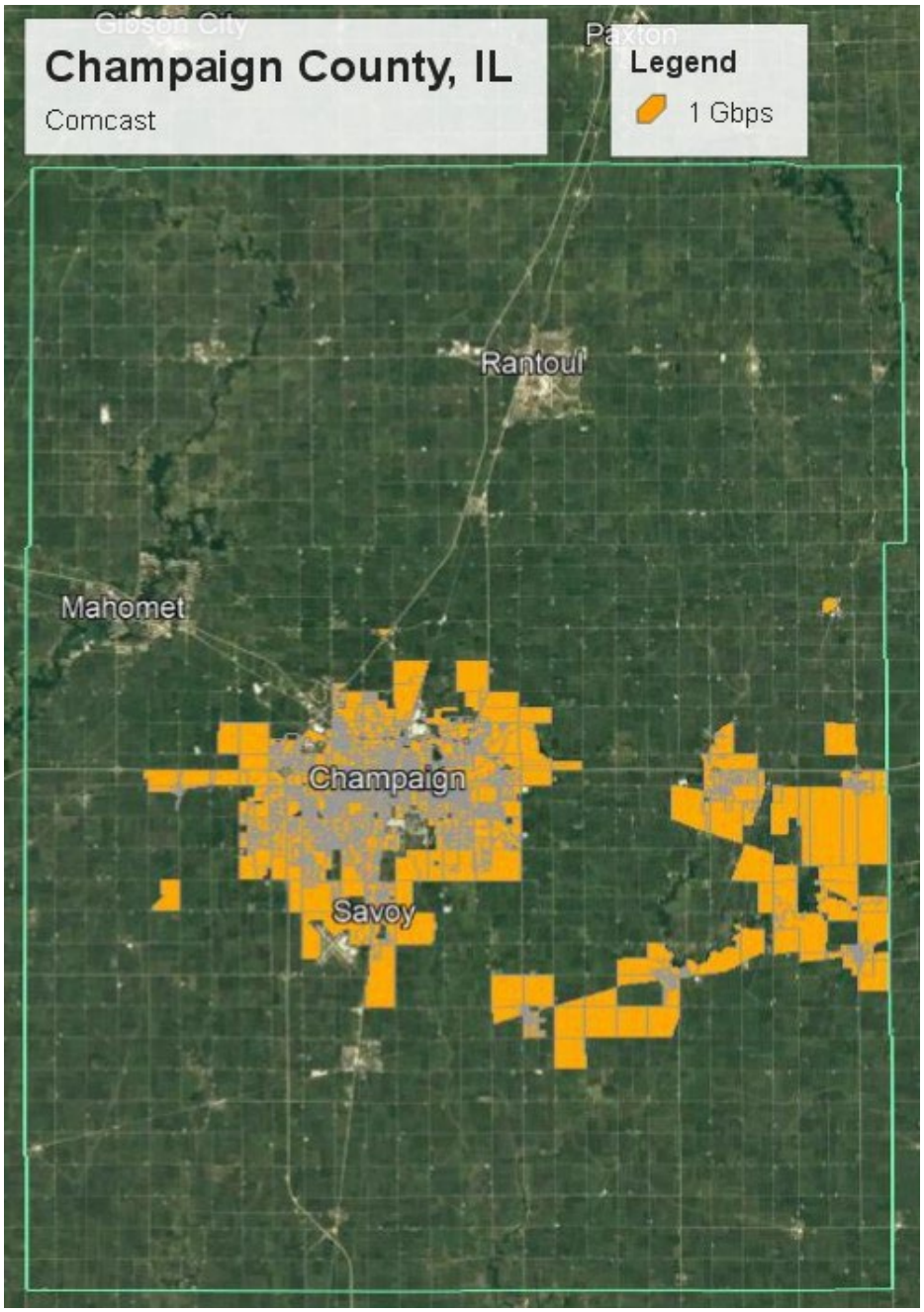
Map 2 - Frontier FCC 477 Data



Comcast (Xfinity)

Comcast (Xfinity) is an incumbent cable company in Champaign County. Comcast provides service in the cities of Champaign and Urbana, the village of Savoy, the town of St. Joseph, and surrounding areas. Comcast advertises speeds up to 1 Gbps for its entire service area. The actual Comcast coverage area is smaller than the areas shown in orange. The coverage area is overstated due to the FCC mapping rules that show a Census block as fully served even if there is only one Comcast customer.

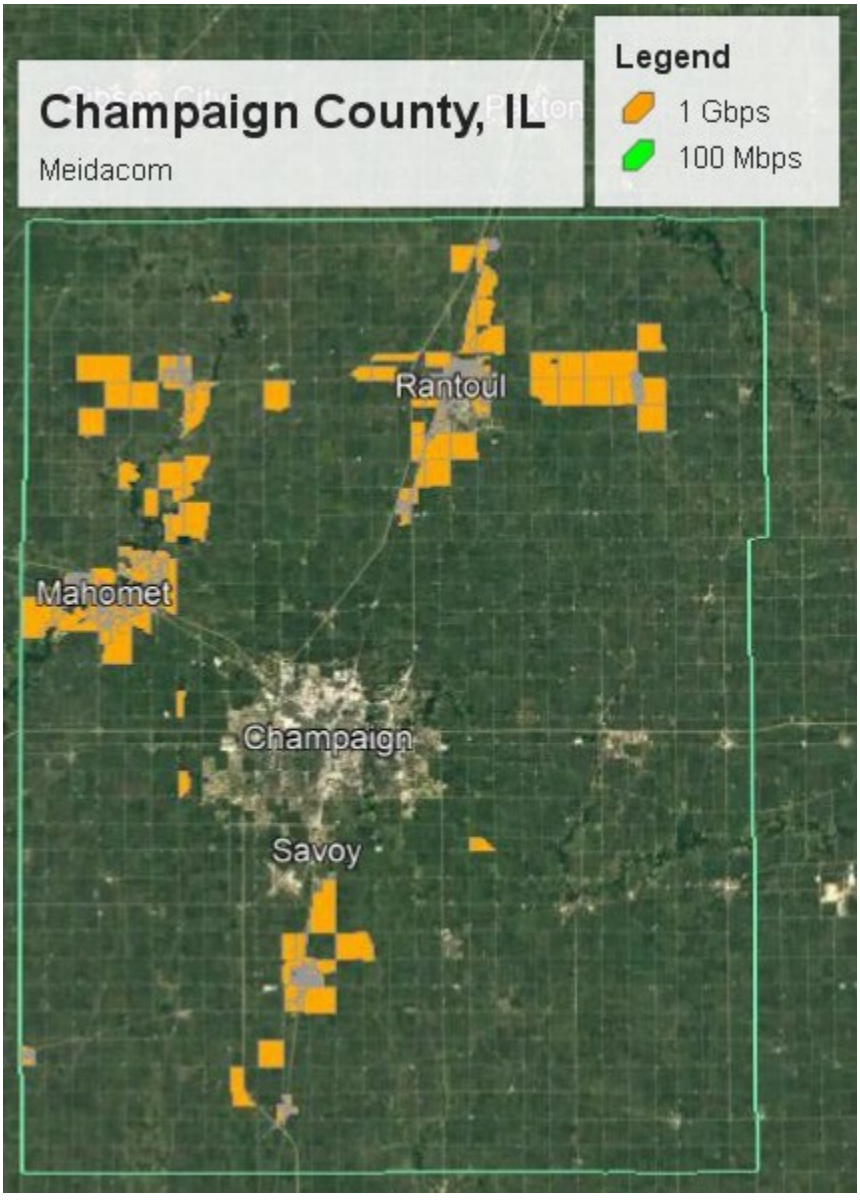
Map 3 - Comcast FCC 477 Data



Mediacom

Mediacom is an incumbent cable provider in Champaign County. Below is the coverage claimed by the company on the FCC Form 477, where the company reports coverage in the villages of Rantoul, Mahomet, Tolono, and surrounding areas. Mediacom claims to provide primarily 1 Gbps speeds in its service areas, shown in orange on the map below. The service area is overstated for Mediacom due to the FCC mapping protocol that allows an entire Census block to be considered served even if there is only one customer. The company shows one Census block with speeds of 100 Mbps – our guess is that this is a reporting error.

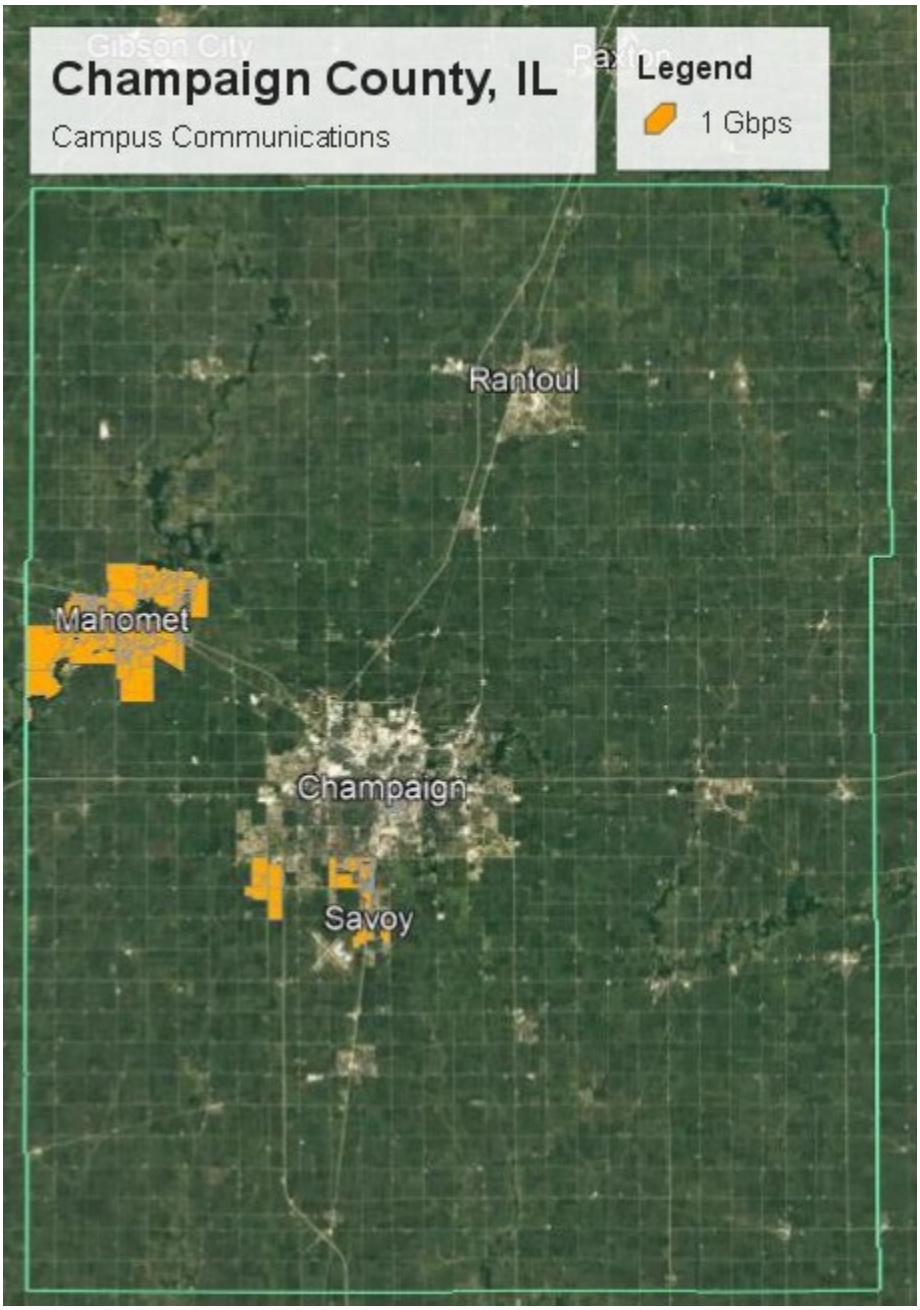
Map 4 - Mediacom FCC 477 Data



Campus Communications Group (CCG)

Campus Communications Group (CCG) is a fiber-optic broadband provider that operates in the villages of Mahomet and Savoy. The map below shows the company's reporting on the FCC Form 477. Campus Communications Group reports speeds of 1 Gbps for the entire coverage area.

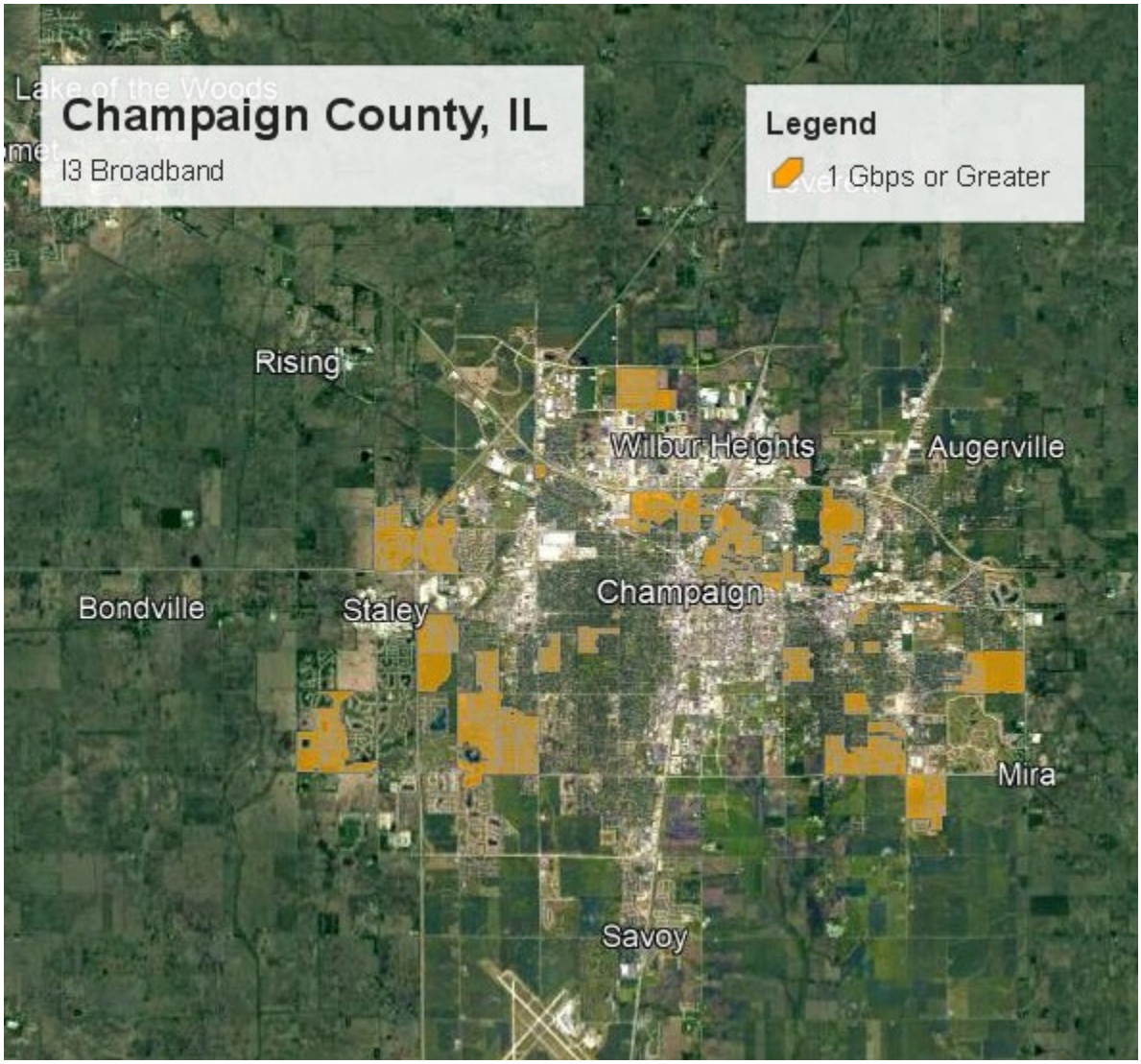
Map 5 - CCG FCC 477 Data



I3 Broadband

I3 Broadband is a fiber-optic provider in Champaign County. In the most recent FCC 477 form process, I3 Broadband claims to provide speeds of 1 Gbps in the area shown in orange on the map below. I3 Broadband claims to only offer coverage in the cities of Champaign, Urbana, and Wilbur Heights in the county.

Map 6 - I3 Broadband FCC 477 Data

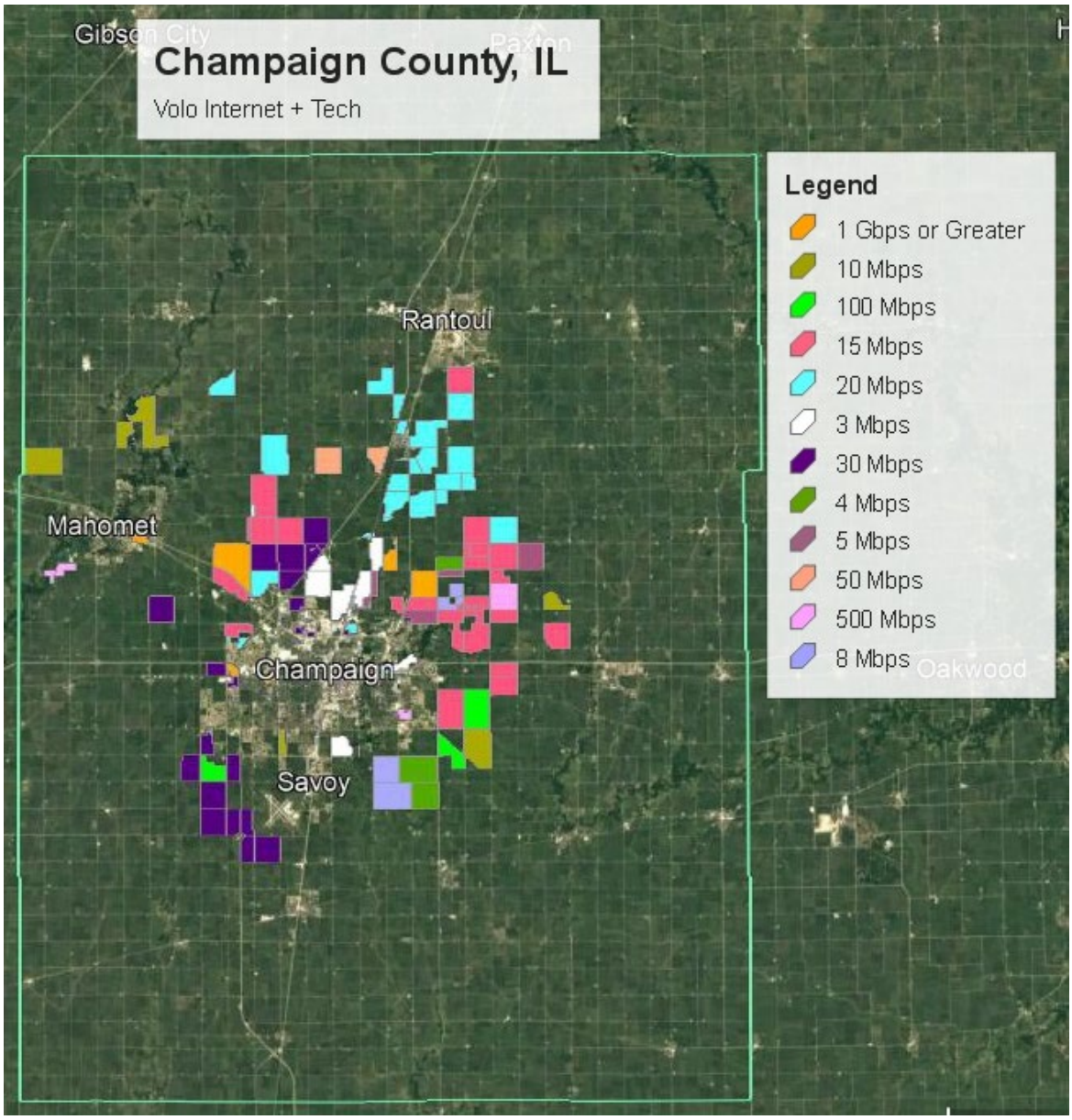


Volo Internet + Tech

Volo Internet + Tech provides both fiber-optic and fixed wireless broadband. The company serves parts of Champaign and Urbana, the village of Mahomet, and the surrounding rural areas. Volo claims download broadband speeds between 3 Mbps and 1 Gbps in the most recent FCC 477 process. Volo claims to provide speeds of 3 Mbps to 50 Mbps on its fixed wireless network and speeds from 100 Mbps to 1 Gbps on its fiber network.

In the following map, the areas in bright green and orange areas are where Volo provides fiber. The remaining colors represent the fixed wireless network.

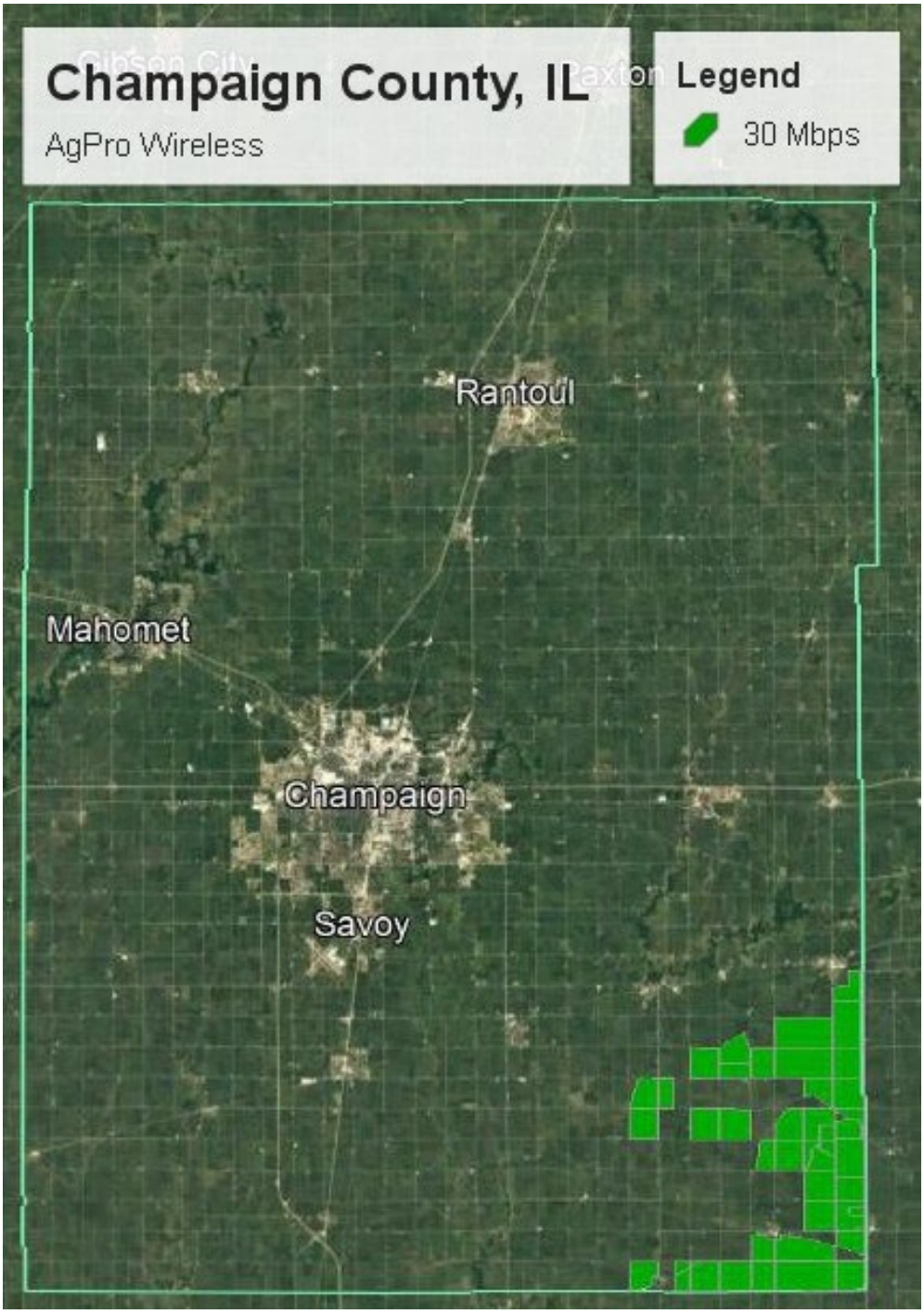
Map 7 Volo Internet + Tech FCC 477 Data



AgPro Wireless

AgPro Wireless is a fixed wireless provider operating in Champaign County. AgPro Wireless claims to the FCC that it can provide 30 Mbps service in the areas shown in green below.

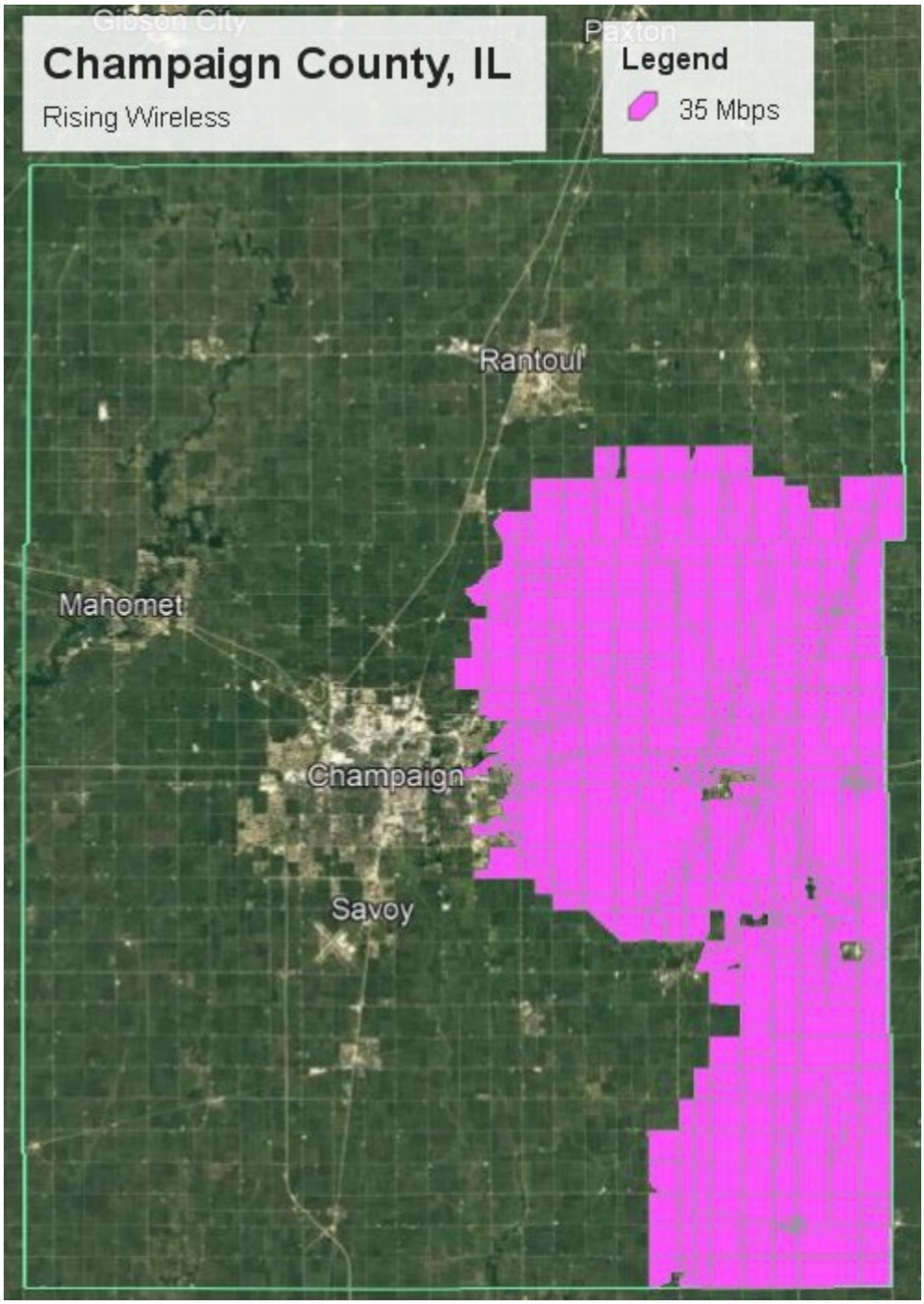
Map 8 - AgPro Wireless FCC 477 Data



Rising Wireless

Rising Wireless is a fixed wireless provider in Champaign County. Rising Wireless provides service in the eastern and southeastern parts of the county. Rising Wireless claims to the FCC that it provides 35 Mbps download speeds for its entire service area.

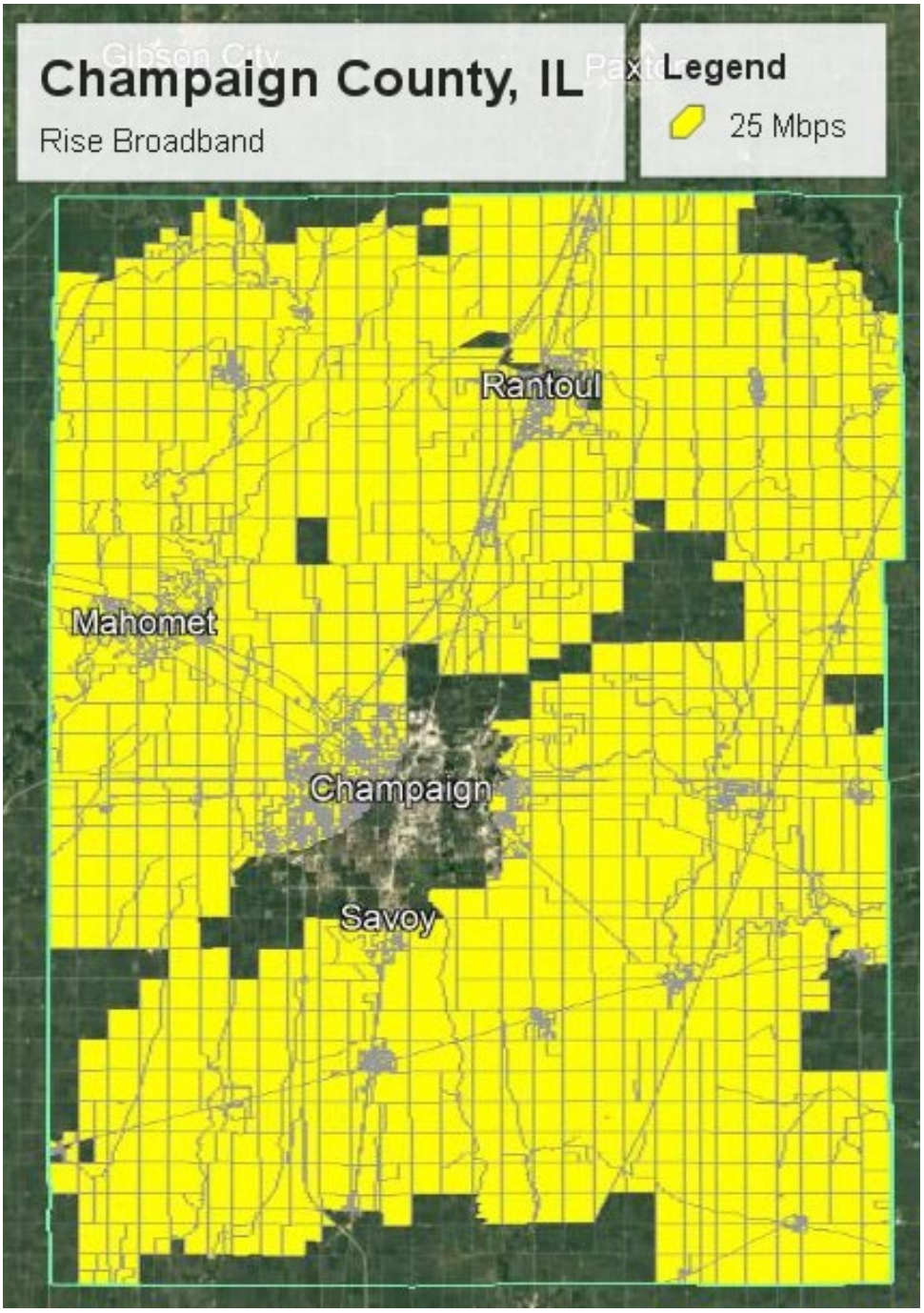
Map 9 - Rising Wireless FCC 477 Data



Rise Broadband

Rise Broadband is a fixed wireless provider. Rise Broadband claims to provide service to almost the entire county. In the most recent FCC 477 form process, Rise Broadband claims to provide 25 Mbps to its total service area in the county. Interestingly, the speed test data shows customers with faster speeds, and we suspect that the company has not updated the FCC reporting to match actual performance.

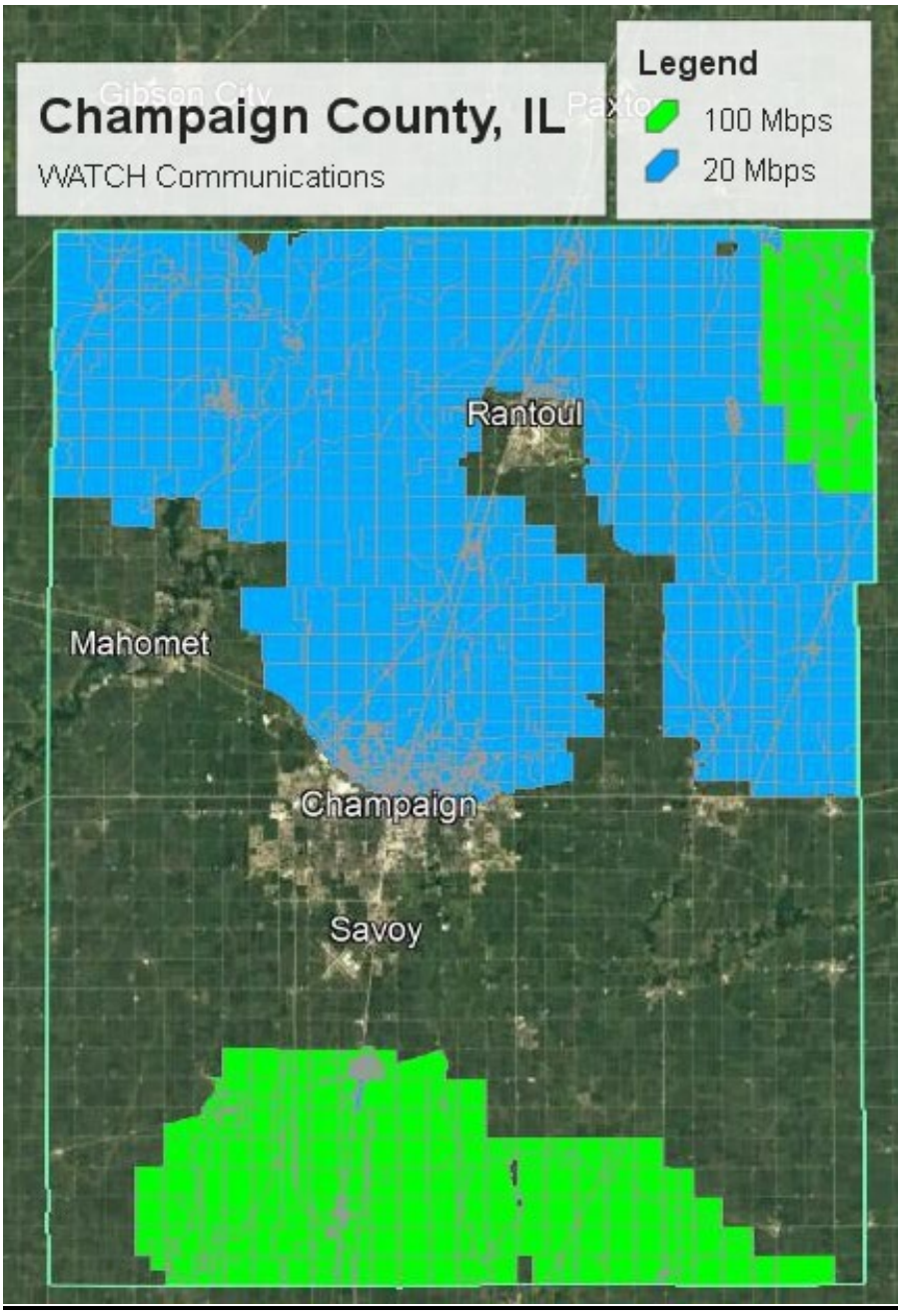
Map 10 - Rise Broadband FCC 477 Data



WATCH Communications

WATCH Communications is a fixed wireless provider in Champaign County. The company is a subsidiary of the Benton Ridge Telephone Company from Lima, Ohio. WATCH Communications provides service in the northern, central, and southern parts of Champaign County. In the most recent FCC 477 reporting, the company claims to be able to provide speeds of 100 Mbps download in the green areas and 20 Mbps download in the blue areas on the map below.

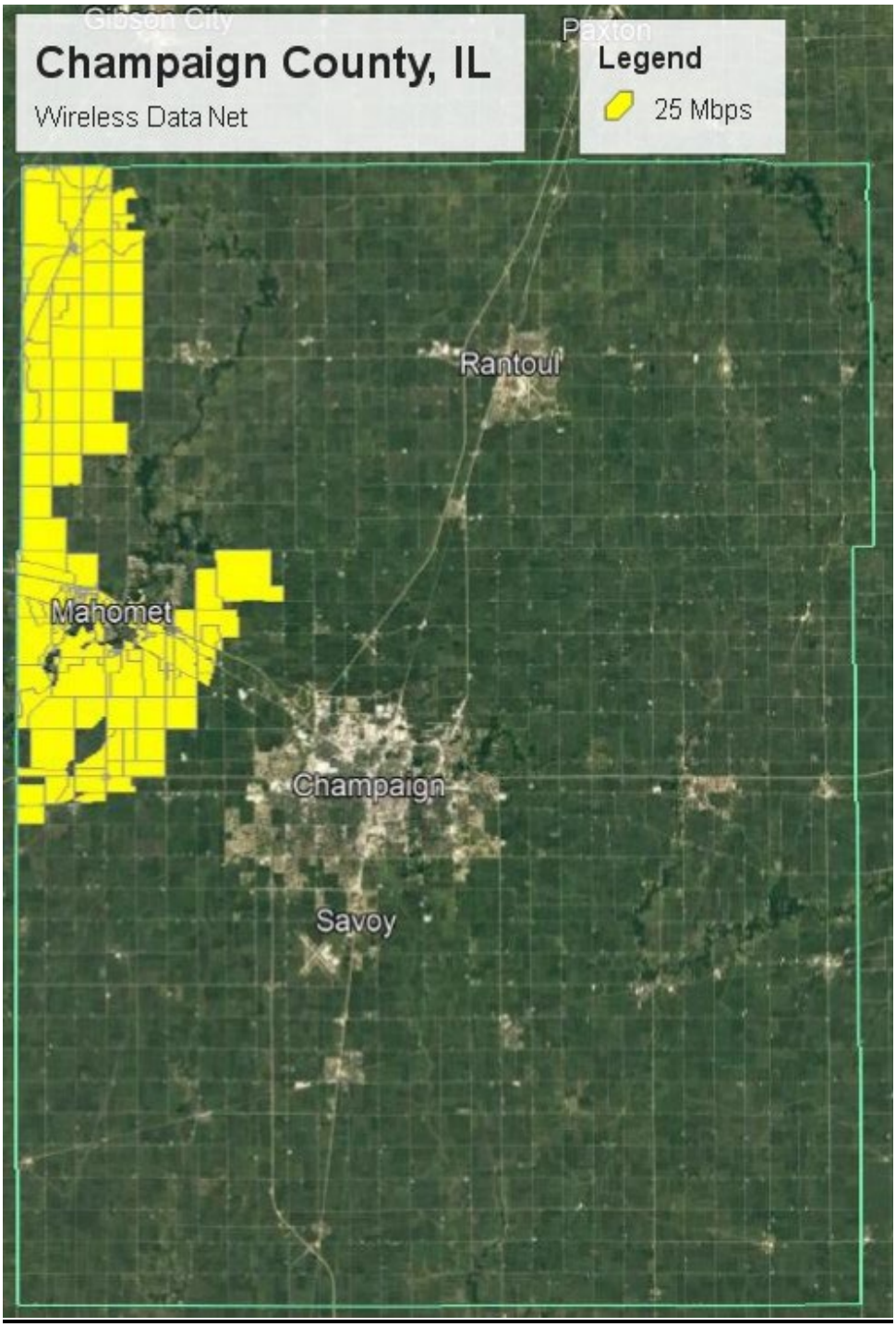
Map 11 - WATCH Communications FCC 477 Data



Wireless Data Net

Wireless Data Net is a fixed wireless provider in Champaign County. Wireless Data Net provides service in the northwestern part of the county. On the most recent reporting to the FCC, Wireless Data Net claims to be able to provide 25 Mbps speeds for the areas shown in yellow below.

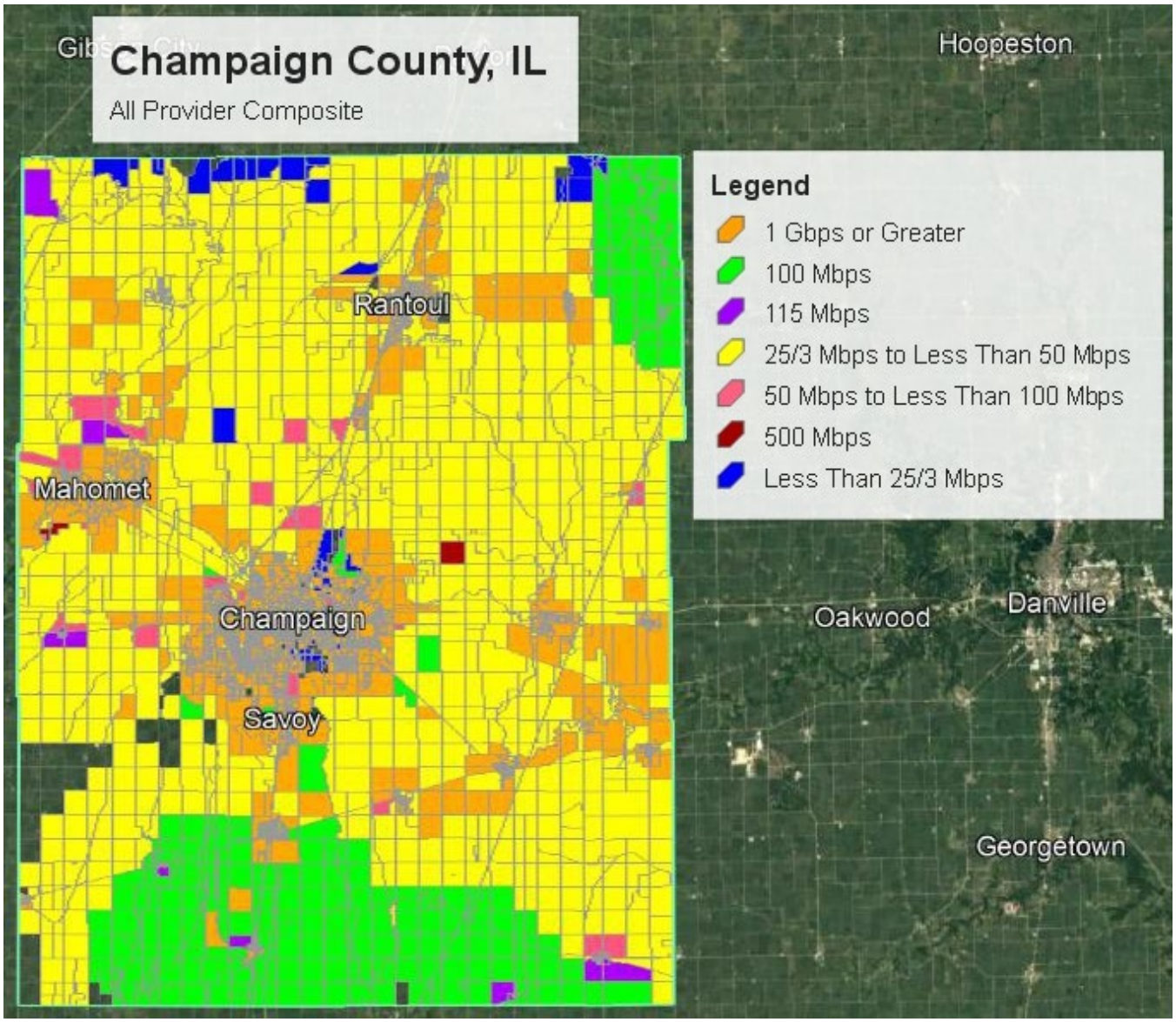
` **Map 12 - Wireless Data Net FCC 477 Data**



Composite FCC Maps

The following map shows the fastest broadband speed that is reported to the FCC for each Census block in the county. If this map was accurate, the only areas where customers can't buy 25/3 Mbps broadband would be the areas shown in blue. This is an important map because it is a visual summary of what the FCC reports to Congress to explain the availability of broadband in the county. The FCC is basically telling Congress that almost everybody in the county has access to broadband faster than 25/3 Mbps – which you know not to be true.

Map 13 - Composite of all FCC 477 Data

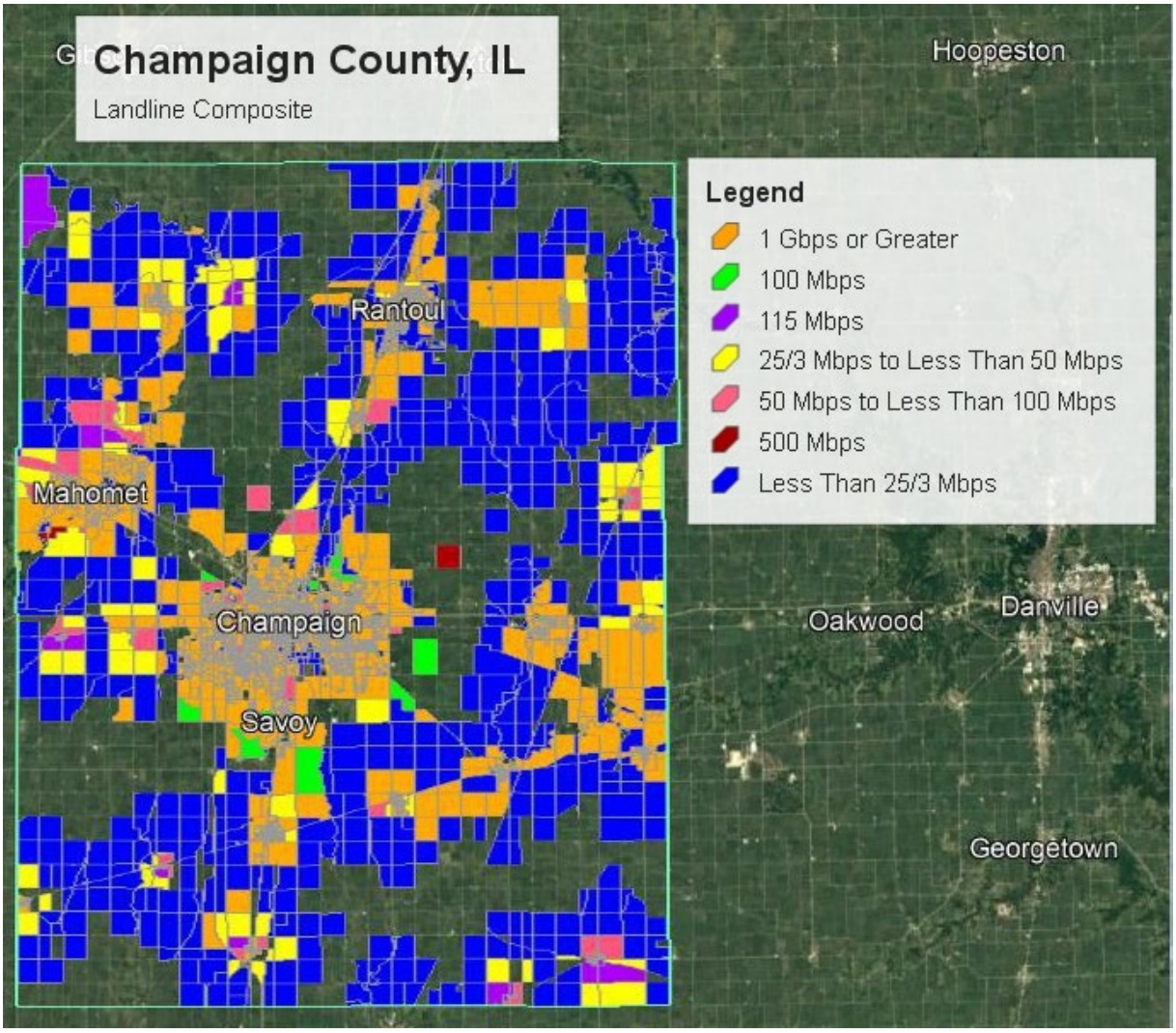


Landline Broadband Map – Grant Eligibility

A more important map than the one above is a map that shows the fastest landline download broadband speeds in each Census block of the county. Many state and federal grants only consider the speeds offered by landline ISPs when determining areas that are eligible for broadband grants. One of the primary purposes of this study was to identify those places in the county that need better broadband and for which grants might be available.

Landline broadband is defined as coverage by DSL, cable company HFC technology, or fiber. Most new grants ignore fixed wireless and fixed cellular broadband when determining grant eligibility. Grants in most cases also ignore the availability of cellphone and satellite broadband, which is available everywhere. The following map shows the fastest landline broadband speeds reported to the FCC for each Census block in the county. The areas in blue should be eligible for grants using the FCC broadband data. The areas with no color are not claimed as covered by any landline ISP and would also be eligible for grants – assuming somebody lives in them.

Map 14 - Landline Broadband FCC 477 Data



In summary, the FCC uses Map 13 to report the state of broadband in the county to Congress. That map shows that most of the county has broadband that meets the FCC definition of 25/3 Mbps. Most federal and state grant programs would use an updated version of Map 14 for determining eligibility for grants. Below we'll look at the adjustments that should be made to Map 14 in order to determine grant areas.

Updating the Landline Broadband Map

There are a few changes that must be made to Map 14 to properly show the state of landline broadband.

Edge Distortions. The map includes distortions along the edges of the telephone companies' historic service areas. This is needed because the FCC reporting gathers information by Census block, and those Census blocks often extend past the areas where the telephone companies serve. Most Census blocks along the border between two telephone companies have some customers from both companies. We will correct Map 14 to remove broadband coverage that doesn't exist.

Possible Upgrades. LTD Broadband, AMG Technology Investment Group, and Connect Everyone has tentatively won the RDOF reverse auction to build broadband in a few areas of the county. However, the FCC has not made these awards. For now, while these awards are pending, these areas are off-limits to other federal grants and probably to state grants. If any of these awards are made, these areas will be ineligible for other federal grants.

There was another federal grant awarded to Benton Ridge Telephone Company (WATCH Communications) in the CAF II reverse auction funding to build broadband for a few areas in northeast Champaign County.

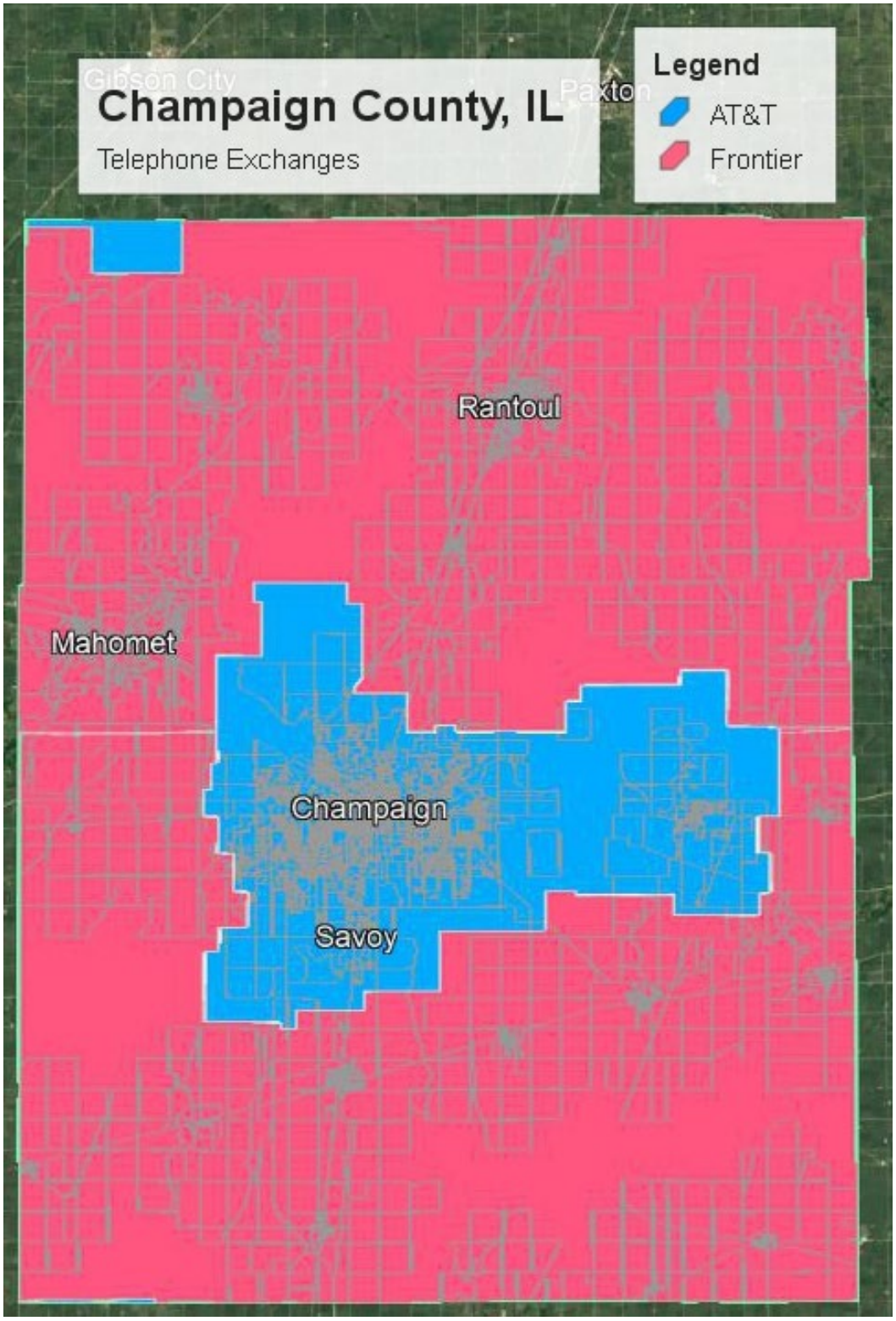
The Edge Issue

Telephone Company Exchange Boundaries.

The incumbent telephone companies in the county are AT&T and Frontier. The map below shows the historical monopoly boundaries for each telephone company. These boundaries were formally awarded a century ago by the Illinois Commerce Commission and each telephone company was given monopoly status within the borders shown on the map.

The FCC 477 reporting doesn't accurately reflect these exchange boundaries since the FCC data gathers information by Census block. Following is a map showing the exchange boundaries of the telephone companies in the county. The county is typical of how this worked a century ago. AT&T (Ma Bell) grabbed county seats and left rural areas go to somebody else. Frontier was not the original phone company in these areas, and the properties likely started as small local companies and then changed hands a bunch of times over the years.

Map 15 Telephone Exchange Boundaries



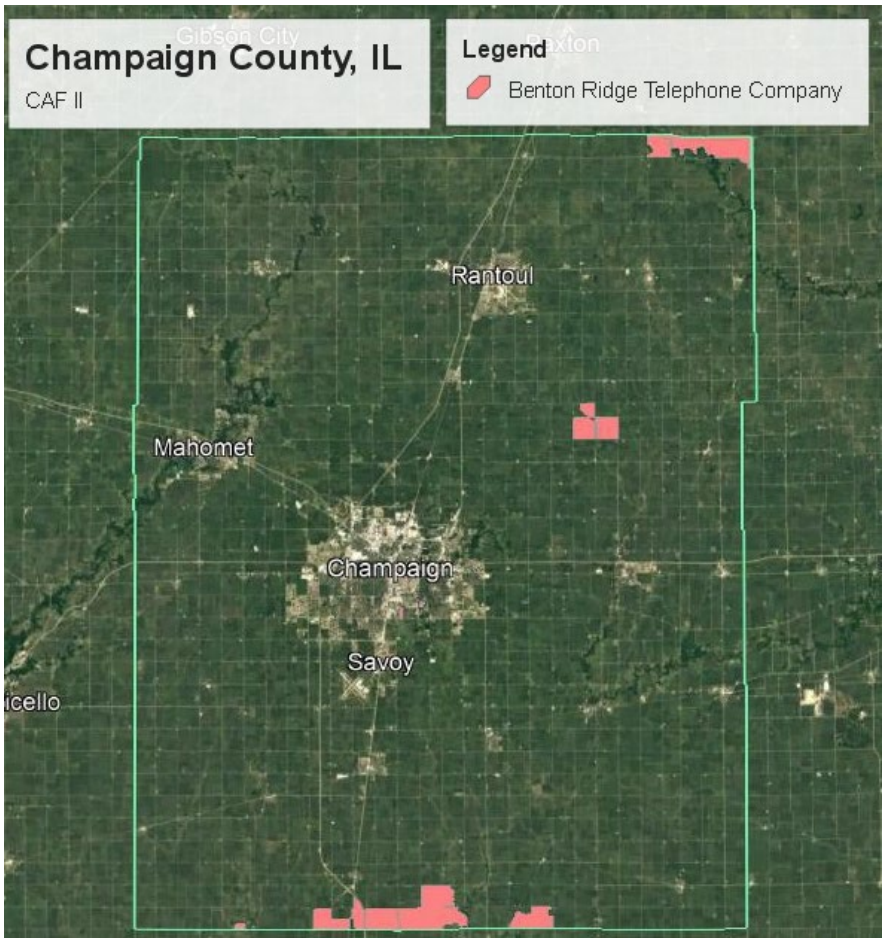
Grants and Upgrades

Following are maps that show where broadband grants have been awarded in the past or are now pending.

CAF II Reverse Auction

In August 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, Benton Ridge Telephone Company and its subsidiary WATCH Communications won $616,515 in Champaign County to be collected over ten years for bringing broadband to 111 rural homes in the county. That's an award of $5,554 per home. The areas won by Benton Ridge Telephone Company are shown in the map below:

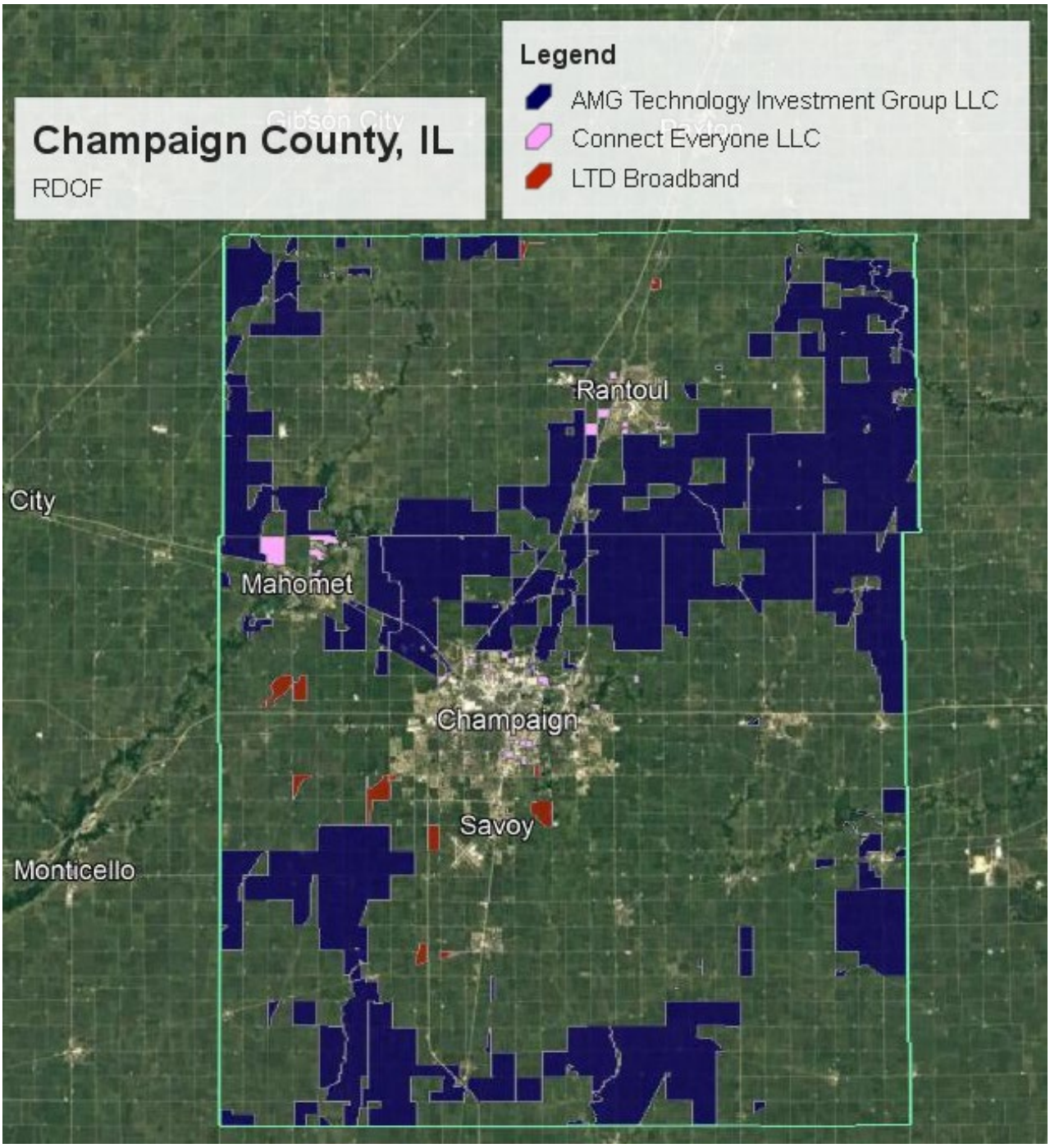
Map 16 CAF II Reverse Auction Winners



FCC Rural Digital Opportunity Fund (RDOF)

This program is funded by the FCC from the Universal Service Fund. ISPs became eligible for the RDOF funding by participating in a reverse auction that concluded in December 2020. ISPs tentatively won over $9 billion to improve broadband in rural America. There was a lot of RDOF funding in the county, as witnessed by the following map.

Map 17 - RDOF Winners



In a reverse auction, the ISP willing to take the least amount of subsidy for a given geographic area is awarded the funding. A reverse auction lasts multiple rounds, with ISPs lowering bids until only one ISP remains. The RDOF allowed a wide range of technologies to participate, from DSL through fiber. There were weightings in the bidding to give a priority to faster technologies. The RDOF subsidy will be paid

out over ten years. A winner is expected to complete construction within six years, with completion milestones starting with the third year.

The FCC has awarded only a small portion of the RDOF at the time that this report was finalized. The agency is wrestling with several controversies.

- Some RDOF areas were included in error. For example, there were some major urban airports included in what was supposed to be a program for rural America.
- Three of the top ten winners were funded to provide gigabit fixed wireless technology. There was a huge outcry in the industry because nobody believes that there is a wireless technology that can deliver a gigabit of speed to everybody in a rural Census block where customers are far apart and where there are a lot of physical impediments to the line-of-sight needed for the technology. The consensus is that the FCC erred by allowing these technologies to bid at this tier because that made the technology functionally equivalent to fiber. Where fiber can deliver a symmetrical gigabit product to every household in a Census block, it's likely that fixed wireless might bring that speed to a handful of households, bring something significantly slower to most households, and would be unable to serve many households due to line-of-sight issues.
- There was also a big outcry when Starlink was a major winner. Many feel that low-orbit satellite is an unproven technology and that there is no guarantee that Starlink will ever launch the needed satellites. There were also complaints that the technology, by definition, is already going to be available everywhere and doesn't need a government subsidy to deploy.
- There were also a few winners that many believed should not have been allowed to win huge amounts of grant funding. The biggest of these is LTD Broadband, a small wireless carrier from Minnesota with fewer than 100 employees. The company won over $1.2 billion in grants and promised to build fiber-to-the-premise. Many doubt that a company of this small size is up to such a gigantic construction challenge. Even more importantly, nobody thinks that a company this small can borrow the billions in funding needed to match the grant funds. There have been estimates that LTD might need to raise $5 - $8 billion to build what it pledged.

There were three RDOF auction winners in Champaign County.

- **LTD Broadband** of Blooming Prairie, Minnesota was awarded $387,924 to serve 234 locations. LTD's bids in the reverse auction are controversial. The small wireless carrier with fewer than 100 employees won over $1.2 billion in RDOF awards spread over numerous states. The company bid to build fiber-to-the-premise, and many doubt that a company of this small size is up to such a gigantic construction challenge for a technology it doesn't provide today. Even more importantly, few think that a company this small can borrow the billions in funding needed to match the grant funds. There have been estimates that LTD might need to raise $6 - $8 billion to build what it pledged. There are not many ISPs other than a few of the giant ones that have access to that kind of funding.
- **AMG Technology Investment Group LLC** (Nextlink) was awarded $4,233,806 to serve 2,490 locations in Champaign County. This is potentially a controversial award since the company proposed in the RDOF auction to build gigabit fixed wireless service. We don't know any engineers who think that this technology is possible in rural areas where homes are far apart, and even in denser areas the technology is expensive since it requires fiber close to homes. However, there is a chance that the FCC will make this award since it recently made a similar RDOF award to Resound Networks that also had proposed gigabit wireless. As of the date of writing this report, the award to AMG has not been made.

- **Connect Everyone LLC** was awarded $767,323 to serve 346 locations in Champaign County. The company is a subsidiary of Starry from Boston, Massachusetts. The company proposed to deliver wireless broadband that can deliver at least 100 Mbps download. Starry recently launched a technology trial of a similar wireless product in Columbus, Ohio where it is delivering speeds as fast as 300 Mbps download. The company says its wireless products are symmetrical, with fast upload speeds. The wireless technology works by bouncing signals between customers and is a different technology approach from other fixed wireless providers that transmit from tall towers. The technology is probably best described as a wireless mesh network. It's impossible to predict how this technology is going to function in a rural area where homes are relatively far apart and where there are a lot of impediments like trees in the environment.

We've identified the RDOF grant as the biggest surprise in conducting this study. These awards have huge implications on the rural parts of the county if the hope is to find a faster landline broadband solution like fiber. Consider the following:

- Calendar Issues. The federal government and likely the state broadband grant office is not going to consider making any grant awards as long as the RDOF awards are open and pending at the FCC. In the CAF II reverse auction, which was only for $1 billion, it took the FCC around 18 months to accept or reject all of the awards. The RDOF awards are for $7 billion and are a lot more complicated. It's likely to take longer for the FCC to clear all these awards. Eighteen months from the close of the RDOF auction will be June 2022. If the FCC makes these awards by that date, there will be no issues. The problems will arise if the FCC takes longer than eighteen months. ISPs and communities are already developing a strategy for pursuing grants and raising the needed matching funds. If the FCC rejects the RDOF awards in these areas late in the year, it might be too late for somebody to plan to pursue BEAD grants in these areas.

- These Awards are Shaky. Two of the RDOF awards are to provide fast rural broadband. We expect that Starry probably will meet its promised broadband speeds – although the company is still going to have to prove that the technology works in rural areas. A mesh network works by bounding signals from customer to customer, and everybody who lives in rural America knows that you can't always see your neighbors – and if you can, the distance might be too great for the mesh technology.

  Nobody knows the specific technology being proposed by Nextlink because the FCC review process for RDOF is behind closed doors – but industry engineers are highly skeptical that any wireless technology can deliver gigabit speeds in a rural market.

  The award to LTD broadband is also of concern. As mentioned earlier, there are big concerns of the company being able to find the matching fiber needed to build the huge areas its awards cover. It would also be a huge logistical challenge for a small company to undertake such a large amount of construction and connect to huge numbers of customers. There are no examples of any ISP that has been able to grow from small to a million customers in just a few years – it's a major logistical challenge. LTD also has no other properties close to Champaign County, and it doesn't look easily feasible for them to serve only a few hundred customers on fiber in such an isolated pocket – the award areas in the county look nearly impossible to serve in the way promised by LTD.

- How Permanent is a Wireless Solution? The size of the broadband grants that will be awarded over the next years are magnitudes higher than all grants ever awarded in the past. There is a lot of concern that there may never be another big grant funding program like this again. If so, then communities have a one-time chance to get this right – and getting it right means finding a long-term broadband solution.

  The question that must be asked is if wireless technologies are a long-term solution? Last-mile wireless technologies have traditionally had a relatively short lifespan, with the electronics lasting only 5 to 7 years. There should be a legitimate concern that RDOF winners won't continue to invest in the replacement capital needed to keep the networks running. The history of rural broadband might best be capsulized as the refusal of ISPs to reinvest in places with sparse populations. Federal funding might help to pay for the initial network, but the rural ISPs operating in rural areas are going to do the math and might see that there is no financial advantage from reinvesting and upgrading. We've seen rural ISPs in the past build a broadband technology and then never invest another dime until the networks die a natural death.

- Long Deployment Window. An RDOF winner has six years to complete construction, with the six-year clock starting the year after the FCC makes the RDOF award. If the FCC awards RDOF to the three winners in the County, they have until the end of 2028 to complete construction. It's likely they would finish sooner, but they are not required to do so. That's a really long time for a huge pile of rural residents to wait on a broadband solution.

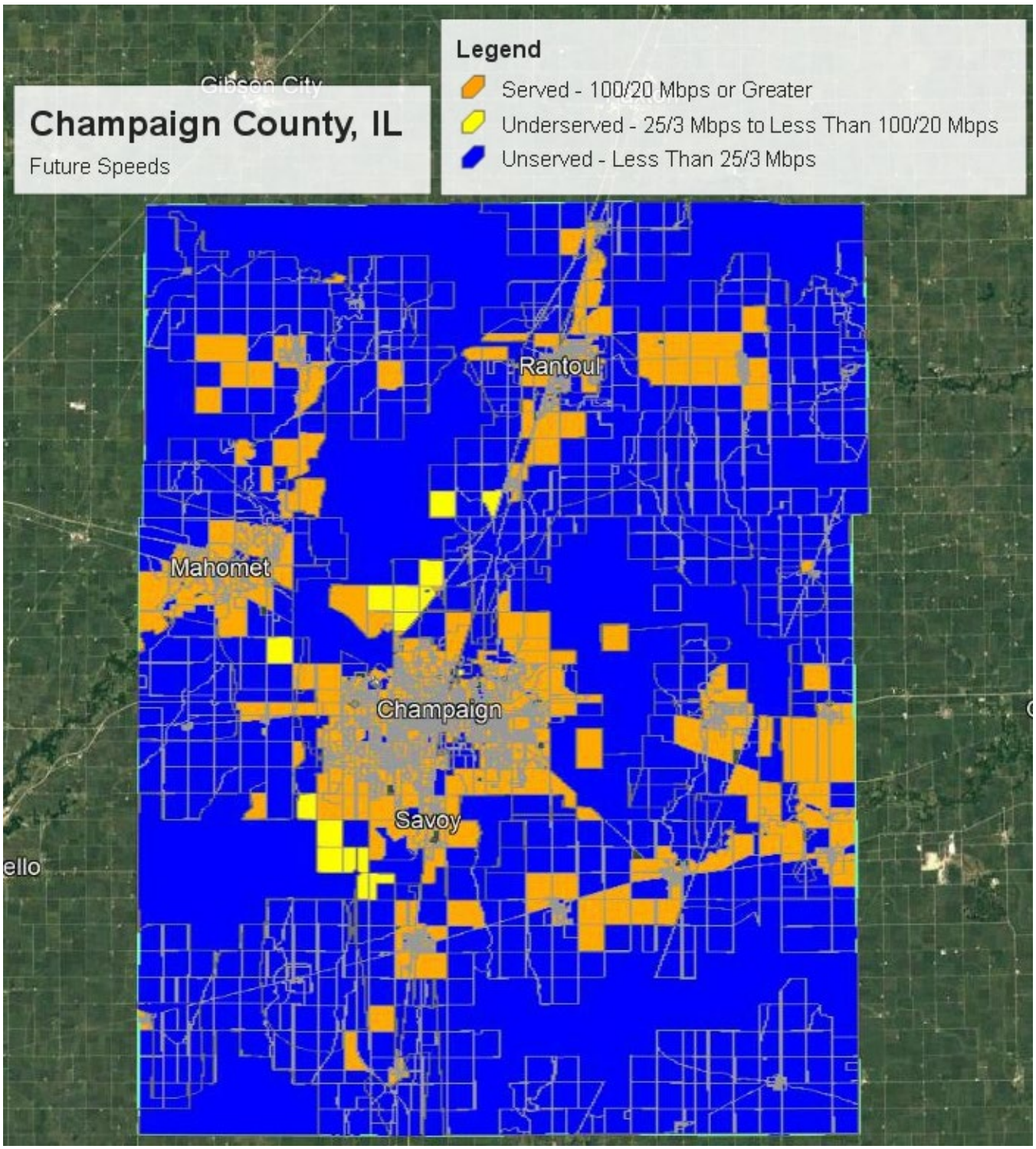
- Makes it Harder to get Other Grants. As will be seen by several maps below, the rural areas left after accounting for RDOF don't make for an easy or coherent service areas for an ISP willing to build a solution. For example, there are pockets of customers surrounded by the RDOF grant winners that would be difficult to reach.

A Map of the Grant Eligible Areas in Champaign County

The following two maps show the parts of the county where rural broadband speeds are slow today. The first map fixes the edge issue between telephone company boundaries. We believe this is the most accurate portrayal of landline broadband speeds in the county. The areas in blue represent the rural areas where the only broadband solution is DSL. There are going to be some customers in the blue areas receiving speeds faster than 25/3 Mbps on a landline technology – but not many. The various new federal grants allow for up to 20% of customers in a grant area be receiving speeds faster than the minimum.

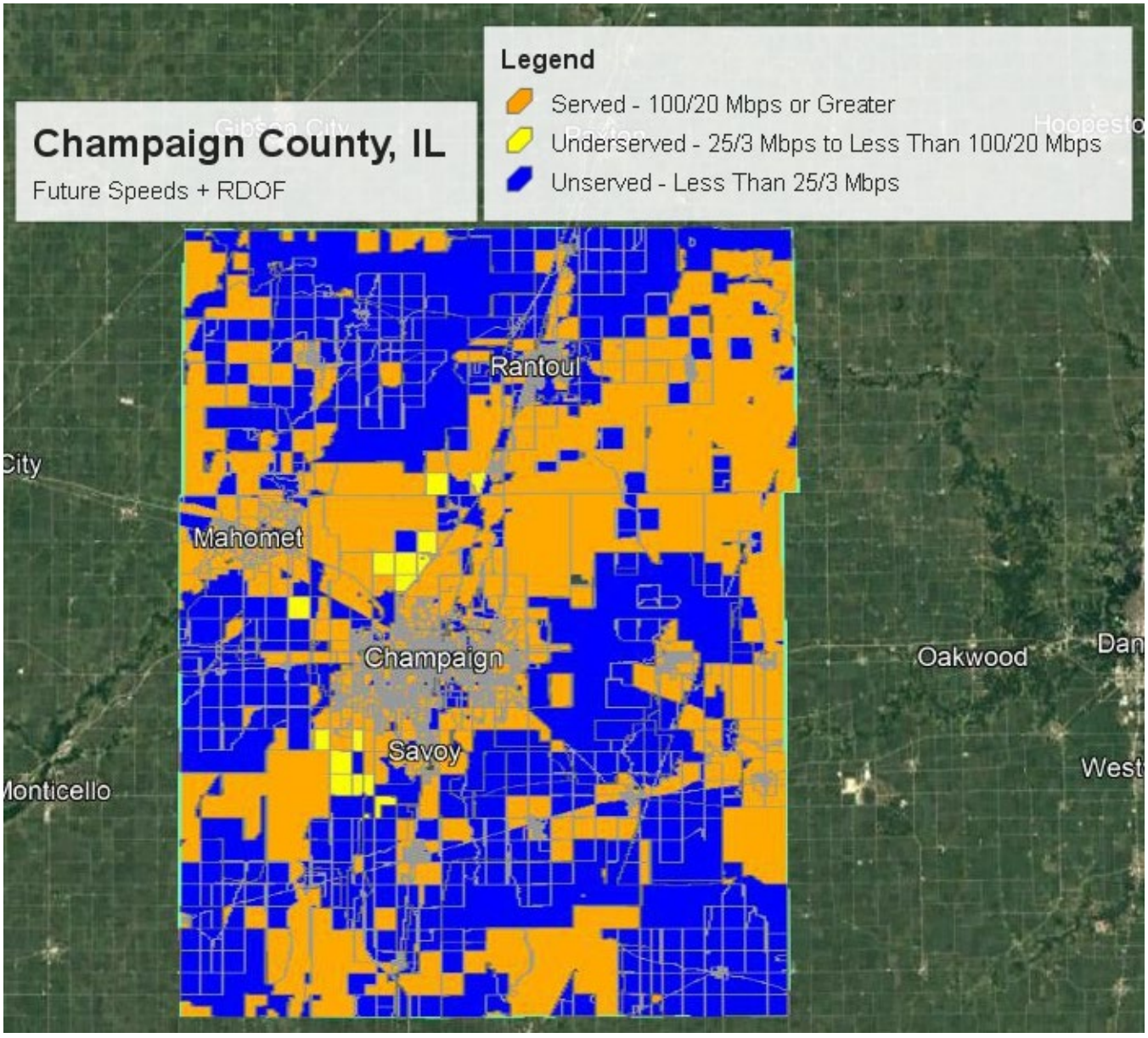
As can be seen, a lot of the area of the county is theoretically eligible for broadband grants to build better broadband. But there is a second map following to consider.

Map 18 Adjusted Landline Broadband Coverage



The following map is the same as Map 19 but shows the areas with RDOF awards as not being eligible for future broadband grants. As discussed above, the FCC has not yet awarded the RDOF in the county – more than a year since the end of the RDOF reverse auction. If the FCC decides not to award RDOF in these areas, the areas will instantly become eligible for other federal grants.

Map 19 Areas Eligible for Broadband Grants



D. Broadband GAP Analysis

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

- The Gap in Broadband Speeds. The broadband speeds vary widely throughout Champaign 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 expect the natural growth of broadband usage to create new broadband gaps in the future.

After describing the different broadband gaps, this report will look at the 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 mapping analysis above shows the coverage areas of the various ISPs in the county and the broadband speeds they say are being delivered. This section of the report is going to look in more detail at the speed question. We will look at speed data from various sources that tell us about the actual broadband speeds in the county.

We specifically want to understand the speeds in the parts of the county that are eligible for broadband grants. The goal of this discussion is to provide context and facts to help anybody that wants to seek grant funding to improve broadband in the county.

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 U.S. don't have access to download speeds of at least 25/3 Mbps. In October 2020, Microsoft claimed that 120.4 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2020 that 98.8% of households in towns and 84.8% of rural households in Champaign County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 52.5% 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.

Comparing Champaign County with the Rest of the World

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

FCC Adoption Rate

How does Illinois 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 Illinois (meaning the percentage of customers who can buy the listed speeds at their home):

Homes buying at least 10/1 Mbps	74.0%
Homes buying at least 25/3 Mbps	60.4%
Homes buying at least 50/5 Mbps	57.8%
Homes buying at least 100/10 Mbps	46.1%
Homes buying at least 250/25 Mbps	3.4%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (74.0%) puts Illinois in the middle of the pack when compared to other states. The lowest coverage is in is Mississippi at 50.4%, and the highest is Delaware at 92.7%. 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 Champaign 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 Champaign County:

Urban population:	180,510
% that can buy at least 25/3 broadband	98.8%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	98.8%
Rural population:	29,179
% that can buy at least 25/3 broadband	84.8%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	84.8%

The FCC data coverage about is probably true for towns, although there are likely small pockets in most medium and larger towns that the cable companies do not reach. The rural percentages are startling because the FCC data shows that 84.8% of the rural parts of the county can buy 25/3 Mbps broadband. According to the FCC, about 4,435 people or 1,848 rural households cannot buy broadband. We know from the analysis above that the FCC claimed broadband coverage is overstated significantly and that there are a lot more homes with poor broadband than are being counted by the FCC.

How Does the U.S. 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 2021.[13] The rankings are based upon many millions of speed tests, and the 2021 average download speed for the U.S. is based upon over 328 million speed tests. The U.S. ranked 14th in the world in 2021 with a national average download speed of 92.42 Mbps which is behind countries like Iceland, Netherlands, Hungary, Singapore, Japan, and others. The average speed in the U.S. has been increasing and was 20 Mbps in 2017, 25.9 Mbps in 2018, 32.9 Mbps in 2019, and 71.30 Mbps in 2020. During that time, the U.S. climbed from 21st fastest to the current rank of 14th. 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 Champaign County with the Rest of Illinois

According to FCC data, two counties in the state – Alexander and Pulaski – have less than 50% broadband coverage. At the other end of the scale, the FCC says that there are 23 counties that have 100% coverage

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

of 25/3 Mbps broadband. According to the FCC data, Champaign county has one of the higher amounts of broadband coverage in the state – which we now know is not true.

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. In the speed tests done as part of this study, we saw average DSL speeds of 11.5 Mbps download and 2.2 Mbps upload.
- 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 download speeds up to 100 Mbps. However, the fast speeds require new technology and also the use of additional spectrum, such as the CBRS spectrum. Any wireless equipment deployed even just a few years ago will deliver much slower speeds. As described elsewhere, issues like the distance between a customer and the tower will have a huge impact on the speed. In the speed tests conducted for this study, we saw average download speeds of 28.7 Mbps and upload speeds of 8.5 Mbps.
- 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. Comcast and Mediacom have 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 real-life limitations in that reduce 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.

Oversubscription. 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.

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

The surveys found residents who claim to have no broadband available at home. This is a bit surprising in a county where the FCC reporting shows wide coverage of DSL, where several wireless ISPs claim coverage across parts of the county, and where customers can theoretically all buy satellite broadband. What do people mean when they tell us there is no broadband at their home?

We know that DSL is often not available. AT&T stopped offering new DSL in October 2020. Rural customers all over the country have been reporting for years that Frontier won't provide new service. Even where Frontier adds a customer, the speeds can be extremely slow – and customers won't pay for broadband that only delivers 1 or 2 Mbps download speeds are barely any upload speeds.

A lot of homes don't consider satellite broadband as a choice. We've talked to countless rural residents who tried satellite broadband and rejected it. The speeds are often far below what is advertised since trees and hills can block a satellite signal. The latency is dreadful - in places where the speeds are impaired, high latency means a household can't hold a connection to a website, making basic things like shopping on the web impossible. Satellite plans also come with tiny data caps, and people find it impossible to make it through the month with a 40 GB or 60 GB data cap. The real killer issue with satellite broadband is the cost. HughesNet told investors last year that its average revenue per customer was over $93 per month. Rural homes refuse to pay that much for a broadband product that doesn't work.

There are a number of WISPs in the county using fixed wireless technology. There are always homes where this technology won't work due to the home being in a small valley or being surrounded by think trees. While the average fixed wireless speeds in the county were faster than 25/3 Mbps, there were customers getting much slower speeds.

Rural homes have also suffered with cellular hotspots. These are the plans that cellular companies have had for years that basically price home broadband at the same data rates as cellular broadband. During the pandemic, CCG heard from families who were spending $500 to $1,000 per month on a hotspot to enable home-schooling during the pandemic. Cellular hotspots aren't available everywhere, and we hard in the county that about 15% of residents said they had bad cellular coverage at their homes.

We think you have to believe a rural household who says they have no broadband available. They will have already tried DSL, fixed wireless, satellite, and a cellular hotpot and decided that none of the technologies work well enough to be worth paying for.

The Gap in Broadband Affordability

The FCC reports that 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 almost always 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 2021 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 (December 31, 2019)[166]

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

There are studies available for those who want to dig deeper into quantitative and qualitative research into broadband affordability for low-income households. The first was published by the Benton Foundation

and authored by Dr. Colin Rhinesmith.[14] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[15] 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[16]. 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 Champaign County

There are many studies that 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 Champaign County. These statistics are based on the new 2020 Census data.

- Population Growth. The 2020 Census reports that the county population grew 2.4% from 2010 to 2020. The population for Illinois as a whole declined by 1.1%. Most of the growth in the county came near the end of the Census period and could be related to the pandemic.
- Population Ages. The county has a slightly lower percentage of children (5.4%) than the state (5.9%) and a lower percentage of persons under 18 (18.7%) than the state (22.2%). Champaign County has a lower percentage of those over 65 (13.3%) compared to the Illinois average of 16.1%.
- Homeownership. There is a lower percentage of homeownership in the county (53.0%) than the state average of 66.1%. The average home in the county costs $162,100 compared to the state average of $194,500.
- Education. The percentage of those with a high school diploma (95.0%) is significantly higher than the state average of 89.2%. The percentage with a bachelor's degree or higher is (45.0%) is significantly above the state average of 34.7%.
- Income. The median household income ($52,797) is significantly below the state average of $65,886. Per capita income ($30,578) is lower than the statewide average of $36,038. The percentage of homes in poverty (15.1%) is significantly above the statewide average of 11%.

Some of the demographics, such as the percentage of homeownership, are suppressed because of the presence of the university. We don't see any demographic factors here that would majorly depress broadband penetration rates.

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

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

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

- We know that household income correlated to broadband subscriptions. While the average household income is lower than the state average, this is still a higher average income than in rural counties in the rest of Illinois and in other nearby states. The demographic that probably has the biggest impact on broadband penetration rates is the percentage of homes living in poverty.
- The level of educational attainment is another factor that correlates well to broadband subscriptions. The higher level of those with college degrees would likely mean a higher percentage of broadband subscriptions.

Comparing U.S. 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.[17] The average price of broadband in the U.S. in 2020 is $60. 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 U.S. ranks as the 131st most affordable out of 211 countries. However, it's worth noting that most the countries that are more expensive than the U.S. are either third-world countries or island nations. The few first-world countries that are more expensive than the U.S. are New Zealand, Norway, and Switzerland.

In that same report, the U.S. looks better when looking at advertised prices compared to advertised bandwidth. In that comparison, the average cost per megabit of speed in the U.S. is $0.20, placing the U.S. 26th 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 U.S. charge prices to many customers that are higher than advertised prices. The actual price of broadband in the U.S. 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.

Access from AT&T

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

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

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

Comcast Internet Essentials

Comcast has a low-income program called Internet Essentials that provides broadband to qualifying households. Comcast delivers 50/5 Mbps speeds for $9.95 per month. The program was created as a condition by the FCC for its purchase of NBC Universal in 2011. For a long time, the program was lowkey, and the company barely advertised it to customers. But over the years, the company has embraced the program, and in August 2019 announced that it had connected over 8 million people to the Internet with the program (not sure how that translates into households).

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

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

Mediacom (Connect 2 Compete)

Mediacom has a low-income program called Connect 2 Compete that provides broadband to qualifying households. The program offers speeds of 25 Mbps and a free modem. Mediacom provides Connect 2 Compete for $9.95 per month.

Qualifying households must have at least one student in grades K-12 living at home and at least one child who qualifies for free or reduced-price school lunch through the National School Lunch Program (NSLP).

Federal Lifeline Program

AT&T, Frontier Communications, and Rise Broadband participate in the FCC Lifeline program that is a part of the Universal Service Fund. With the program, a customer can receive a discount in Illinois 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.

Affordable Connectivity Program

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

One of the principles in the new plan is that ISPs must allow households to apply the $30 discount to any broadband product at the same price and terms available to other customers. The new rules have a direct rebuke of Verizon and a few other ISPs and prohibit upselling - forcing customers to buy a more expensive plan to get the discount. The ACP rules also prohibit requiring customers to sign long-term contracts to get the discount.

There are a few new rules that ISPs are not going to like. An ISP may not require a household to submit to a credit check to get the discount. It also appears that the new rules stop ISPs from disconnecting customers for non-payment until after 90 days.

There is no set ending for the plan, and if not renewed in the future, the program will expire when the $14.2 billion of funding has been spent. The big $42.5 billion federal BEAD grant requires that any grant winners must join this program or have an equivalent discount plan.

Illinois Low-Income Subsidy

There has been legislation introduced in the last several legislatures to create an Illinois monthly broadband subsidy that would add to and enhance the federal subsidies. The legislation has never been enacted, but this is one of the few states that has considered the option.

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 2021 shows a huge disparity between income and technology adoption. Consider the following results of that poll:

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

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

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

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 demand for a new computer scientist, 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 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 requirements for bandwidth have 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 hubs. Both companies estimate that home Internet need for broadband speeds are growing currently at about 21% annually. Business requirements for broadband speeds has been growing at 23% annually.

This report earlier discussed how the FCC set the definition of bandwidth speed in 2015 at 25/3 Mbps. If you accept that speed as an adequate definition of bandwidth in 2015, then growing the requirement 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	2022
25	30	37	44	54	65	79	95

This is somewhat arbitrary because it assumes that the broadband needs in 2015 were exactly 25 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 by the end of 2022 ought to be almost 100 Mbps. As it turns out, that is the exact discussion being held at the federal level and the FCC has been thinking about changing the definition of download speeds to 100 Mbps. Doing so would be saying household that can buy a product of at least 100 Mbps download do not have a broadband option.

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
3rd Quarter 2021	435 Gigabytes
4th Quarter 2021	536 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%. In 2021 the use of broadband has grown 23% from the end of the first quarter through the end of the year.

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 2020, average usage had grown to an average of 483 gigabytes of download data and 31 gigabytes of upload data. OpenVault reports an average monthly upload usage of 26 GB at the end of 2021.

One of the most startling numbers to come from OpenVault is what they call power users – homes that use more than one terabyte of data per month. 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%

3rd Quarter 2021	10.1%
4th Quarter 2021	15.1%

Within these numbers are also what OpenVault calls extreme power users, which are households that use more than two terabytes of data per month. That's grown from 0.3% of households in 2019 to 2.5% at the end 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	Sept 2021	Dec 2021
Under 50 Mbps	18.4%	10.5%	9.8%	9.4%
50 - 99 Mbps	20.4%	9.6%	8.0%	7.6%
100 - 199 Mbps	37.8%	47.5%	38.4%	36.9%
200 - 499 Mbps	13.5%	17.2%	27.4%	28.5%
500 - 999 Mbps	5.0%	4.7%	5.1%	5.5%
1 Gbps	4.9%	10.5%	11.4%	12.2%

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 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 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 Comcast and Mediacom networks 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 download bandwidth are fiber-to-the-premise, cable company hybrid-fiber technology, 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 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 Champaign 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 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 common practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from watching videos in class. The whole education process is increasingly moving to the web, and kids without access to the web 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),[18] an agency within the U.S. 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 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 huge range of undergraduate and advanced degrees that can be achieved mostly online. Online training courses require decent broadband speeds but also low latency since the training is usually done live.

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 has instantly created a crisis in rural homes that don'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 open for as long as the connection to the school WAN is in use. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. Most of the types of broadband available in Champaign county have much slower 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

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

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 all data usage above the data caps can be expensive.

Another recent survey[19] was released by the Pew Research Center that looked at the problems uncovered when we sent kids home to learn.

93% of parents in the survey said that K-12 children received some online learning during the pandemic. That alone is big news because it means that 7% of students didn't partake in any online learning.

30% of the parents in homes that tried online learning said that it was somewhat or very difficult to use technology and the Internet needed to take classes from home. I think it's fair to say that students who struggled with the technology or who didn't have adequate broadband fared poorly in terms of learning during the pandemic period.

As might be expected, the households that struggled varied by demographic. Low-income homes were twice as prone to struggle with the technology, with 36% of low-income homes reporting the problem. Rural areas (39%) had more problems with technology and the Internet than other groups like urban (33%) and suburban (18%). What's scariest about this survey response is that almost one in five suburban kids – areas that likely have the best broadband – struggled with technology and the Internet.

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

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

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

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

Hopefully, the pandemic is now behind us, and we won't close so many schools again – although even now, schools are closing temporarily due to Covid outbreaks. But even as we return to a normal school year, we need to pause and recognize that the students without home broadband and computers are at a disadvantage compared to their peers even when school is back to normal. Hopefully, we won't stop caring about the homework gap.

- Working at Home: More and more jobs today can be done at home, even if only part-time. But people without adequate home broadband can't participate in this part of the economy. Increasingly, companies are willing to hire people who work out of their homes. The beauty of such jobs is that they can be done from anywhere.

  Working from home is one of the fastest-growing parts of the national economy. 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 for connecting to school WANs. Working at home is also coming to mean connecting by video conference with others as an alternative to face-to-face meetings. This requires a dedicated 1 – 3 Mbps connection for both upload and download – again, something that is a challenge for somebody working from home with a slow Internet connection.

  Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it 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.

  As this report was being written, *U.S.A Today* reported on the results of the fifth annual survey of the State of Remote Work[20] conducted by Owl Labs and Global Workplace Analytics. The

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

nationwide survey was done last summer at a time when almost one-fourth of workers continued to work at least partially from home.

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

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

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

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

From an economic development perspective, work-from-home employees are a huge boon to a rural community that has likely been aging and slowly shrinking over time. Employees making good salaries can provide a huge boost to a local economy. For years, rural communities have sunk big tax incentives into trying to attract new employers. It probably costs a lot less to attract one hundred remote workers than to lure a traditional employer that will bring a hundred jobs.

I have rural clients that operate rural fiber networks who tell me that their communities are seeing a new demand for building new homes and that housing prices are increasing as people want to move to the community. This presents an interesting challenge to rural communities wondering how to get the word out to prospective work-from-home employees. This is a new challenge that

is a 180-degree turn from traditional economic development efforts, but communities that master it ought to grow and thrive and bring fresh breath into aging communities.

- 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.

  The coronavirus crisis has highlighted the need for telemedicine. Doctor's offices and clinics all across the country have shifted some of their office "visits" to video meetings on Zoom or other video platforms in order to reduce contact between doctors and patients when it can reasonably be avoided. There have been widespread reports that some doctors require video connections for all non-emergency visits. Councilors and mental health workers also report largely migrating most or even all contacts with clients online. It's immediately become clear that patients without home broadband or without a strong cellular signal can't make the needed video connection. There is a lot of speculation that video meetings and telemedicine are going to become mainstream by the end of the coronavirus crisis 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:
  - Security. Millions of homes now have video cameras at the front door or elsewhere on their property that they can view remotely. A video camera requires a 1 – 3 Mbps upload

connection for low-resolution cameras and up to 16 Mbps upload for an HD quality camera.

- Machine-to-Machine Traffic. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes 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 they get into range of a home broadband connection to provide a log of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that this traffic would represent over 50% of all the traffic on the web by 2023.
- Online Everything. 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.

- Keeping Talent at Home. An issue we often hear about in rural communities is what is called the "rural brain drain." Most rural counties don't have enough good-paying jobs to keep recent graduates 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.

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.

Impact on Day-to-day Operations. Just like with households, most businesses are seeing their broadband needs grow rapidly each year. Each one of the following routine business functions requires decent bandwidth. Businesses without adequate bandwidth must forgo or compromise on how they communicate with the world and function day-to-day.

- To Communicate with Customers. 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 eCommerce ordering sites need big 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 businesses may not even have sufficient broadband to consistently process credit card transactions.
- To Communicate with Vendors. Businesses also routinely use the portals of their own vendors to buy whatever they need to operate.

- To Communicate with Other Branches of the Company. Many businesses are branches of a larger corporation and maintain open data connections to communicate with other parts of the company and with headquarters.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, or Microsoft, or it can be a private cloud available only to employees of the business. This is the change in the way that companies operate that has probably created the most recent growth in bandwidth. A business doesn't need to be highly sophisticated to work in the cloud. Today banking is routinely done in the cloud. A lot of basic software like Microsoft Office has migrated to the cloud. Even interfaces with local, state, and federal governments have migrated to the cloud.
- Security Systems. Businesses often have their network and computer security monitored by offsite firms. Security today also means the use of video surveillance cameras, which require uploading video streams to be viewed outside of the business.
- 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. Some surprisingly small businesses like photographers, architects, engineers, and others routinely want to send and receive big data files.
- 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.
- 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 COVID-19 crisis as students and employees increasingly used video conferencing services, but these services had already become routine for businesses before the crisis.
- Email and Advanced Communications. 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. These services require good download and upload bandwidth.
- Supporting Remote Employees. Many businesses now save money by allowing employees to work from home full or part-time. They need reliable broadband links to provide home-based employees the same access to systems that are on site. A complaint heard from rural businesses is that they must physically carry files to their homes or other places with good broadband to conduct routine business.
- Data Back-Up. 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. Data back-up requires a steady and reliable upstream broadband connection.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that monitors data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function when connected to the Internet.

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.

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 for 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 parcel 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.

E. Solving the Digital Divide

The digital divide is not as simple as recognizing that some parts of the county have faster broadband than others. For example, even in parts of the county today with good broadband, there are many homes that don't have broadband because they can't afford the monthly subscription fee, they can't afford to buy and maintain a computer, or they don't feel comfortable and able to use the Internet. The digital divide is total of the many different reasons why homes don't have broadband.

The broadband gap analysis discussed earlier identified a number of different gaps that are present in almost every community in the country. Following will be some ideas and suggestions on how other communities are tackling the various broadband gaps.

Temporary Broadband Solutions During the Pandemic

The most drastic and immediate problem faced by most communities in March 2020 was the impact of suddenly sending students home to learn. Attempting to make this work instantly highlighted a number of problems:

- A significant percentage of students didn't have a home broadband connection. Even in suburban school districts, this was 5% - 10% of students, but in some cities there were neighborhoods where almost no students had home broadband access.
- The installation of broadband was slow. Even when homes could afford broadband, the ISPs were hobbled by the pandemic and were not able to add new customers quickly, particularly if construction was required at the home or if a technician needed to enter a premise.
- In rural areas, it because quickly clear that the problem was the total lack of broadband options. Many rural students didn't have access to a broadband service that was fast and robust enough to support schooling or working from home.
- It also became apparent that many homes didn't have computers. Students were trying to keep up with schoolwork on cell phones and quickly started hitting monthly data caps.
- Many teachers also didn't have access to adequate broadband. Rural teachers were in the same position as rural students. But many urban teachers found that their broadband connection was not robust enough to make and hold a Zoom-like connection to multiple students. People quickly came to realize it the more people on a Zoom call, the greater the bandwidth needed.
- We suddenly discovered a new broadband gap that nobody had ever talked about. We found that upload bandwidth is essential to work or school from home. It turned out that broadband connections that were adequate for downloading would not work with the available upload streams. The homes hit by this the most were homes with slow technologies like DSL or homes where multiple people wanted to use the bandwidth at the same time. Many people were shocked when they could connect to a school on a 100 Mbps download cable company connection.
- Schools also instantly hit a digital skills gap where parents or students couldn't figure out how to make the remote technology work. Many parents of young students had no familiarity with computers, and tackling online classes is a hard place to figure out the needed basic skills. Many other families couldn't navigate making and maintaining the connection to the school. Many of these homes gave up and stopped trying. Even more common was students who walked away from the computer in mid-lessons and disappeared for the day.
- Many students and families looked for solutions outside the home. People would flock to outdoor hotspots located at libraries, schools, and fast-food restaurants. Many of these sites suffered the same fate as home broadband when too many people tried to use the public hotspots at the same time. Students faced sitting in the cold or heat to take classes. Some students faced safety issues if they had to sit outside in dangerous neighborhoods. Students that had to reach rural hotspots often had no transportation.
- Adults being asked to work at home faced basically the same set of issues.

CCG talked to many communities during the last two years, and we heard hundreds of horror stories of things that went wrong due to the pandemic. For example, we talked to six different counties where 7% to 9% of the student base disappeared during the pandemic. The schools never heard from them or knew what happened to the missing students – did they move away or simply stop going to school? It's going to take many years to get such students back on track.

CCG witnessed many different solutions to the pandemic broadband crisis. Here are a few examples:

- Schools scrambled to get computers into the hands of students that needed them. Some school districts were able to get computers to everybody, while others fell far short.
- Some larger school districts struck almost immediate deals with cellular companies to provide cellular hot spots. This means that the schools typically paid for the monthly cellular connections

– but the cellular companies usually gave the hot spots at rates far below the going rate for home hotspots. This instantly identified the places in communities with lousy cellular coverage. Cellular coverage is not bad only in some rural places, and every city found the cellular hotspots scattered throughout the community. People also quickly learned that being able to make a voice call did not mean that a data connection was going to be available.

- One of the groups that struggled the most during this period were state universities and junior colleges that quickly discovered that a lot of their students lived in rural areas without broadband, often scattered across the country and the world. Foreign students were quickly stranded when they were sent away from campuses when international travel came to a halt. Many students were unable to complete the spring 2020 semester. Most universities found solutions by the fall of 2020.
- All of this was done during the time when it became obvious that the pandemic was going to cause some major supply chain problems. We saw coalitions coming together to find laptops and hotspots. This might have included neighboring school districts working together, junior colleges and universities helping K-12 schools, or local corporations volunteering purchasing experts who were able to track down solutions.
- Government buildings like libraries, schools, city halls, and other buildings that had broadband scrambled to buy and connect outdoor WiFi hotspots. Many business owners also enabled public WiFi hotspots.
- We saw even more creative solutions. A lot of rural communities put WiFi units on school buses and parked them in rural places where there were no businesses or government buildings to provide WiFi. Many of the WiFi units on the buses will remain after the pandemic to provide WiFi to students on the bus ride to and from school.
- Many libraries started to lend laptops, tablets, and hotspots in the same manner that they lend books. The devices were most commonly lent for a week or two at a time.
- Schools got creative and began recording classes so that students who couldn't connect during live classes could catch up later.
- Funding was a huge part of the solution and Congress passed the $2.2 trillion Coronavirus Aid, Relief, and Economic Security (CARES) act by the end of March 2020. Many states also provided funding.
- Many small telephone companies and cooperatives stepped up to help make this all work. They might have brought free broadband to the school buses or installed free outdoor WiFi hotspots on poles. These companies scrambled to get faster broadband to the businesses and government buildings that were providing hotspots.
- The big cable companies stepped up by offering low-cost broadband connections to homes with no broadband. These plans were normally priced low at $10 or $20 per month, and in many cases, the school systems picked up the tab.
- We did not see much, if any, improvement in broadband upload speeds, and in fact, the ISPs with slow upload speeds often put a lot of effort in denying there was a problem.
- Particularly hard hit were businesses. Retail businesses were required to shutter. Many other businesses had to send employees home. Factories stumbled quickly when the supply chain materialized almost instantly due to the shutdown of airlines and the slowdown in trucking. The CARES act helped millions of businesses by providing Paycheck Protection Program (PPP) loans. These loans were converted to grants and excused for businesses that could demonstrate the funding went to paying employees to keep them off unemployment. Otherwise, the funding converts to long-term low-interest rate loans.

We saw some bigger initiatives by the start of the fall semester of 2020.

- The federal government launched the EBB program to provide a discount of up to $50 per month for home broadband to qualifying households. This meant that many homes were able to get off hotspots and get a normal home broadband connection. ISPs had to voluntarily participate in this program, and not all of them did.
- By the fall, most of the big ISPs took a pledge to not drop homes and businesses from broadband for non-payment. This was met with only limited success when some ISPs only honored this for a short time.
- Most school systems had training over the summer to help teachers be more effective at teaching online.
- Many businesses had struggled at first and didn't have the needed hardware, software, or knowledge to enable employees to work from home. But by the fall, the majority of businesses figured this out. ISPs and other software companies rolled out products that enabled safe VPN connections to reduce the risk of hacking.
- A few cities were already looking for ways to bring broadband into student homes before the pandemic. For example, the city of Buffalo, New York had already started using CBRS spectrum to beam free broadband to the lowest-income parts of the city. The city placed transmitters on short towers on top of government-owned buildings to reach students in the immediate vicinity. When the pandemic hit the city already was providing free broadband for about 7,000 students. The city stepped up the effort when the pandemic hit. This initiative also provided free laptops or tablets to students, something that had been only done previously for high school students.
- Other cities followed the same example. For example, Tempe, Arizona used spectrum it already owned to send 4G LTE broadband to students at home. The city intends to use this network after the end of the pandemic to support smart city initiatives. The Tempe plan avoids the worst pitfalls from the pandemic since there is a broadband connection made to each device rather than to each home.

It's now been two years, and in many communities the pandemic is still causing havoc. The funding section of this report discusses the Infrastructure, Investment, and Jobs Act that provided $1.9 trillion for infrastructure, and that also includes funding to tackle the many aspects of the broadband gaps caused by the pandemic.

Solving the Physical Gap In Broadband Availability

The gap in broadband availability is what drove the county to authorize this study. This is the gap defined by rural areas with poor or no broadband options. The rest of this report and the recommendations describe how the county might try to solve the availability and speed gaps. We won't repeat conclusions from elsewhere, but there is funding and solutions for bringing broadband to the rural parts of the county.

What's often overlooked is that there are physical broadband gaps in the cities and towns. There are likely pockets of customers in Champaign, Urbana, and other cities who don't have access to good broadband. It's not unusual in most towns to find apartment buildings, entire residential streets, or pockets of business districts that are not served by the cable companies.

The cable companies originally built networks to reach residential neighborhoods. However, landlords have always had the ability to keep others out of apartment buildings, and some chose to do so when the

cable company networks were first constructed. Remember that the cable company networks were built at a time when the only product being delivered was cable TV, and not broadband. Apartment landlords at the time might have been receiving cable signal from DirecTV or Dish networks and didn't allow access to the cable company.

It's also been well-documented in many communities that cable companies avoided and redlined low-income neighborhoods. There are still many communities where the cable company isn't connected to public housing or to older, run-down neighborhoods.

Cable companies also didn't build the original networks to reach business districts since the penetration rate of cable TV in businesses was never high. When cable companies avoided business districts, that often also meant not reaching pockets of homes that are intermixed with businesses.

After the cable companies started selling broadband in the early 2000s, most cable companies built into business districts but didn't always build to everybody. Again, some building owners didn't let the cable companies into buildings. The cable companies often elected to bypass streets where there were no obvious broadband customers. Cable companies also sometimes elected to not build networks if the wires had to be buried.

The bottom line is that there are likely pockets of homes and businesses in Urbana and Champaign that still don't have the option to buy broadband from the cable company – meaning that the only alternative is DSL. In neighborhoods served by AT&T, DSL is no longer an option since the company stopped selling DSL in October 2020. Any business or resident with no cable and no DSL likely has no option for buying broadband other than from the satellites. Fixed wireless signal often doesn't carry far into cities and might not be an option.

These pockets of places are not easy to identify, and cities often only hear about them when residents and businesses complain about the lack of broadband.

If you can identify the broadband dead zones in the cities there is a way to now serve these customers. One of the allowable uses of the American Rescue Plan Act (ARPA) money is to solve broadband gaps. A community can use these funds to directly build broadband to reach these pockets in towns. A community could partner with a fiber overbuilder or a cable company to reach these pockets of no broadband. There is still no solution we know for getting broadband into apartment buildings where the landlord won't allow access.

The Homework Gap

We have a huge amount of evidence that students from home with a computer and broadband underperform homes with broadband.

The Quello Center is a part of the Department of Media and Information at Michigan State University and released a definitive study[21] in March 2020 that looks at the impact of lack of broadband on students. The

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

study was done in conjunction with Merit Networks, the organization that acts as the ISP for schools in Michigan.

I describe the study as definitive because it used study techniques that isolate the impact of broadband from other factors such as sex, race, and family income. The study was done in conjunction with the schools to allow Quello researchers to get blind performance results from student participants without violating student confidentiality. The study involved 3,258 students in grades 8 – 11 in Michigan from schools described as being in rural areas.

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

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

One of the most important findings was that there is a huge gap in digital skills for students without home broadband. To quote the study, "*The gap in digital skills between students with no home access or cell phone only and those with fast or slow home Internet access is equivalent to the gap in digital skills between 8th and 11th-grade students*." It's hard to grasp that the average 11th-grade student without home broadband has the equivalent digital skills as an 8th-grader with home broadband. Digital skills not only involve competence in working with technology, but is manifested by the ability to work efficiently, communicate effectively with others, and manage and evaluate information.

Students with lower digital skills don't perform as well on standardized tests. Students who are even modestly below average in digital skills (one standard deviation below the mean) rank nearly seven percentiles lower on their total SAT/PSAT scores, five percentiles lower in math, and eight percentiles lower in evidence-based reading and writing. Students who are even moderately lower in digital skills are also 19% less likely to consider a STEM-related career (that's science, technology, engineering, and math).

The study also showed lower expectations for students without broadband at home. For example, 65% of students with home broadband have plans to pursue post-secondary education. Only 47% of students with no Internet access have such plans.

This study is significant because it is the first study that isolates the impact of home broadband from other factors. There are other studies that have shown that lack of broadband hurt school performance, but in other studies, it was impossible to isolate Internet access from factors like household income levels.

This study should be a wake-up call for getting broadband into the home of every student. It's not tolerable to allow a big percentage of our kids to underperform in school due to the lack of home broadband. We know that underperforming in school translates to underperforming in lifetime earnings, and so the cost to society for not fixing the homework gap is probably far larger than the cost of finding a broadband solution.

In 2021 the Pew Research Center released the results of a survey[22] that provided a post-mortem of how students handled remote learning.

In the survey, 93% of parents surveyed said that K-12 children received some online learning during the pandemic. That alone is big news because it means that 7% of students didn't partake in any online learning. This matches what we've been hearing. For example, we recently talked to a high school principal in Arkansas who said that online learning went reasonably well but that the high school 'lost' 7% of students. The students never logged into online classes, and the households didn't respond when contacted by the school. We've heard the same story in many other counties where some students seemingly dropped off the grid during the pandemic. That's going to cause problems for years to come.

30% of the parents in homes that tried online learning said that it was somewhat or very difficult to use the technology and the broadband needed to take classes from home. Students who struggled with the technology or who didn't have adequate broadband fared poorly in terms of learning during the pandemic.

As might be expected, households that struggled varied by demographics. Low-income homes were twice as prone to struggle with the technology, with 36% of low-income homes reporting the problem. Rural areas (39%) had more problems with technology and broadband access than other groups like urban (33%) and suburban (18%). What's scariest about this survey response is that almost one in five suburban kids – areas that likely have the best broadband – struggled with technology and broadband.

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

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

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

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

The Affordability Gap

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

Section 1.D of this report discusses the subsidies that are available for low-income households. For example, ISPs like Comcast and Mediacom have low-priced broadband products for qualifying homes. All ISPs can now participate in the new federal Affordable Connectivity Program (ACP) that provides a $30 monthly discount on any existing broadband product for qualifying households.

There are some specific steps that can be taken to help close the affordability gap.

> Lobby ISPs to Participate. ISPs are not required to participate in the subsidy programs or offer low-income products. Some federal grants now require that ISPs that accept grant must participate in the federal subsidy programs. The County should be contacting ISPs to make sure that they are participating in these programs and pressure any ISPs that don't have low-income alternatives.
>
> Promote the Low-Income Discount Programs. Probably the most effective step that the County can take is to advertise the availability of the discounts. This effort starts with the becoming knowledgeable about the nuances of all of the low-income programs available in the county.
>
> Many ISPs participate in these programs but are passive about making sure that customers know about the discount. An ISP might occasionally mention the programs in a mailing but not actively work to bring the discount to homes that qualify.
>
> Educate the Public. A large percentage of those eligible for the discounts don't ask for them because the ISPs don't let them know the discounts are available. A widespread public information campaign can help to make sure your citizens get the discounts.
>
> Actively Enroll Residents in the Plans. We've already heard about a few communities that are taking this issue to a more participatory level. We've heard of a few cities that have hired somebody to help residents navigate the registration process to get the broadband discounts. That might mean getting on the phone or meeting live with residents to gather any needed documents and to navigate the enrolment process.
>
> The County already helps low-income residents navigate other kinds of subsidies, and you should treat the broadband discount like any other subsidy. The easiest way to make this work is to integrate education about low-income broadband discounts into other existing low-income programs. The County could also advertise the programs on its website, in social media, and in other ways to create public awareness of the broadband discounts.

There is a lot of national debate that the $30 discount for the ACP program is not sufficient to lure low-income households to buy broadband. This is understandable when looking at the full cost of broadband at some ISPs. For example, the cost for basic broadband for Comcast is $90 per month if a customer gets no discounts from the company. That's $76 for the basic broadband and $14 for the cable modem. Even

after the ACP discount, the remaining price is $60. Luckily, most first-time broadband customers can get a significant discount when buying broadband.

About the only way we can think of to address this issue is to somehow provide an additional local discount to homes receiving the ACP discount. This would be costly because a local or state government doing this would be paying ISPs each month for every customer participating in discount plans. We know the state legislature has considered this plan in the past two sessions, but it has not been funded. At a minimum, the County should consider lobbying for a state plan to increase the discount.

Other Approaches. A different approach is to provide a broadband alternative that doesn't involve the incumbent ISPs. There are a number of ways that communities are finding alternate sources of broadband:

> Build Broadband Infrastructure to Low-Income Areas. There are a lot of cities and counties considering the use of the ARPA funding to bring broadband connections to public housing or low-income neighborhoods. This is often being done in the name of affordability and not availability. For example, there are low-income neighborhoods served by the cable company in many cities with an extremely low broadband penetration rate due to cost.
>
> This doesn't necessarily mean building fiber – although many communities are planning to build fiber. As mentioned, cities like Tucson and Buffalo are doing this with wireless networks.
>
> We know cities that are planning to build or expand public WiFi networks. This might mean building WiFi mesh networks to cover downtowns, parks, or parts of the community where people routinely are present. It might mean installing WiFi routers in the hallways in public housing to provide free WiFi.
>
> Non-Infrastructure Approaches. There are non-profit organizations around the country that are tackling the affordability issue in other ways. This may involve efforts to provide broadband access in other ways than building infrastructure. This might include initiatives like:
>
> - Providing more free hot spots through libraries or non-profits.
> - Providing free cellular phones and broadband plans to the homeless.
> - Creating high-bandwidth outdoors around City buildings using WiFi hotspots.
> - Providing incentives for businesses to provide more public hotspots. This could mean something as simple as publicly recognizing participating businesses or could be more formal such as a providing tax relief for businesses that expand free WiFi.
>
> One of the more formal approaches to these ideas has been done for many years by Mobile Beacon.[23] This is a non-profit that works nationwide to bring low-cost mobile broadband to non-profit organizations around the country, and through those local non-profits bring low-cost broadband to low-income households.
>
> There are numerous solutions being used by the non-profits working with Mobile Beacon. One common effort 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

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

broadband to students and others that is priced as low as $10 per month for an uncapped cellular broadband connection.

An interesting study[24] 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 participating in Mobile Beacon connections reported 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.

The Computer Ownership Gap

A recurring issue that we find in doing surveys is that many homes cannot afford to buy or maintain a computer. There is not a lot of reason to bring broadband to homes that don't have the needed computers, tablets or other devices needed to use the broadband. Many communities ran headlong into this issue during the pandemic when students were sent to school from homes where there wasn't a computer.

There are ways that other communities have tackled the issue.

Take-Home Computers for all School Kids. The most common solution to the homework computer gap is for schools to 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 will be students in homes with no broadband connection.

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, Champaign 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.

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

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 non-profit that is willing to tackle the computer issue. Most home and business computers last 3-5 years, and non-profits 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 non-profit E2D[25] (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 non-profit PCs for People[26]. They provide PCs to households that need them and work with other entities, including Mobile Beacon and E2D. Champaign County or some local non-profit could connect with PCs for People to find ways to get computers into the hands of the neediest households in the county. A local non-profit could also mirror what's been done elsewhere.

Create More Public Hot Spots. Champaign 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. Champaign County can start this process by extending the WiFi at county buildings to the outside areas surrounding the buildings. 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

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

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

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.

The Broadband Skills Gap – The Literacy Gap

In the early years of personal computers in the 1990s and early 2000s, there were numerous basic computer training classes available in almost every community. But it seems that over time, as computers have become ubiquitous that the assumption has been made that everybody knows how to use a computer – or at least can figure it out on their own. It turns out that this is far from the truth and there is a significant percentage of the population in every community that doesn't know how to use a computer. This has always been a hard problem to pinpoint because many people often won't admit that they are computer illiterate.

One of the most successful solutions to this problem is to provide hands-on digital training classes. Most such classes teach basic skills like how to use a computer, how to navigate social media, how to do online banking, how to navigate public websites for government agencies, etc.

Many communities have taken this idea further and also provide one-on-one training for people with specific needs. For example, somebody in a library might help somebody hunt for a job or navigate a social welfare agency website.

There are a few basic needs for digital literacy training:

- Qualified trainers willing to conduct the classes.
- Computers for participants to use.
- A space to hold the classes.

The County can play a big role in helping to find solutions for these needs. There are a number of ways that other communities are tackling this issue.

- The County can identify and help to secure the locations needed for holding classes. This could be done in schools after hours, in community colleges, in government buildings, or in spaces provided by businesses.
- The County could directly offer courses, or could encourage non-profits, community colleges or other to establish training courses supported by the new federal grants.
- Grants can also be used to create computer labs needed for training courses.
- Recruit Trainers. Another challenge is to find those willing to teach the courses. The grants will allow paying a living wage for this work.

How Communities are Maximizing the Benefits of ARPA Grants

Section III.D of this report discusses large federal grants that are available to help solve the broadband gaps discussed in this report. There are grants aimed at providing computers and other devices to the

community. There are grants to develop digital literacy training. There are grants that will cover the cost of workforce development programs to train fiber techs and other technical jobs.

Following are a few of the ideas we are hearing from communities on ways to use ARPA and other grant funds:

- Hiring Digital Coordinator. To help implement the ideas discussed below.
- Getting Computers into Low-income Homes. There is grant funding to help more households get computers.
- Establishing Computer Labs. These are places people can use computers or that can be used for computer training.
- Digital Literacy Training. Cities are tackling these directly or helping to fund non-profits, schools, or others to establish courses to teach the use of computers, how to use the Internet, and basic digital literacy.
- Advanced Computer Training. Using grant funding to teach coding and other advanced computer topics as part of workforce development
- Coworking Space. Establishing public workspace to provide areas for self-employed people, meeting spaces for work-from-home workers, and as incubators for new businesses.
- Technology Training. Creating courses for fiber technician certification, computer repair, or other technical fields.
- Provide Technology for the Homeless. Cellphones, tablets, or other ways to get them connected.
- Build Broadband to Public Housing / Low-Income Neighborhoods. This could be anything from WiFi to fiber.
- Build Outdoor WiFi Networks.
- Create / Promote Public WiFi Hotspots. The local government can create hotspots or encourage others to do so.
- Wireless Broadband to Student Homes. Create wireless networks to connect students to school networks.
- Creating a Local Stakeholder Collaboration. This can tie the many small grant opportunities into the bigger grant programs to maximize community investments.
- Collaborating with Neighboring Community to Create Larger Grant Opportunities. Most of the current federal grants make it easier for collaborations to get grant funding.
- Making Subgrants to Non-profits or Others to Accomplish these Tasks.

Future Broadband Gaps

The broadband gap analysis demonstrated how the need for broadband speeds and total bandwidth is expected to continue to grow at a rapid rate in the future. This provides a cautionary warning that any solution to close the digital divide must be ready to eventually be upgraded to meet future demand.

For example, if a community puts in a wireless network to reach student homes, it's likely over the next decade that the speeds delivered by that network will become slow and obsolete. A plan to get computers into a home will be inadequate if there is not a longer-range plan to replace computer that wear out. Plans that are not sustainable are not much more than band-aids. We applied a lot of band-aids to broadband during the first two years of the pandemic – it's now time to find sustainable, permanent solutions because many of the underlying causes of the broadband gaps are not going away.

II. ENGINEERING DESIGN AND COST

The RFP asked us to consider fiber-based technologies that can bring better broadband to the rural parts of the county. This first section of the report discusses our research and conclusions. We also look at the other technologies in use in the county today as well as looking at likely future technology we expect to be deployed.

A. 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 / 25 Gbps PON and 50 Gbps PON – Passive Fiber Technology

For the last fifteen years, the industry standard for passive optical networks has been GPON. XGS-PON has been available for the last five years; however, the price premium for XGS-PON (10 Gbps Symmetrical PON) was almost 15% over GPON. Starting in 2021, we've seen quotes for XGS-PON that are nearly identical in price to buying the GPON that's been the industry standard. Even with XGS-PON just now gaining traction, manufacturers are already looking forward with 25G-PON (# Gbps Symmetrical PON) now already available from one manufacturer and several others looking to roll out 50G-PON. Price points for 25 and 50G-PON are significantly higher than XGS-PON.

New technology is usually 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 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 10 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 provide 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.

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. We have finally reached the tipping point where most new OLT purchases are now XGS-PON, even for customers with extensive GPON deployments.

With the price difference between GPON and XGS-PON 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 in the same location as the fiber core or distributed around the serving areas 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 128 customers. These fibers go to splitter cabinets, where each fiber is then "split" into separate fibers that go to individual 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 up into individual paths. The paths between the splitter and each customer are referred to as "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). With XGS-PON, ITU's design criteria allow for a 1x64 customer split to reach a minimum of 20 km (12.4 miles). The ITU standards now call for XGS-PON to reach as far as 60 km (37.28 miles). Reducing the split ratio will allow most systems will now easily reach 50 km (31.1 mi). While that distance limitation is generally not a problem in a city network, it still can be a challenge in rural areas.

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

PON Advantages

- No electronics in the field. PON uses passive splitters to distribute the bandwidth over the fiber to the customers. There are only two active components in the PON distribution network – the Optical Line Terminal (OLT) and the Optical Network Terminal (ONT). The OLT sits in an

environmentally controlled hut or building, and the ONT sits on the side of the home or inside of the home.

- Less field maintenance and more reliability. Because PON uses passive splitters in the field, there are fewer powered network elements in the distribution network. This equates to less maintenance, fewer field personnel required, more reliability, and fewer managed network elements in the distribution network. A PON network also means less land and rights-of-way required due to less need for large powered huts.
- Less fiber needed. PON uses significantly fewer fibers than an active system. A PON network carries up to 128 customers (we recommend not more than 64) 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.
- Higher density electronics. Because PON electronics have only one optical port for every 64 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 back-up power requirements.
- Ability to still use active Ethernet. Most PON manufacturers offer the option to serve some customers on active Ethernet in the same chassis by the use of a separate core card.
- Location Flexibility PON cabinets continue to get smaller, allowing them to be placed on utility poles or in the public right-of-way, eliminating the need to purchase, lease, or obtain an easement to place them in most cases. Eliminating the need for commercial power also opens 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 the customers in a neighborhood assigned to the same splitter in a PON node share the bandwidth. This is a more efficient use of bandwidth than sending a dedicated amount of bandwidth to each customer. Some Active Ethernet proponents will claim that this is a major fault of PON networks; however, what they do not discuss is that oversubscription takes place in every network - it is just a matter of where. Most Active Ethernet systems first layer of oversubscription takes place at the central core where they provide 1, 2, or 10 Gbps to each 48-port subscriber gateway that then provides a 1 Gbps link to the individual customer.
- Reach: XGS-PON design specifications call for the ability to serve out to 60 km (37.28 Miles) has solved most of the reach issues.

PON Weaknesses

- Redundant Feeder Routing. While PON claims that it can be set up to provide redundancy in the local feeder portion of the network (the fiber between the OLT and Splitter); however, due to cost and complexity, it has not been deployed at any scale. Therefore, cutting a feeder fiber could put hundreds of subscribers out of service. This weakness can be mitigated somewhat by using multiple routes to bring the feeders for any given area back to the OLT.

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 37-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 adverse effect on capital costs, pole loading, conduit, 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 back-up 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 back-up, and generators. While the sites do not consume a lot of power on their own, many active companies with numerous active remote sites are experiencing significant commercial power costs just from the minimum meter charge.
- 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 or deploying additional remote electronics, battery back-up, and the ongoing cost of power at a new location.

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. With just six active sites in the network, the ongoing operational cost will be less than an active system.

Aerial versus Buried Fiber

The final network design provides for buried fiber throughout the network even where some broadband providers may be on poles in the urban areas.

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. While aerial fiber can be less expensive than direct burial; however, if most of a network is buried, many operating companies elect to stay buried throughout the entire network, eliminating the need two sets of equipment and training/certifications to work on both in the aerial and buried facilities.
- Topography. Champaign County has relatively good conditions for directly burying fiber. Within Illinois, the greatest risk for widespread damage to a broadband network is from ice storms or tornados. A buried network will withstand both events with far less damage than an aerial network.
- 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.
- Local Issues. This study focused primarily on the rural portions of Champaign County. The existing rural pole lines are owned by the power companies, and while the poles are in good condition and unencumbered by other broadband providers, they are not practical for broadband deployment due to their height and spacing. Finley found most spans to be too long to safely deploy fiber in the Communications Space and still maintain adequate clearance to ground, especially given the size of modern farm equipment being used in the area. The cost of installing taller poles would negate any savings from putting the fiber on poles.

Considerations for Burying Fiber. 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. Champaign County has sufficient topsoil in most places making it less expensive to bury fiber than it is to put it onto poles. While there are some places with rock that must be dealt with, we can typically find a way though, or around most rocky areas. Where we cannot, then aerial deployments may be considered for short stretches.

The other issue that impacts the cost of burying fiber is the method of construction. Following are the primary methods used to bury fiber, listed from the least desirable to the most desirable:

Trenching. 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. The only time trenching is used in the rural is when the contractor needs to get through an area with significant underground 6" to 12" rock.

Boring. Boring is the most common method of burying fiber in urban areas, wetland/water crossings in the rural, or any hard-surface crossing. In boring, a "pothole" is dug at the starting and ending points. A pothole is a hole approximately two feet wide by up to four feet long. A boring machine bit is inserted into the empty pothole and laterally drills a hole through the substrate at approximately three to four feet deep or under the obstacle. Empty conduit is then pulled back through the path created by the boring machine. Conduit is flexible and durable plastic tubing. Eventually, the fiber will be pulled through the empty conduit. Boring costs can vary widely depending upon the composition of the substrate. Boring through normal dirt or under wetlands can be relatively easy to bore through an area. Boring is much harder and expensive, and sometimes impossible, in areas where there is native rock in the way. There is often an intermediate condition called cobble, where the boring bit hits boulders that is native to the area or where it was used as fill when a street or railroad track was originally created.

Plowing / Direct Burying. In rural areas where there is an unpaved ditch along roads, a common construction method is to direct bury the fiber into the ground. This involves using a piece of heavy equipment called a cable plow that knifes the cable into the ground. The plow creates a two- to four-inch-wide slot and places the cable at the bottom of the slot. There is most often not even any follow-up construction since the plowed furrow naturally closes quickly after the plow passes. Champaign County's road ditches provide the reasonably wide right-of-way and shoulder along a road necessary for plowing fiber.

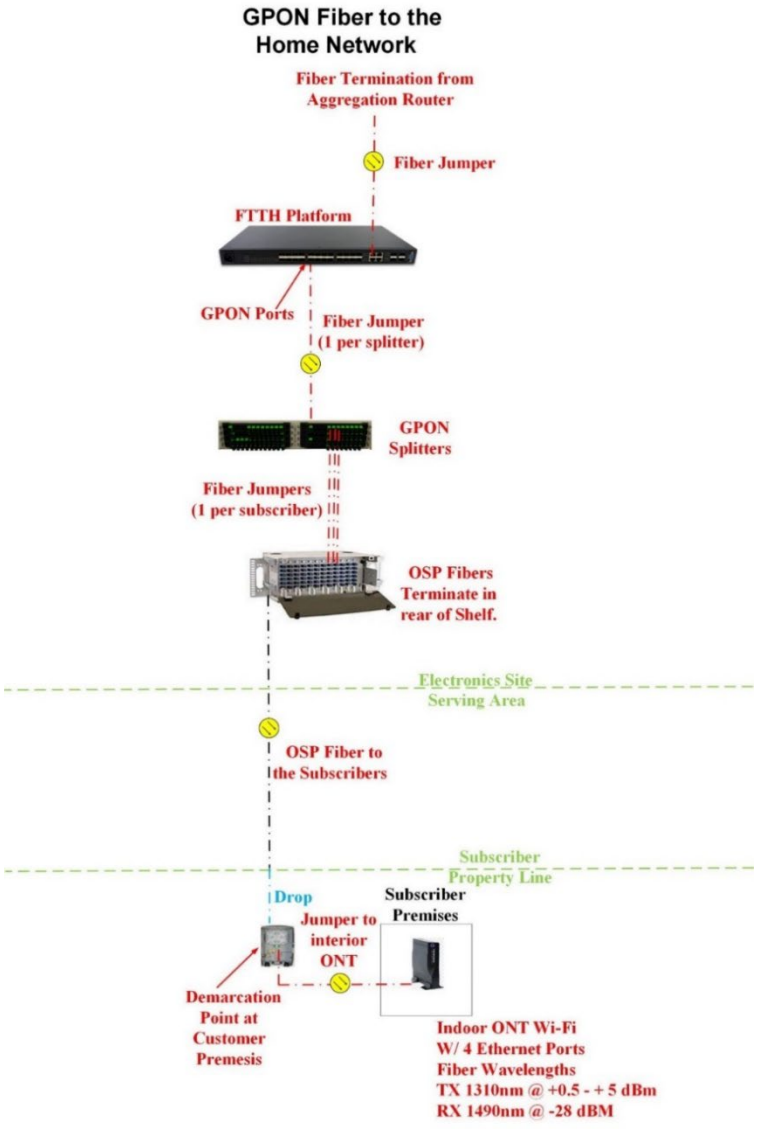
The Components of a Fiber Network. There are several major components of a fiber network, and sometimes the design decisions depend upon which type of fiber is being constructed. For example, there might be different decisions made for fiber that goes along a major business corridor versus fiber that is built in an older residential neighborhood or in a rural setting. 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/roads to pass each potential residential or business customer.
- Drop Fiber. This is the fiber that is built from the street/road public right-of-way 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.



Connection to the Internet. 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 county is cut, the network will continue working.

Central Core. 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 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 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 back-up power to keep the network functioning in case of a power outage.

An OLT is configured with circuit cards which can each serve between 256 to 512 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 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 128 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 128 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 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 144 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 communicates 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.

The original ONTs were only placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. The next generation of ONTs moved indoors and was powered from an indoor outlet, much like the cable modems used by cable companies. They included advanced wireless options combined into the ONT in an attempt to provide a single box solution. With the rapid evolution of WiFi, manufacturers and operators quickly learned that the wireless portion of the combined OLT/wireless device quickly became obsolete. Updating the wireless functions then included the cost of the ONT, which may not have needed an upgrade. The industry is now focusing on standalone no-frills indoor ONTs and separate home gateways that include firewalls and wireless functionality. The indoor ONT is now significantly less expensive than most outdoor ONTs. This study has specified the lower cost indoor ONT and home gateway as separate devices.

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.

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 back-up 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 back-up solution for customers that buy telephone service that is not delivered on copper. That ruling said that fiber ISPs only must 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

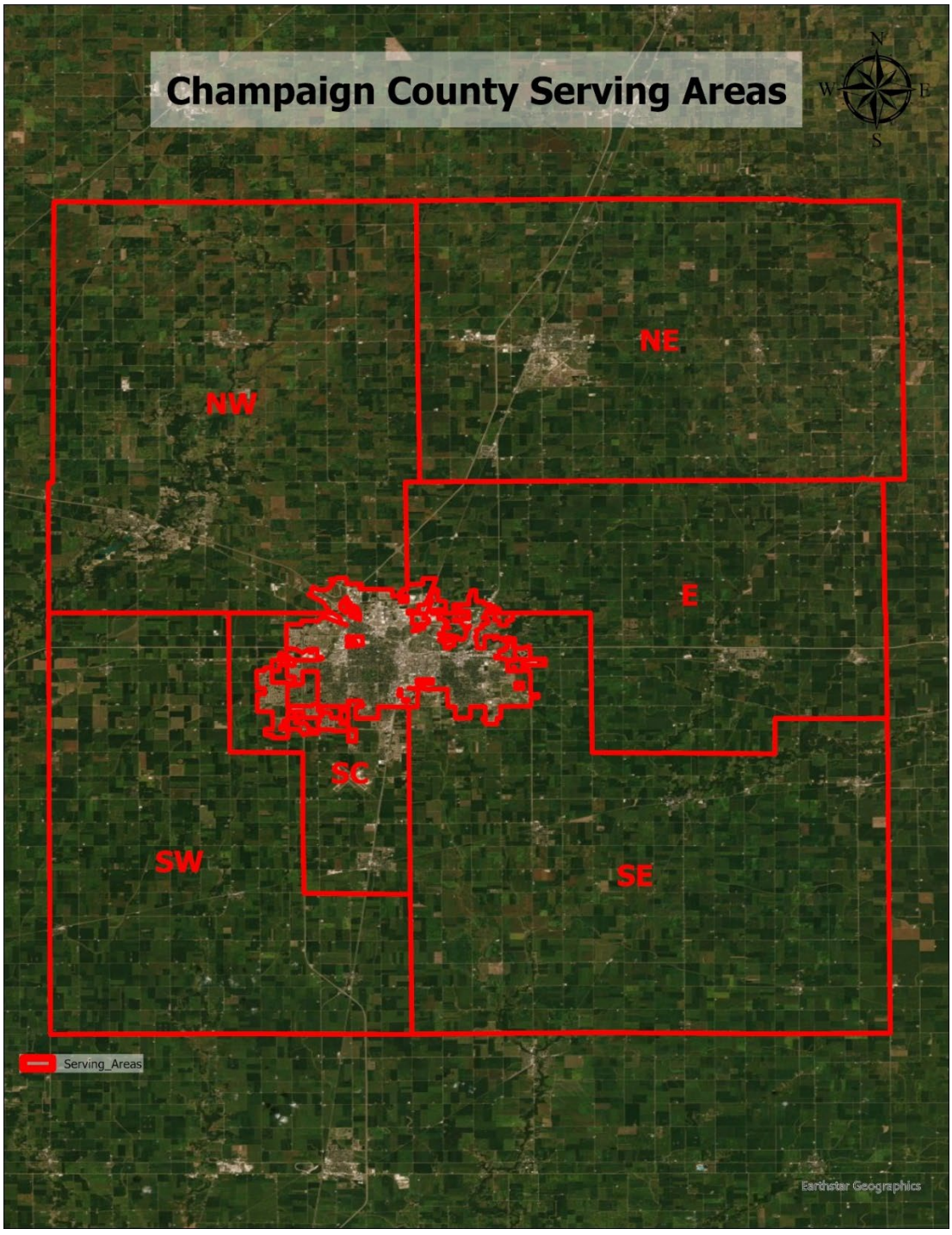
The engineering estimate was made using a method we call high-level design model. This involves the following steps:

- 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 six 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 next analyzed the data and determined the best locations for OLT electronics hubs. Finley determined that the best configuration was to locate six OLT cabinets throughout the county.
- After analyzing the feedback from the field visit, Finley conducted the full network design. This process began with each of the 25 ONT sites to determine the size of the fiber needed to reach each neighborhood and along each street.
- As the 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 six sectors – and costs were then aggregated to get total costs.

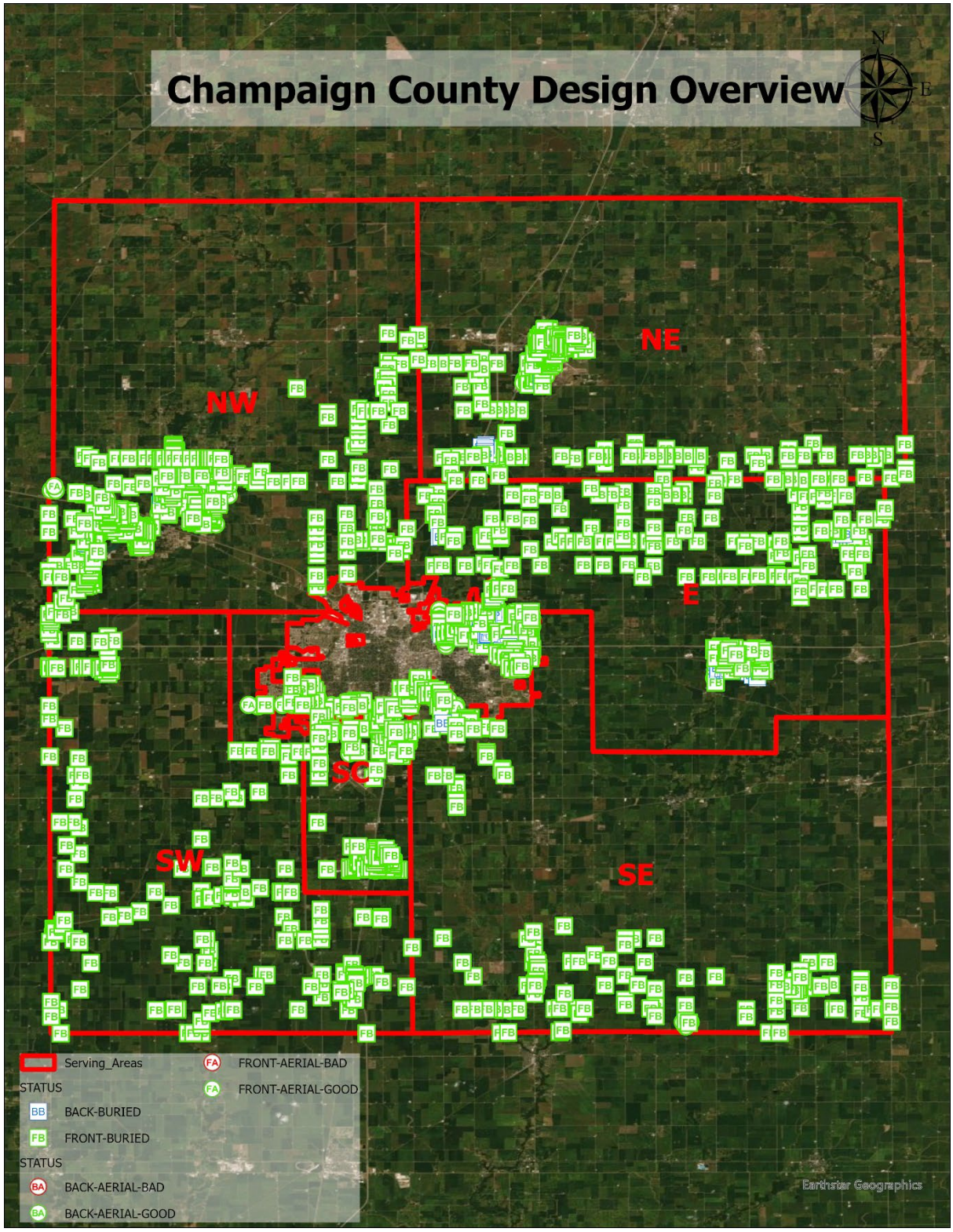
We know from experience that this method of estimating costs is pretty accurate. By visiting multiple places in the county, we get a good feel for local conditions.

Examples of the Design Process

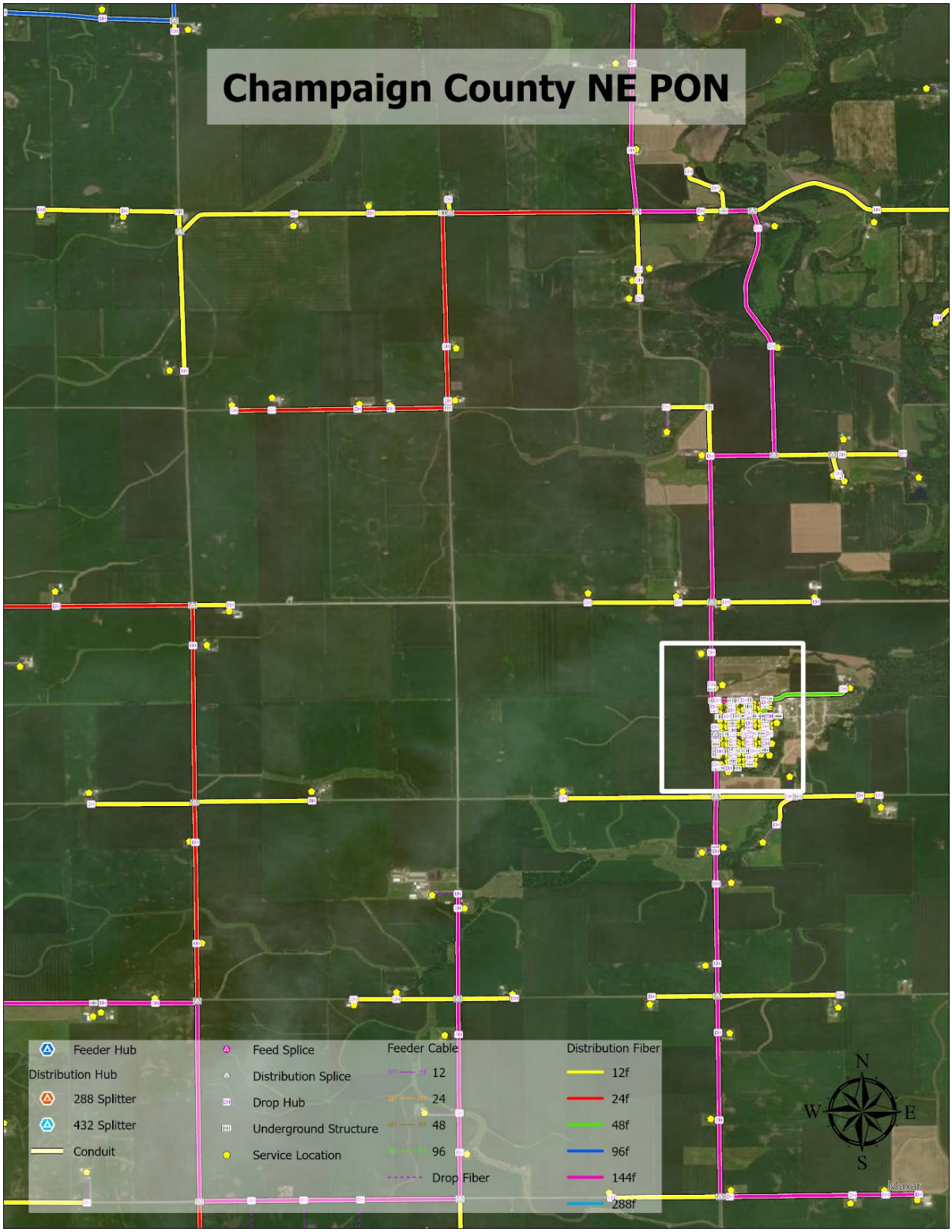
Following are three maps that demonstrate some of the most important steps in the design described above. This first map shows that we divided the county into six distinct study areas.



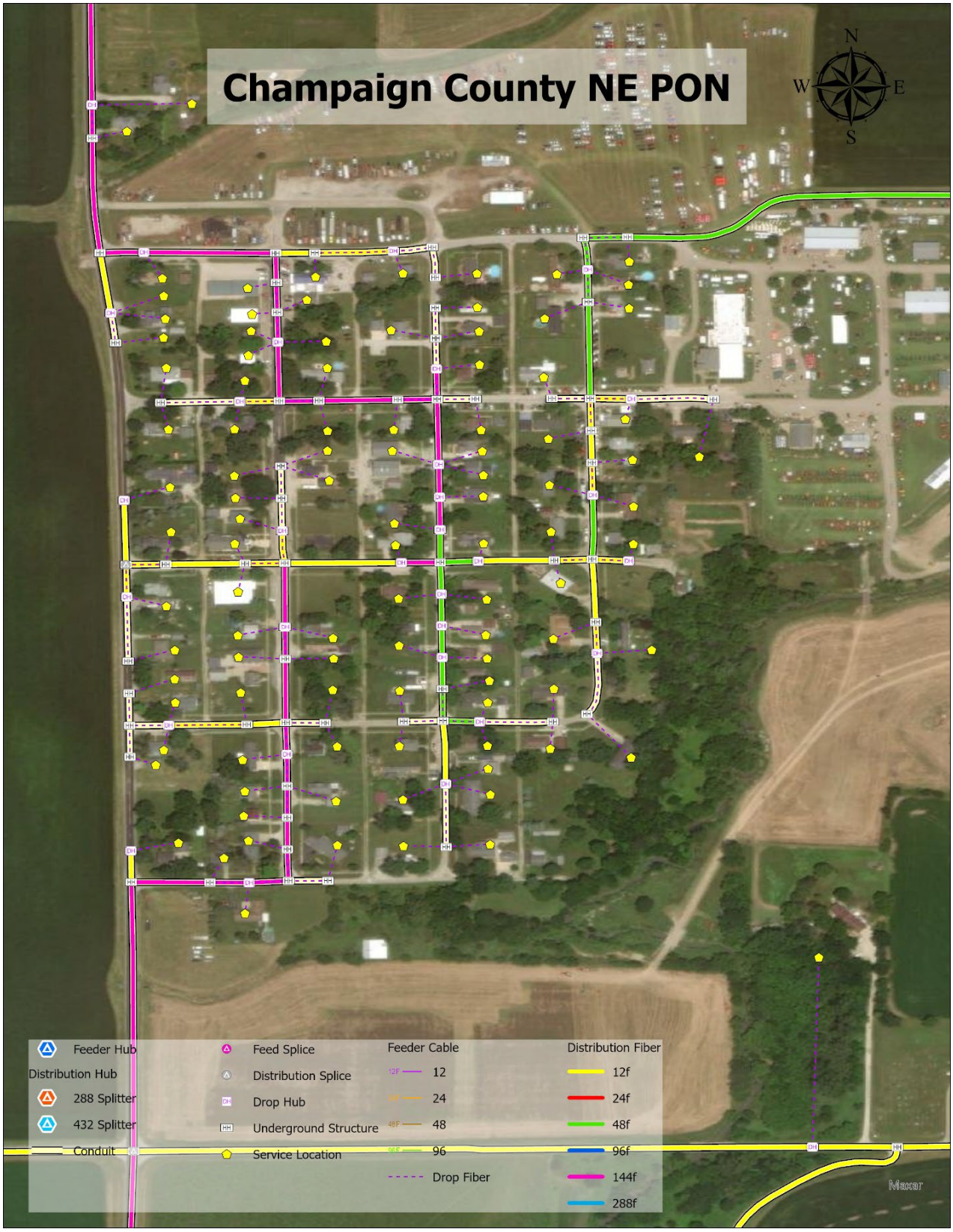
The following map shows the locations where a Finley Engineer visited and looked at the local conditions that affect construction costs. The larger open areas in the county were sufficiently uniform so that fewer data points were recorded in those areas.



The next map is an example of a high-level view of the Northeast serving area. The yellow dots represent homes or businesses. The lines are fiber routes, with the different colors representing fibers of different sizes.



The following map shows the higher level of design detail within the community of Penfield Gerald.



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 given neighborhood.

The first design completed by Finley is the Full Study area that includes everything in the county outside of Champaign and Urbana. We determined that many customers in the study area are already served by fiber or coaxial networks offering speeds greater than 100 Mbps down and 20 Mbps up, thereby making them ineligible for any type of grants.

The second design looks at the rural areas outside of any place that already has a cable company provider or fiber. We looked at this area in two ways – the whole rural area and then rural area that excludes areas that have a tentative award of RDO funding from the FCC to build faster broadband.

The key takeaway from the table above is that by concentrating on just the areas likely to be eligible for funding, the number of eligible passings dropped to just 11.5% of the original passings.

Passings	Full Study Area	Rural Only	Without RDOF
Residential	32,363	5,406	6,643
Larger Apartments	2,745	68	68
Businesses	5,107	1,127	919
Total	12,716	6,601	4,630

The passings in each category are defined below.

- Residential. 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. This includes any apartment buildings 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 activate 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 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. Champaign County has numerous fiber routes that would provide transport to a major ISP. The fiber ring connecting all the remote electronics sites circles the Champaign Urbana metro area, leaving multiple opportunities to provide secure redundant routes from the proposed core network to the cloud.

Summary of Fiber Construction

The assessment contemplated building fiber to every part of Champaign County outside of the Champaign and Urbana metro area where there are homes or businesses. As previously discussed, the Total County plant design is based on the entire county except for Champaign and Urbana. The Rural Study excludes areas that are served today by a cable company with fiber/coaxial broadband. The third scenario further excludes areas that have tentatively been claimed but not yet awarded in the FCC's RDOF reverse auction.

These investments are for the fiber to reach each street in the serving areas. The numbers include fiber construction, engineer, construction management, and a construction contingency. These numbers do not include fiber drops that reach from the street to each customer.

	Miles	Cost	Cost / Mile
Total Study Area	1,956 miles	$133,669,758	$68,338
Rural Study Area	1,332 miles	$ 61,133,570	$45,896
Rural No RDOF	920 miles	$ 47,232,678	$51,340

The cost per miles of fiber highlights that the urban areas included in the study have some relatively dense urban areas where the primary method of buried fiber construction will require boring, more expensive, on a per-mile basis when compared to the more rural areas. This drives up the cost per mile compared to the Rural Study area design. With that said, the cost per passing is lower in the urban areas due to the greater number of customers per mile of fiber.

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. Finley elected to use PON electronics for this design.
- 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 PON electronics. The advantages of this technology were discussed above. From a cost perspective, this technology made the most sense in the county 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 extra fibers that could be used to bring a dedicated fiber signal up to 10 gigabits to a customer that wants greater bandwidth. Effectively, the network design incorporates the best of both fiber topologies.

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 128 customers to share a single feeder fiber. We elected to limit each neighborhood PON to 64 customers. The primary reason is to ensure that each customer can be provided with a gigabit broadband product, if desired. Even with XGS-GPON technology, there is enough bandwidth on a single PON (10 gigabits symmetrical) that there is almost always a gigabit of bandwidth available to any customer at any given time. 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 125 Passive Optical Network (PON) areas in the Total Study design and 58 PON areas in the Rural design. All designs are supported by 6 OLT electronics sites. Each PON serving area covers from 200 to 550 passings (430 average). This design concept is known in the industry as a distributed network, meaning that electronics are spread throughout the network rather than all the OLT electronics being placed at one or two centralized hubs. There were several reasons we chose the distributed network:

- This makes sure that no customer is more than 25 miles away from a neighborhood hut. This distance limitation means 25-miles of fiber along a road, not a 25-mile circle.

- This design makes it easier to activate neighborhoods as the fiber is being built. Once a neighborhood OLT 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 design using a fiber cable with more than 288 fibers since larger fibers require the use of hand holes instead of pedestals, thereby adding significant cost to the network. Larger fibers also mean more splicing costs. 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 smaller fiber cables. Each of the PONs has one to four splitter cabinets. The design puts some 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 consideration for fiber route redundancy. We built local redundancy into the network by designing the network so that each OLT Cabinet/Hut is connected to the two nearest adjacent OLT. 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 ring network where every active device has two paths to the cloud.

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 to be in two different huts to provide full redundancy.

Multi-Dwelling Units (MDUs)

Multi-swelling units are any building that houses more than one tenant. This could be anything from duplexes through large apartment buildings, condominiums, and townhouses. The large variety of MDU structures and construction methods have an impact on the cost to provide broadband services:

- Most ISPs treat smaller MDUs the same in the same way as single-family homes. For example, an ISP is likely to build individual drops and use separate ONTs to serve each side of a duplex/triplex/fourplex because it would typically treat each resident 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 is a saving on fiber drops for a larger MDU since one fiber drop can serve the whole building. But this savings is generally offset by 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 larger multi-floor MDU that contains hundreds of units, like is found in large cities. The cost for serving large MDUs is specific to the building – some cost less per unit than serving single-family homes, and some cost significantly more, all depending upon the specific issues of the building.

- Because of modern wiring techniques, it is usually possible to get fiber to every unit at a manageable cost. There will invariably be apartment buildings that cost extra to serve for various reason, such as having solid concrete slabs between floors that make it hard to run fiber where utilization of the existing copper or coaxial cable is the only practical solution.

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.

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:

Exclusive Arrangements. 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 county that would not allow a new fiber network owner into the building.

There was a new FCC ruling on the MDU issue released in February 2022. The FCC is trying to end additional anticompetitive tactics of ISPs trying to get exclusive use of MDUs. The new FCC ruling found that exclusive arrangements between ISPs and landlords hurt consumers.

The current ruling bans specific practices between ISPs and landlords that the FCC says block competition.

- The order bans exclusive revenue share arrangements where the ISP and a landlord agree that the ISP is the only one who can give a cut of revenues to the landlord.
- Also banned are graduated revenue sharing arrangements where the percentage of revenues shared with a landlord increases as the number of tenants subscribed to an ISP grows.
- Also banned are sale-and-leaseback arrangements where an ISP sells inside wiring to the landlord and then leases it back in an exclusive basis so that other ISPs can't use the wiring.
- Finally, the order requires ISPs marketing in MDUs to disclose to tenants in plain language if they have an exclusive marketing arrangement with the landlord. The intent of this ruling is to let tenants know if there are other competitive choices.

One issue the FCC ruling didn't acknowledge is the popularity of bundling broadband in with the rent. A Parks Associates survey released in July 2021 showed that 40% of apartment tenants liked having broadband included in the rent. This ruling might make it a challenge for a landlord to bundle broadband with the rent.

Financial Roadblocks**.** Property owners often create financial roadblocks for a new ISP:

High Access Fees. 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.

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 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, which 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 a 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 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 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 as 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 can't provide 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.

B. 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 and Frontier serve Champaign County with copper telephone wires using DSL technology.
- Comcast and Mediacom use 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.
- We're starting to see faster fixed cellular data plans labeled as 5G.
- Metro Ethernet is used to bring fiber directly to large businesses, schools, cell towers, etc.

Technology is Improving

CCG recently reviewed all of these technologies and we realized that every technology in use for broadband is better now than just 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 almost five years, the technology 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.

DSL over Copper Wires

AT&T 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 Champaign 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 – newer copper and larger gauge copper wires mean better bandwidth. Many of the copper wires in the county are now 50 to 70 years old and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Comcast and Mediacom are the incumbent cable company in parts of the county. The technology each 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 lab test of the technology and achieved symmetrical 4 Gbps bandwidth. 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?

Fixed Wireless

This technology is used by several wireless ISPs (WISPs) in the county. When considering fiber for open farming areas we automatically consider wireless technology to see if it might be a fit. We asked ourselves of the likely speeds that could be delivered by a new deployment. Our conclusion is that a new network built with the best wireless technology available could deliver broadband speeds between 50 Mbps and 150 Mbps to some customers in the county – but the network would still not reach everybody due to trees and terrain.

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

In practical use, in wide-open conditions, these frequencies can be used to serve customers up to about 6 miles from a transmitter, although speeds can be slow at the far end of 6 miles. Nationwide many wireless carriers advertising speeds in the range of 25 to 50 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 limit the number of customers on a given radio system.

- 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. The second wave of potential SAS administrators have applications pending with the FCC; however, a schedule has not been published as to when they will be approved. The marketplace is also starting to see SAS administration brokers looking to aggregate numerous smaller CBRS operators and relieve them of the effort required to get registered with the current SAS Administrators. 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 2.4 and 5 Gbps WiFi bands used for fixed wireless today and has great operating characteristics.

- White Space Spectrum: The FCC has approved deployments of point-to-multipoint radios 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 key advantage of TV White Space is the low, non-line of site frequencies can fill in the gaps (valleys, back side of ridges, dense tree cover, etc.) that defeats any of the Gbps frequencies. Range is also significantly longer; however, the throughput per channel is much lower than WiFi or CBRS. The extended range comes with a burden, TVWS will interfere with television stations 100s of miles away, limiting deployment in areas with numerous active TV broadcast stations. The FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices.

  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 low power 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. With the exception of TVWS, 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.
- 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.

Wireless Conclusion: Wireless can be a solution the county can encourage to provide adequate broadband services. Finley Engineering feels that it should only be used where it is financially impractical to build a fiber to the home solution 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.

- 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.
- 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. While wireless can reach those speeds, current grants typically give priority to faster technologies.
- Probably the biggest concern about making this investment is that there might be enough grant money coming to build fiber. We believe that when fiber is built to a rural area that the WISPs will not be able to compete and will fade away over time. Wireless would be a poor investment if somebody else built fiber within a few years to compete with a wireless network.

Geostationary Satellite Broadband

There are two satellite providers using geostationary satellites (GEO). The technology is called geostationary because the satellites sit in a parked location over 22,000 miles above the early. The two companies are 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 a problem with real-time applications such as streaming video, voice-over-IP, gaming, online education, or making connections to corporate WANs (for working at home). 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.

Low Earth Orbit Satellites

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. The low-orbit satellites can 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 above a given customer in about 90 minutes. This means that there must be a large fleet of satellites so that there is always a satellite in the sky over every 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 2020. Starlink has

over 1,900 satellites in orbit and says it will cover the whole U.S. by the end of 2022. The company has signed over 100,000 customers in a beta test mode. The monthly rate is $99, and the receiver costs $500. Starlink has also taken over 500,000 deposits of $99 for customers on a waiting list. There is no guarantee that any customer will be able to receive service. 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 many industry engineers who question the ability of the constellation to handle a significant number of customers.

Starlink's biggest challenge will be in having enough frequency to be able to pass data between the cloud and the earth. The company lost a battle at the FCC trying to get access to frequency owned by Dish Networks. The battle is over the spectrum between 12.2 – 12.7 GHz. 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.

The other active satellite company is OneWeb. Eutelsat, one of the world's largest operators of satellites, recently made an investment and took 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 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.

The final big player is Jeff Bezos and 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.

4G LTE Cellular Broadband

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 the rural parts of Champaign 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 Champaign County are a lot closer to the national averages than the large city averages.

The survey showed that there are rural homes in Champaign County using their cellphone data plans for home Internet access. Since cellphone data plans have small monthly data caps, anybody using a cellphone for home broadband is by definition, a light broadband user. These customers may be getting access to broadband on their cellphones using WiFi at school or an office.

5G Cellular Broadband

We are starting to see the cellular carriers deploying a new generation of home cellular products. These plans use the new frequencies that have been deployed in recent years to offer both faster broadband speeds and larger data caps. We saw several customers taking speed tests that are using T-Mobile. Verizon and AT&T are still in the process of deploying the new technology.

These new plans are being marketed as 5G. 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, these claims are marketing hype.

Currently, 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. The latest estimate from vendors is that real 5G is still five or six 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.

These broadband products that are being called 5G are still using 4G LTE technology but are being deployed on 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. We heard from a few customers in the county who are receiving speeds over 100 Mbps download on this product.

These products look to have potential for substantial growth. In the fourth quarter of 2021, T-Mile added 244,000 new customers on a product that only hit the market seriously in the second half of last year. T-Mile says that is surprisingly gaining more customers in urban and suburban markets than rural markets, probably due to the most consistent cellular bandwidth in cities.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in Champaign 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

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 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 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 residential neighborhoods in cities, suburbs, small towns, or rural America. A lot of industry experts are asking why anybody needs gigabit broadband for a cellphone, 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 it is mixing millimeter-wave and CBRS spectrum as it expands the product. The company plans to pass 25 million homes with the technology by the end of 2025. Analysts expect this expansion to occur in major cities and surrounding suburbs and will not likely be extended to places like rural Champaign County.

Wireless Mesh Wireless - Starry

This is the technology that Starry has proposed to use in the RDOF program. The company is owned by Chet Kanojia, an inventor and entrepreneur, who has developed several proprietary wireless technologies. He's been operating wireless networks in major markets like Boston, Washington DC, Denver, New York City, and Los Angeles. Starry beams broadband to apartment units in high-rises through receivers placed in windows.[27] The technology uses the 37 GHz spectrum band obtained as a test frequency from the FCC. The product delivers roughly 200 Mbps upload and download – the latest speeds are always posted on the website.

Starry is ready to roll out a new kind of wireless technology that is probably best described as a wireless mesh. The technology begins with a fiber-fed radio and then bounces the signal from the first customer to subsequent customers. Stary launched this product last year throughout the Columbus, Ohio metropolitan area. The technology is available to anybody from high-rises to single-family homes and will cover downtown and stretch into nearby suburbs.

Starry is taking a different approach from other wireless technologies and is using Time Division Duplex (TDD). This is the same technology that has been used in the telecom industry for decades and is used to deliver T1s. The benefit of the technology is that there are both download and upload timeslots built automatically into the transmission path. This allows a single frequency and channel to handle both upload and download functions simultaneously. One user in a household can be downloading while somebody else uploads at the same time using a single frequency channel. Other radio technologies use separate radio paths for upload and download, which adds to radio costs. Starry can easily vary the number of upload or download time slots depending upon demand, and it's the TDD feature that lets Starry deliver symmetrical upload and download speeds.

Starry launched in Columbus with a $25 introductory price for early adopters but will likely get back soon to its standard $50 rate. Starry has big plans to eventually pass up to 40 million households with the technology. In the RDOF auction, Starry won $268.9 million to bring broadband to pass over 100,000 rural homes – including a few in Champaign County.

[27] https://starry.com/

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 Champaign 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. Ownership Models

The RFP asked us to consider different ownership models for a network solution. The following section looks at the most common ownership models found around the country. This includes a retail model where a single ISP owns and operates the network – this can be done by the local government or by a commercial ISP. Open-access is an ownership model where the local government owns the network and invites multiple ISPs to use the network. Another common model is public-private partnerships where the local government and a commercial ISP somehow share ownership. Another possible ownership structure comes with the creation of a broadband cooperative. The final option discussed is ownership by a non-profit.

Retail Model – Single Provider as the ISP

This scenario considers the network being built and operated by a single entity. From an ownership perspective, this is the simplest operating model. A retail ISP is a single entity (could be the local government or a single ISP) that operates a retail broadband network. A retail ISP normally owns the network, hires the staff, operates the business, and benefits from any profits. It's not hard to cite examples of single-operator networks since most broadband networks in the country are owned and operated by a single ISP.

CCG has learned from experience that if a market can't be profitable with one provider, then the other options discussed below, like partnerships and open-access can't be successful since these other operating models divvy up profits among multiple entities. If there's not enough profit to sustain one owner, then there is not enough profit to support multiple owners.

Advantages

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

Flexibility. A single owner/operator makes all of the decisions related to building, funding, and operating the business.

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 a commercial ISP doesn't succeed, the ISP can lose any investments in the new business and also can risk the entire business if financing leveraged the parent company.

If a municipal venture doesn't succeed, the business can fold. In many cases, even with revenue bonds, the municipality is still on the hook to cover bond payments even after a business fails.

Financing. The primary impediment to building and operating a fiber ISP is raising the funding to pay for the network.

Cities often wonder why commercial ISPs aren't building fiber networks if a business plan shows a broadband business can be profitable. There are a few reasons why ISPs are not rushing around the country building fiber networks. The first is borrowing power – most small ISPs have a limited borrowing capacity and can only borrow to finance projects up to a relatively small limit. Cities are often surprised to find how few ISPs are able to borrow tens of millions of dollars.

Even if funding is available, a lot of investors and ISPs are not interested in the slow and low return that comes from building broadband networks. In the industry, the returns that can be made on broadband projects are referred to as "making infrastructure returns". This means an entity investing in fiber likely will make a return under 10% over the long run, and it often takes many years for a new fiber business to show any return. Most ISPs concentrate on broadband projects with the highest returns. This might mean building broadband only to businesses or building very selectively in neighborhoods with better-than-average expected returns. Many of the large ISPs like AT&T and Verizon only build selectively. This means that there is a limited number of ISPs willing to tackle a project with infrastructure returns.

Open-access

The open-access ownership model comes when a local government builds a fiber network and makes it available to multiple ISPs. The ISPs market and sell broadband and other products to customers. This model operates financially by the fiber owner selling access to the ISPs in an arrangement that is often referred to as selling loops. The loop charges are the only source of revenue for the municipal network owner.

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 the model (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 only one example of a big telco operating on somebody else's network, and it's in nearby Springfield, Missouri, where CenturyLink is in the process of using a network built by the city. However, it's hard to know where that venture will go since the Missouri operations are part of the sale of assets from CenturyLink to Apollo Asset Management. We don't know of any other examples where one of the largest telcos or cable companies has agreed to operate as a competitor on somebody else's network to serve residential customers. The large ISPs in the U.S. often lease fiber outside of their footprint to serve large business customers but 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, that was reduced at one point to having only one 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. The network now has two ISPs, but even with that it's hard to call the Chelan County network open-access.

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 this was reduced to 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.

Examples of Open-Access Networks. 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 had significant financial problems during the first decade. However, after several rounds of refinancing, the Utopia network is growing vigorously and adding new towns to the consortium.
- 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 was the retail provider of cable TV, but connections to the network for telephone and broadband were sold wholesale to ISPs. That was a losing venture, and the city is now leasing the network to an ISP.
- 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 which are promoted as "open-access" to carriers. For the most part these networks only serve business customers, and most of the industry refers to this as a wholesale model rather than open-access.
- 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 was unable to find ISP partners and decided to offer 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 hope is always that having greater competition will lead to lower prices and better customer service.

Disadvantages

Retail/Wholesale Revenue Gap. There is a big difference in the revenue stream for a network owner between collecting a retail revenue stream from customers versus collecting only open-access 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 likely 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. It doesn't have to sell, 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 must cover the full cost of debt on the network. The network owner still must maintain the fiber network and provide the core electronics. In most scenarios, the network owner is responsible for continuing to install fiber drops and customer electronics.

Not Many Quality ISPs. Most open-access networks in the U.S. have 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 forces these ISPs to compete against other small competitors, which holds down prices and puts pressure on ISP earnings.

Leads to Cherry-Picking. The open-access model, by definition, leads to cherry-picking by the ISPs. When ISPs are charged to use the network, they tend to concentrate on selling only to customers that bring the highest margin – and tend to not sell low-priced products with low margins. The only way to get broadband to everybody in an open-access network is for the network owner to lower its 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 and a smaller revenue stream for the network owner. Municipalities often build networks with the goal of getting broadband to the neediest citizens in the community, and open-access makes it a challenge to do so.

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, many of the small ISPs operating on open-access networks 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 fiber 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. A retail ISP typically strives to keep customers on a network once it has made the initial capital investment to connect a customer. However, in an open-access network, the ISPs don't make this same effort. Over time, an open-access network owner will see a growing inventory of homes and businesses with a fiber drop and customer electronics that are no longer used - and which are not contributing to the bottom line.

Public-Private Partnership (PPP)

There are a wide variety of public-private partnerships that can be created between a government entity and an ISP. There are many ways that revenues, profits, and risks can be shared between partners. The following discussion examines the most common forms of PPPs.

PPPs initially arose internationally as a way to finance infrastructure needs that local, regional, or national governments could not pay for upfront or finance from taxes, bonds, or other methods of raising government money. Over the last fifty years, governments collectively in the U.S. have been unable to fund the needed level of infrastructure - and PPPs were often formed to help finance the infrastructure deficit.

There are three major ways that a fiber PPP can be structured depending 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. 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 has built a fiber network with some upfront assistance from a community. In most cases, the parties don't think of these arrangements as a partnership.

For example, ISPs often ask for some concessions when building a fiber network. 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. The city might have provided concessions like free rights-of-way, expedited permitting, use of city land for placing facilities, etc.

Another common form of this kind of partnership is happening this year as local governments are providing grants to ISPs using the American Rescue Plan Act funding. The municipalities rarely get an ownership share in the business for these kinds of contributions.

For this kind of arrangement to be considered as 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 to poorer parts of the city that a commercial ISP might otherwise not have considered. In some rare cases, this might mean that the local government takes an ownership share in the business.

PPP Funded Jointly. When a municipality and an ISP both contribute significant cash or hard assets to a venture, it's clearly a PPP. Following are a few examples of the different ways such partnerships can be structured.

- Zayo partnered with Anoka County, Minnesota to build a middle-mile fiber network throughout the county. This is a suburban county just north of the twin cities. Both entities made a significant cash contribution to the project, plus the two parties together pursued and received a grant to help pay for the network. 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, Tennessee partnered with a commercial ISP to build fiber to city buildings 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 allows commercial providers to build fiber 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, each pays to lease access on the other's network. However, both parties share some parts of the network, portions of which each has funded.

- 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 a partnership with West Des Moines, Iowa, in a network that can best be described as open-access conduit. The city is building empty conduit along every street in the city and will also extend the conduit to each home and business in the city. The network will be available to any ISP, and Google Fiber is the first announced network tenant. Google will pay to pull fiber through the conduit, and the company says it plans to serve the whole city. The City recently made a similar arrangement with Mediacom. In this partnership, the city has tackled the most expensive part of the network, but ISPs still have to make a sizable investment to pull fiber to reach customers.
- There are hundreds of examples of government entities that have built fiber routes jointly with a commercial partner. This is referred to in the industry as fiber sharing, and generally, each contributor to the fiber route gets some specific number of fibers for their contribution. For example, this is a common 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, conduits, 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. 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.

Following are the advantages of public-private partnerships.

Advantages

Smaller Government Investment. Funding from a commercial ISP lowers the amount of borrowing needed by a local government.

Help in Financing. City access to bond funding often makes it a lot easier for a commercial ISP to raise the rest of the needed investment.

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, which ISPs prefer to build to only selected neighborhoods. It's often difficult to put together a structure that can satisfy all the different goals.

Expensive Money. Since commercial partners generally want to make at least a 20% return on equity, this can be expensive funding.

Tax-Free Funding Issues. It's difficult to obtain tax-free bond funding to support a PPP. Tax-free bonds generally can't be used for a project that benefits a commercial entity.

Process Driven by Commercial Partner. Our experience is that the commercial partner drives the structure of the business as a likely precondition for investing. This means that a local government will not have a lot of say in the details of how to operate the business.

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 go through a defined deliberative process, including holding open meetings to make any significant decisions. This does not mesh well with the decision-making process and the expected timeline for a commercial partner. A commercial partner might make decisions in days, while the government process can't be any faster than weeks.

Public-Public Partnerships

There are a few examples around the country of ISPs formed by multiple local governments working together. One example is Southwest Broadband (SMBS) in Minnesota, that was formed jointly by seven small rural communities.

SMBS followed the typical models for public-public partnerships. The towns all formed a joint venture where each member town is a partial owner of the business. States have different mechanisms for communities to band together, and this is a common model for numerous kinds of regional public ventures like water systems, transportation systems, etc.

Another successful public-public partnership is MINET, which was jointly formed and operated by the cities of Monmouth and Independence, Oregon. This ISP has gained over an 80% market share in the two cities.

Advantages

Easier Financing. Many public-public partnerships have been created when the member cities alone did not have enough borrowing power to finance a project. Combining the bonding capacity of multiple communities can make a project feasible.

Economy of Scale. In the case of SMBS, none of the communities were large enough to have created a successful standalone ISP. It took all of the communities together to justify hiring the manager and staff needed to be successful in the business.

Disadvantages

Like Any Other ISP. The only downsides to this kind of arrangement are the typical risks that come from operating an ISP, in that the business has no guarantee of success.

Cooperatives

Cooperatives are owned by the customers of the business. Somebody that buys broadband from a broadband cooperative is given a share of ownership in the business. Around the country, there are a huge number of telephone cooperatives and electric cooperatives that operate broadband networks and power networks. There are no barriers against starting new broadband cooperatives, although it's a fairly rare occurrence. Once formed, a cooperative broadband ISP looks like any other standalone ISP. The new cooperative must find a way to fund the business and must hire the needed staff to operate the business. Most cooperatives are for-profit and must pay income taxes, although there are ways in some states to remain tax-free as long as a cooperative follows narrowly defined rules.

The only new broadband cooperative we know about is RS Fiber in Minnesota. This is a cooperative formed by a coalition of two counties, seven cities, and numerous rural townships.

Advantages

More Funding Flexibility. A cooperative has more financing options than a municipal ISP. A cooperative can raise money from traditional lenders like banks. There are also several boutique banks – CoBank and the RTFC - that are owned by cooperatives and mostly lend to cooperatives. Cooperatives often solicit some funds from cooperative members. Cooperatives can also borrow money at attractive interest rates from other existing cooperatives.

Good For Customers. Since a cooperative is owned by customers, the businesses can be highly focused on taking care of members. This typically means great customer service and often means lower rates than nearby ISPs.

Disadvantages

Harder Start-up. Most new commercial ISPs are started by existing ISPs, meaning that there is a commercial entity that can contribute start-up capital and perhaps provide financing assistance. However, a new cooperative is starting from scratch in terms of start-up capital and funding. RS

Fiber cobbled together financing from half a dozen sources since no lender was willing to trust a new start-up business with a loan large enough to fund the whole business.

Non-Profits

It is also for an ISP to be funded and owned by a non-profit corporation. There are a handful of urban non-profit ISPs that are bringing broadband to places like public housing. The only larger non-profit we know of is in the city of Dallas, Oregon. The fiber network was funded by a non-profit and hired MINET (mentioned above) to operate the business.

There have been large non-profits in the past that started ISPs or have thought about starting ISPs. The largest one we know is the Fastenol Foundation, which started a non-profit ISP in eastern Minnesota. The non-profit's motivation was to bring broadband to small cities that were suffering from poor broadband. The ISP became financially successful, and Fastenol sold the business to a commercial ISP.

Advantages

Tax-Free. The main advantage of a non-profit owner is that the business is not subject to taxes in the same manner that municipalities are tax-free.

Disadvantages

Like Any Other ISP. The only downsides to this kind of arrangement are the typical risks that come from operating an ISP, in that the business has no guarantee of success. Non-profits have the same issues with borrowing money as any commercial ISP. A new cooperative will have a challenge borrowing money due to being a new company – lenders like companies with a track record.

B. 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 2023. 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 rural area.
- First Customer. We've assumed that the first customer could be added to the network in October of the first year. 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.

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. There are a few fiber ISPs that offer only one broadband product, most typically a gigabit.
- Low Basic Price. Some ISPs set a low price for the basic product. 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 slow speed 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.

  It's debatable if setting 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 for this study, we began by considering existing market rates. 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 sells DSL for $60 per month plus $10 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.
- Comcast's basic broadband product is $76 per month for up to 200 Mbps, with a mandatory fee of $14 for the modem. Comcast offers faster speed tiers up to 1.2 Gbps.
- Mediacom offers a 60 Mbps broadband product with data caps. They charge $49.99 with a 200 GB cap and $69.99 with a 400 GB cap. The standar5d starting product is $79.99 for 100/10 Mbps and a 1 terabyte data cap. The modem is $10.
- Campus Communications group (CCG) charge $69.99 for a symmetrical 1 gigabit connection.
- I3 Broadband charges $54.99 for 250 Mbps, $64.99 for 500 Mbps, and $89.99 for a gigabit connection, all symmetrical speeds. A router is $7 per month.
- Volo Internet charges by the gigabyte of usage for fiber. A customer can get 10 gigabytes per day for $49.95, 20 gigabytes per day for $59.95, 40 gigabytes per day for $69.95, and unlimited use for $89.95.
- Rise Broadband has speeds from $42 to $57 for wireless speeds between 5 Mbps and 50 Mbps. All plans have a 250-gigabyte data cap, with additional data sold at $5 per ten gigabytes.
- Watch Communications prices start at $59.99 for 10 Mbps and climb to $120 for 100 Mbps.

- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds are whatever is delivered, and usage is unlimited. AT&T has a simple DSL pricing. Most speeds are $60 per month plus $10 for the DSL modem.
  A new ISP with a fiber network will be able to offer significantly faster download speeds than all of the ISPs other than the cable companies. Fiber would bring significantly faster upload speeds than every other technology. 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 we used $60 as the starting price for broadband. That's the same as AT&T but higher than Frontier. It's less than the cable companies, but they don't sell in rural areas. The $60 price is in the middle of prices for fixed wireless.

  The forecasts assume some rate increases over time. Rates must be increased to keep up with expense inflation. The model is conservative and assumes rates increases 5% every fifth year, which works out to a little less than 1% per year. The big cable company have been raising rates 3% to 5% every year.

- 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	20%	$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. The primary complaint about broadband from businesses in the county is reliability. They told us there are regular broadband outages and slowdowns.

- 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. 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. Most ISPs do not offer a low-priced product for low-income households. An increasing number of ISPs are instead participating in the federal programs that provide qualified low-income customers with a monthly discount from list prices.

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 nationwide have been dropping traditional cable every year and are instead using 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.

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	20%
Gigabit	$ 90.00	5%
Business Fiber Broadband		
100 Mbps	$ 80.00	50%
25- Mbps	$ 95.00	35%
Gigabit	$110.00	15%

Most ISPs charge more to businesses for broadband, and the studies assume a $20 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. The cabler companies have data caps. Most cellular and satellite broadband has data caps.

Managed WiFi

This is a relatively new product that's been around for a few years. ISPs have found that the biggest quality problems with home broadband are due to obsolete or poorly placed WiFi routers in the home. A poor WiFi router translates to a poor broadband experience.

Many ISPs are now offering managed WiFi. This product places carrier-class WiFi routers in the home that are placed and operated by the ISP. High-quality routers, and the placement of multiple routers for larger homes usually mean better broadband coverage throughout 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 Champaign 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.

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 struggled with setting capital costs due to the current pressure in the industry from 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 was the biggest year we ever saw for building fiber. The future looks to be even busier 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, the big telcos have announced aggressive plans to finally build fiber.

As an example, AT&T said that the supply chain resulted in the company only achieving 2.5 million of the 3 million planned new passings in 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 2021 compared to a year earlier. Factories that are already working at 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 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 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.

Our goal is to 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 20% or more higher than costs from a year ago. 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 the two options we studied. These investments are at the end of the sixth year of operations – the time when the ISP business achieves full market penetration. The estimates below represent the assumption that a new fiber ISP would eventually gain a 40% market share in the towns and cities and a 65% penetration in the rural areas. 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.

	Total Study Area	Rural County	Without RDOF
Fiber	$133,669,758	$61,133,570	$47,232,678
Drops	$ 14,551,173	$ 5,962,110	$ 3,983,360
Electronics	$ 14,848,896	$ 3,888,042	$ 2,453,748
Huts	$ 270,000	$ 270,000	$ 202,500

Operational Assets	$ 1,072,962	$ 511,454	$ 504,704
Total	$164,412,788	$71,765,175	$54,376,990
Passings	40,215	6,601	4,630
Cost per Passing	$ 4,088	$10,872	$11,744

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the average electronics for an ONT cost $499, 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 $175. This is a middle-of-the-road price and there are both more expensive and less 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.

The engineering analysis looked at average drop length throughout the study area – being the average distance in various parts of the county from the road to reach homes and businesses. We've estimated average cost of drops for the whole study area to be $1,042. For the rural area the average increases to $1,305 based upon average longer lengths in the rural area versus the urban areas. The average cost of drops in the area with RDOF is $1,280.

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 Champaign County that will buy broadband service.

The analysis looks at customer penetration rates in several different ways. The base scenario begins with what we call expected rates. We used an expected penetration rate of 60% to begin our analysis. We think this is a conservative penetration rate because a fiber provider would likely win a large majority of customers over time.

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 large area like the rural 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 commercial ISP offering the services. We know the county is not interested in being an ISP, but we still 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:

Customer Service Representative. Takes new orders, answers customer questions about billing, services, etc. We've assumed the business will require the following new positions:

Full Study Area	10 new CSRs
Rural Only	2 new CSRs
Without RDOF	2 new CSR
Full Study Area	1 CSR supervisor

Install/Repair Technician. These technicians provide maintenance and repair calls. The technicians would maintain both network electronics and facilities as well as customers. We've assumed the business will require the following new positions:

Full Study Area	10 new outside technicians
Rural Only	2 new outside technicians
Without RDOF	2 new outside technicians

Full Study Area	2 new inside technicians
Rural Only	1 new inside technicians
Without RDOF	1 new inside technicians
Full Study Area	1 fiber optic foreman

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.

Full Study Area	4 salespeople
Rural Only	1 salesperson
Without RDOF	1 salesperson
Full Study Area	1 marketing analyst
Rural Only	0 marketing analyst (outsourced)
Without RDOF	0 Marketing analyst (outsourced)

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.

Full Study Area	1 general manager
Full Study Area	1 office manager
Rural Only	0 local market manager – managed by parent ISP
Without RDOF	0 local market manager – managed by parent ISP

The Full Study Areas scenario grows to thirty new employees.
The Rural scenario grows to six new employees.
The Rural without RDOF scenario grows to six 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. There have been rural ISPs 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 six years of operations for the two scenarios are as follows:

Total Study Area	$4,510,000
Total Rural	$1,070,000
Without RDOF	$ 781,000

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 Champaign 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 $9.00. 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.

Software Maintenance: ISPs typically maintain a complex software system called BSS/OSS (billing and operational support systems). This software provides a wide range of functions: order taking, provisioning new customers, tracking 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 if a commercial ISP operates the business that there will be state and federal income taxes. These taxes would not apply if this were operated as a municipal business or as a non-profit.

We have assumed no property taxes on assets, but it's possible that some amount of this might apply. There are a few places in the country that charge property taxes on fiber networks, but most of the country doesn't.

The forecasts do not include any taxes that are assessed to customers. For example, this business would be expected to charge and collect various sales and 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 assumed to be 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.

C. 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 ISPs are interested in understanding the amount of capital spending that is required. ISPs are also interested in financial projection, particularly in any work that has been done to quantify the possibility of raising grant funding.

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.

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 sixth 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 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 the Whole Study Area

As a reminder, the full study area is essentially everything outside of Urbana and Champaign. The base study assumes a commercial ISP funds the network using commercial debt.

Base Study

	No Grant	Breakeven Grant
Asset Costs	$164.4 M	$164.4 M
Grant	$ 0.00 M	$ 22.0 M
Equity	$ 26.7 M	$ 23.4 M
Bank Debt / Bond	$151.4 M	$132.4 M
Total Financing	$178.1 M	$177.8 M
Penetration Rate	40% / 65%	40% / 65%
Cash after 10 Years	(-$10.30 M)	$ 0.53 M
Cash after 20 Years	(-$20.83 M)	$ 3.75 M

This shows that building fiber to the whole study area is not feasible without substantial grant funding. In this case, the grant required is not large compared to many other projects we've studied, and the $22 million grant represents a little over 12% of the total cost of funding the project.

Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the lowest amount of grant funding needed for the project to always be cash positive. It's

worth noting that no commercial ISP would tackle this project if they didn't expect to perform better than breakeven. That probably means that an ISP would expect more than a $22 million grant before considering the project. We'll look harder at the possible amount of grant funding that might be available to the county in scenarios below.

Probably the most significant number in the above numbers is the more than $20 million in equity that might be expected from 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 many ISPs that have access more than $20 million in free cash available. The need for equity funding is one of the biggest reasons why small ISPs have trouble expanding – they don't fit the desired borrower profile for banks. A small ISP more typically has a rotating line of credit where they can borrow some modest amount and keep reborrowing it as they pay off the loan. It takes a large ISP with a deep balance sheet to tackle a $160 million network build.

It's possible that the banks would lower the amount of needed equity if there were a sizable grant, but banks are leery about projects of this magnitude when there is no financial pain felt by an ISP for walking away from the project.

Municipal Financing

We were also asked to consider municipal financing. The following results show the impact of financing this scenario with bond financing instead of commercial bank financing.

	GO Bond No Grant	GO Bond Breakeven	Rev Bond No Grant	Rev Bond Breakeven
Asset Costs	$164.4 M	$164.4 M	$164.4 M	$164.4 M
Grant	$ 0.0 M	$ 44.0 M	$ 0.0 M	$ 52.0 M
Equity	$ 0.0 M	$ 0.0 M	$ 0.0 M	$ 0.0 M
Bank Debt / Bond	$197.0 M	$149.7 M	$213.4 M	$150.5 M
Total Financing	$197.0 M	$193.7 M	$213.4 M	$202.5 M
Penetration Rate	40% / 65%	40% / 65%	40% / 65%	40% / 65%
Cash after 10 Years	($22.62 M)	$ 1.37 M	($27.47 M)	$ 1.36 M
Cash after 20 Years	($49.46 M)	$ 4.99 M	($62.78 M)	$ 5.95 M

The nuances of bond and bank financing are discussed later in this section of the report. There are a few major reasons the amount that must be borrowed for municipal bond funding is so much higher than banked debt:

- A municipality can usually borrow 100% of the funding, and rarely has to put any equity into a project. That means larger debt, and the debt must be further increased to cover the larger loan.
- Bonds most typically borrow the money for a project upfront. This contrasts drastically with bank financing where an ISP draws each month from a line of credit and only pays interest expense on the amount of the loan that has been drawn. Construction financing means significantly less interest expense in the first few years of the project.

- Municipal bonds typically pre-borrow the money needed to repay the interest expense for the first 2 – 3 years of a project. That removes any early pressure to make interest payments, but it significantly increases the size of the borrowing.
- Since revenue bonds are largely only supported by the project, and not by tax revenues, bond lenders usually insist that revenue bond borrowers borrow extra money and hold it as a safety net in case there is ever a problem meeting bond payments. This extra borrowing is most typically referred to as a debt service reserve fund.

The larger size of the municipal debt requires a significantly larger grant in order for the project to be assured of at least breaking even. In this case, the grant required for typical bank financing is $22 million, while the breakeven grant balloons to $44 million with general obligation bod funding and $52 million with revenue bond funding. The extra grant money is used strictly to cover the larger debt.

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 40% penetration rate in towns and cities and a 65% penetration in the rural areas. The numbers below show two additional scenarios – lowering the penetration rate across the board by 5% (35% / 60%) or raising the penetration rate by 5% (45% / 70%).

	40% / 65%	35% / 60%		45% / 70%	
	Breakeven	Base	Breakeven	Base	Breakeven
Asset Costs	$164.4 M	$161.6 M	$161.6 M	$169.5 M	$169.5 M
Grant	$ 22.0 M	$ 22.0 M	$ 34.0 M	$ 22.0 M	$ 0.0 M
Equity	$ 23.4 M	$ 23.4 M	$ 21.2 M	$ 23.6 M	$ 27.7 M
Bank Debt / Bond	$132.4 M	$132.8 M	$120.0 M	$133.6 M	$157.1 M
Total Financing	$177.8 M	$178.2 M	$175.2 M	$179.1 M	$184.8 M
Penetration Rate	40% / 65%	35% / 60%	35% / 60%	45% / 70%	45% / 70%
Cash after 10 Years	$ 0.53 M	($ 3.23 M)	$ 0.49 M	$ 7.80 M	$ 0.49 M
Cash after 20 Years	$ 3.75 M	($10.38 M)	$ 2.62 M	$27.00 M	$ 2.62 M

The above results show the following:

- The asset line shows how much the capital changes due to installing different levels of customers.
- The analysis shows that 1 5% lower penetration rate would increase the amount of grant funding needed for breakeven from $22 million to $34 million.
- Interestingly, if the penetration climbs to 45% in the towns and 70% in the rural areas there is no need for grant funding.
- The above numbers show the importance of understanding potential market penetration rates. There is a huge swing in cash for ending 5% below or above the base penetration we assumed in the study.

Other Scenarios

We also looked at alternate business structures.

Operator for Hire

In the operator for hire business plan, the County would finance and build the fiber network and would hire an ISP to operate the business. The ISP operator would have no ownership in the business but would also make no investment into the business. Operating an ISP is a huge amount of effort, and an operator is going to want to make some a profit for the hard work of fully operating the business. I've estimated that an ISP would likely want to make at least $1 million per year for the effort expended. It's not an unreasonable expectation because the ISP could be using that same effort to operate an ISP market where it has ownership and is growing value.

For this scenario to make any sense the business must be generating at least $1 million per year in cash. There are scenarios where the business could do that well for the whole study area. For example, financing the business over 25 years instead of 20 years could increase cash, as could raising rates. The biggest risk of this scenario would be to hire the operator and then not make enough money to cover the cost of the operator.

ISP Leases the Network

In this scenario the County would build the network and then lease it to an ISP. The ISP would operate the business and would be able to earn any extra profits for doing so. There are a few examples of this scenario – this is similar to the arrangement between Google Fiber and the City of Huntsville, Alabama.

The biggest challenge of this business plan is to find an ISP that will guarantee the debt payments of the government. If debt payments are guaranteed, then the government takes little risk in this scenario. However, the ISP take a huge amount of risk including having to cover the cost of debt in the early years before there is enough revenue to pay the lease.

The following results show why this scenario won't make sense to ISPs. The County would do well because of guaranteed debt payments while the ISP must borrow a lot of money in the early years to guarantee debt payments. We can't imagine any ISP that would make an equity investment in a business plan that is guaranteed to lose money over ten years.

	County	ISP
Cash after 10 Years	$19.06 M	($ 7.11 M)
Cash after 20 Years	$ 6.34 M	$ 7.17 M

Open Access

The open access scenario turned out to be a loser for the County. In the open access scenario, the County would pay for all of the network up to an including customer electronics. The network would then be leased to ISPs at a rate between $35 and $55 dollars per customer per month depending upon the product. The ISP would sell to customers and would incur some small capital costs for things like WiFi routers inside customer homes.

As the numbers below show, this scenario loses a huge amount of money for the County while the ISPs are profitable. These losses are fairly easy to understand:

- The County would be making nearly the identical capital investment as in the retail scenarios.
- The County would still need to employ a small staff of technicians to care for the fiber network and the electronics.
- The County would collect the smaller open access loop fees instead of the much larger retail revenues. Looked at simply, the County still must cover the debt with half the revenue stream.

	County	ISP
Cash after 10 Years	($ 4.91 M)	$11.18 M
Cash after 20 Years	($48.62 M)	$42.97 M

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we refer to as a sensitivity analysis.

Changing Broadband Prices

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing the base rate from $60 to $65) increased cash flow over 20 years by almost $18 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $3.6 million. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by over $19 million. This provides evidence that an ISP should be careful in lowering rates. For example, if a marketing plan suggests cutting rates to gain customers, the long-term impact of lower rates could be devastation for cash generation.

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 more than $7.5 million over twenty years. The impact from increasing the interest rate was similar, where increasing the rate by 50 basis points lowered cash flow by more than $7.2 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 there are strong rumors of increasing interest rates.

Loan Term. The base scenario assumed a 20-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 20 years to 25 years. This increased

cash over 20 years by over $23 million. That is a giant swing that is mostly due to the large size of the network being constructed.

We also looked at decreasing the loan term from 20 years to 15 years. This scenario doesn't work – the shorter loan terms mean higher loan payments, and the 15-year term doesn't look feasible. The business doesn't generate enough cash to be able to cover the higher debt payments.

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 the construction contingency by 5% - this added $5.1 million to the cost of the project. This lowered cash flows over 20 years by $6.2 million. Decreasing the cost of the capital by 5% had nearly the same impact and increased cash flow by $6.2 million. The change in cash flow is due the change in the size of the annual debt payments.

The Additive Nature of the Variables

It's worth noting that the impacts of the various variables are somewhat additive. For example, if the project was able to get a lower interest rate and also spent less on capital – two changes that improve cash flow – the benefit is largely the same as adding the changes described above together.

Most of these variables have a significant impact on cash flow, which means that anybody wanting to undertake a fiber project of this size must make certain early in the financing stag to understand the likely variables. The variable that drives the biggest change is the customer penetration rate, and an ISP must feel certain they can achieve the targeted number of customers.

Fiber to the Rural Areas

The rural study area is everything not located in a town or city that currently has broadband available from a cable company.

Base Study

	No Grant	Breakeven Grant
Asset Costs	$ 71.7 M	$ 71.7 M
Grant	$ 0.00 M	$ 38.0 M
Equity	$ 12.1 M	$ 5.6 M
Bank Debt / Bond	$ 31.9 M	$ 31.9 M

Total Financing	$ 80.9 M	$ 75.5 M
Penetration Rate	65%	65%
Cash after 10 Years	(-$14.77 M)	$ 0.31 M
Cash after 20 Years	(-$41.20 M)	$ 0.67 M

This shows that building fiber to the whole study area is not feasible without substantial grant funding. In this case, the grant required represents just over 50% of the cost of the total cost of funding the project. The good news is that there are grant programs that can finance projects up to 75% of the cost of the network.

Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the lowest amount of grant funding needed for the project to always be cash positive. It's worth noting that no commercial ISP would tackle this project if they didn't expect to perform better than breakeven. That probably means that an ISP would expect to receive more than a $38 million grant before considering the project. We'll look harder at the possible amount of grant funding that might be available to the county in scenarios below.

Another significant number in the above summary is the $5.6 million in equity that might be expected from a commercial ISP to build the rural 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. It's possible that with a large amount of grant funding that lenders would reduce the needed equity, but any lender is going to want a borrower to have a financial stake in a project of this magnitude.

Municipal Financing

We were also asked to consider municipal financing. The following results show the impact of financing this scenario with bond financing instead of commercial bank financing.

	GO Bond No Grant	GO Bond Breakeven	Rev Bond No Grant	Rev Bond Breakeven
Asset Costs	$ 71.8 M	$ 71.8 M	$ 71.8 M	$ 71.8 M
Grant	$ 0.0 M	$ 44.0 M	$ 0.0 M	$ 46.0 M
Equity	$ 0.0 M	$ 0.0 M	$ 0.0 M	$ 0.0 M
Bank Debt / Bond	$ 86.1 M	$ 37.7 M	$ 93.2 M	$ 39.4 M
Total Financing	$ 86.1 M	$ 81.7 M	$ 93.2 M	$ 85.4 M
Penetration Rate	65%	65%	65%	65%
Cash after 10 Years	($22.08 M)	$ 1.47 M	($27.22 M)	$ 2.06 M
Cash after 20 Years	($53.82 M)	$ 0.82 M	($59.62 M)	$ 0.71 M

The nuances of bond and bank financing are discussed later in this section of the report. There are a few major reasons the amount that must be borrowed for municipal bond funding is so much higher than banked debt:

- A municipality can usually borrow 100% of the funding, and rarely has to put any equity into a project. That means larger debt, and the debt must be further increased to cover the larger loan.
- Bonds most typically borrow the money for a project upfront. This contrasts drastically with bank financing where an ISP draws each month from a line of credit and only pays interest expense on the amount of the loan that has been drawn. Construction financing means significantly less interest expense in the first few years of the project.
- Municipal bonds typically pre-borrow the money needed to repay the interest expense for the first 2 – 3 years of a project. That removes any early pressure to make interest payments, but it significantly increases the size of the borrowing.
- Since revenue bonds are largely only supported by the project, and not by tax revenues, bond lenders usually insist that revenue bond borrowers borrow extra money and hold it as a safety net in case there is ever a problem meeting bond payments. This extra borrowing is most typically referred to as a debt service reserve fund.

The larger size of the municipal debt requires a larger grant in order for the project to be assured to at least break even. In this case, the grant required for typical bank financing is $38 million, while the breakeven grant balloons to $44 million with general obligation bond funding and $46 million with revenue bond funding. The extra grant money is needed to cover the larger debt.

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 40% penetration rate in towns and cities and a 65% penetration in the rural areas. The numbers below show two additional scenarios – lowering the penetration rate across the board by 5% (60%) or raising the penetration rate by 5% (70%).

	65%	60% Penetration		70% Penetration	
	Breakeven	Base	Breakeven	Base	Breakeven
Asset Costs	$ 71.7 M	$ 71.0 M	$ 71.0 M	$ 72.4 M	$ 72.4 M
Grant	$ 38.0 M	$ 38.0 M	$ 41.0 M	$ 38.0 M	$ 35.0 M
Equity	$ 5.6 M	$ 5.6 M	$ 5.0 M	$ 5.7 M	$ 6.2 M
Bank Debt / Bond	$ 31.9 M	$ 31.8 M	$ 28.6 M	$ 32.0 M	$ 35.2 M
Total Financing	$ 75.5 M	$ 75.5 M	$ 74.6 M	$ 75.7 M	$ 76.4 M
Cash after 10 Years	$ 0.31 M	($ 0.74 M)	$ 0.20 M	$ 1.28 M	$ 0.35 M
Cash after 20 Years	$ 0.67 M	($ 3.12 M)	$ 0.14 M	$ 4.33 M	$ 1.07 M

The above results show the following:

- The asset line shows how much the capital changes due to installing different numbers of customers.

- The analysis shows that a 5% lower penetration rate would increase the amount of grant funding needed for breakeven from $38 million to $41 million.
- If the penetration climbs to 70% in the rural areas, the needed grant funding drops from $38 million to $35 million.
- The above numbers show the importance of understanding potential market penetration rates. There is a big swing in the needed financing for a scenario that is expected to need a 70% versus a 60% penetration.

Other Scenarios

We also looked at alternate business structures.

Operator for Hire

In the operator for hire business plan, the County would finance and build the fiber network and would hire an ISP to operate the business. The ISP operator would have no ownership in the business but would also make no investment into the business. Operating an ISP is a huge amount of effort, and an operator is going to want to make some a profit for the hard work of fully operating the business. I've estimated that an ISP would likely want to make at least $1 million per year for the effort expended. It's not an unreasonable expectation because the ISP could be using that same effort to operate an ISP market where it has ownership and is growing value.

Because of the smaller size of the business to serve only the rural customers, there doesn't appear to be any scenario where there would be enough cash generated to ever afford to pay somebody else to operate the network.

ISP Leases the Network

In this scenario the County would build the network and then lease it to an ISP. The ISP would operate the business and would be able to earn any extra profits for doing so. There are a few examples of this scenario – this is similar to the arrangement between Google Fiber and the City of Huntsville, Alabama.

The biggest challenge of this business plan is to find an ISP that will guarantee the debt payments of the government. If debt payments are guaranteed, then the government takes little risk in this scenario. However, the ISP take a huge amount of risk including having to cover the cost of debt in the early years before there is enough revenue to pay the lease.

In the smaller rural footprint, the ISP has to borrow a lot of money to cover the debt for the first ten years, and it's hard to believe any ISP would be willing to take a chance on this scenario in a rural environment.

	County	ISP
Cash after 10 Years	$ 8.85 M	($ 1.62 M)
Cash after 20 Years	$ 5.53 M	$ 2.29 M

Open Access

The open access scenario turned out to be a loser for the County. In the open access scenario, the County would pay for all of the network up to an including customer electronics. The network would then be leased to ISPs at a rate between $35 and $55 dollars per customer per month depending upon the product. The ISP would sell to customers and would incur some small capital costs for things like WiFi routers inside customer homes.

This scenario was a huge loser for the County. In the total study area scenario, the County loses nearly $10 million over 20 years while the ISPs collectively make $9 million. These losses are fairly easy to understand:

- The County would be making nearly the identical capital investment as in the retail scenarios.
- The County would still need to employ a small staff of technicians to care for the fiber network and the electronics.
- The County would collect the smaller open access loop fees instead of the much larger retail revenues. Looked at simply, the County still must cover the debt with half the revenue stream.

	County	ISP
Cash after 10 Years	$ 1.68 M	$ 1.91 M
Cash after 20 Years	($ 9.76 M)	$ 8.81 M

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we refer to as a sensitivity analysis.

Changing Broadband Prices

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing the base rate from $60 to $65) increased cash flow over 20 years by almost $4.6 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $910,000. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by almost $4.6 million. This provides evidence that an ISP should be careful in lowering rates. For example, if a marketing plan suggests cutting rates to gain customers, the long-term impact of lower rates could be devastation for cash generation.

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 more than $1.8 million over twenty years. The impact from increasing the interest rate was similar, where increasing the rate by 50 basis points lowered cash flow by more than $1.7 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 there are strong rumors of increasing interest rates.

Loan Term. The base scenario assumed a 20-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 20 years to 25 years. This increased cash over 20 years by over $5.5 million. That is a significant swing and is one of the highest sensitivities in the analysis.

We also looked at decreasing the loan term from 20 years to 15 years. This scenario doesn't work – the shorter loan terms mean higher loan payments – and in the models we built, the 15-year term doesn't look feasible – the company doesn't generate enough cash to be able to cover the higher annual debt payments.

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 the construction contingency by 5% - this added $2.5 million to the cost of the project. This lowered cash flows over 20 years by $2.9 million. Decreasing the cost of the capital by 5% had nearly the same impact and increased cash flow by $2.9 million. The change in cash flow is due the change in the size of the annual debt payments.

The Additive Nature of the Variables

It's worth noting that the impacts of the various variables are somewhat additive. For example, if the project was able to get a lower interest rate and also spent less on capital – two changes that improve cash flow – the benefit is largely the same as adding the changes described above together.

Most of these variables have a significant impact on cash flow, which means that anybody wanting to undertake a fiber project of this size must make certain early in the financing stag to understand the likely variables. The variable that drives the biggest change is the customer penetration rate, and an ISP must feel certain they can achieve the targeted number of customers.

The Rural Area without the RDOF Awards

This scenario looks at excluding the parts of the rural County that might be receiving better broadbands as a result of the FCC's RDOF reverse auction in 2020. Those awards have not yet been made by the FCC, but if they are, then the RDOF areas will be getting faster broadband.

Base Study

Breakeven

	No Grant	Grant
Asset Costs	$ 54.4 M	$ 54.4 M
Grant	$ 0.00 M	$ 37.0 M
Equity	$ 9.4 M	$ 3.0 M
Bank Debt / Bond	$ 53.3 M	$ 16.8 M
Total Financing	$ 62.7 M	$ 56.7 M
Penetration Rate	65%	65%
Cash after 10 Years	(-$13.17 M)	$ 0.88 M
Cash after 20 Years	(-$38.12 M)	$ 2.56 M

This shows that building fiber to the areas without RDOF is not feasible without substantial grant funding. In this case, the grant required is $37 million grant represents a little almost 60% of the total cost of funding the project. As can be seen from the earlier scenarios above, as the size of the grant footprint gets smaller and more rural, the percentage of the cost of a project that must be raised from grants gets larger. This is a natural consequence of economy-of-scale where having the revenues from larger numbers of customers make it easier to be profitable in a broadband business.

Breakeven is defined as a scenario where the project never runs out of cash – so the breakeven grant amount shows the lowest amount of grant funding needed for the project to always be cash positive. It's worth noting that no commercial ISP would tackle this project if they didn't expect to perform better than breakeven. That means that an ISP would expect more than a $37 million grant before considering the project.

Another significant number in the above summary is the $3 million in equity that might be expected from a commercial ISP to build the rural 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. It's possible that with a large amount of grant funding that lenders would reduce the needed equity, but any lender is going to want a borrower to have a financial stake in a project of this magnitude.

Municipal Financing

We were also asked to consider municipal financing. The following results show the impact of financing this scenario with bond financing instead of commercial bank financing.

	GO Bond No Grant	GO Bond Breakeven	Rev Bond No Grant	Rev Bond Breakeven
Asset Costs	$ 54.8 M	$ 54.8 M	$ 54.8 M	$ 54.8 M
Grant	$ 0.0 M	$ 40.0 M	$ 0.0 M	$ 42.0 M
Equity	$ 0.0 M	$ 0.0 M	$ 0.0 M	$ 0.0 M
Bank Debt / Bond	$ 65.8 M	$ 19.7 M	$ 71.3 M	$ 18.8 M
Total Financing	$ 65.8 M	$ 59.7 M	$ 71.3 M	$ 60.8 M

Penetration Rate	65%	65%	65%	65%
Cash after 10 Years	($19.70 M)	$ 0.75 M	($21.32 M)	$ 1.35 M
Cash after 20 Years	($48.16 M)	$ 1.95 M	($52.61 M)	$ 3.38 M

The nuances of bond and bank financing are discussed later in this section of the report. There are a few major reasons the amount that must be borrowed for municipal bond funding is so much higher than banked debt:

- A municipality can usually borrow 100% of the funding, and rarely has to put any equity into a project. That means larger debt, and the debt must be further increased to cover the larger loan.
- Bonds most typically borrow the money for a project upfront. This contrasts drastically with bank financing where an ISP draws each month from a line of credit and only pays interest expense on the amount of the loan that has been drawn. Construction financing means significantly less interest expense in the first few years of the project.
- Municipal bonds typically pre-borrow the money needed to repay the interest expense for the first 2 – 3 years of a project. That removes any early pressure to make interest payments, but it significantly increases the size of the borrowing.
- Since revenue bonds are largely only supported by the project, and not by tax revenues, bond lenders usually insist that revenue bond borrowers borrow extra money and hold it as a safety net in case there is ever a problem meeting bond payments. This extra borrowing is most typically referred to as a debt service reserve fund.

The larger size of the municipal debt requires a significantly larger grant in order for the project to be assured of at least breaking even. In this case, the grant required for typical bank financing is $38 million, while the breakeven grant balloons to $40 million with general obligation bond funding and to $42 million with revenue bond funding. The extra grant money is used strictly to cover the larger debt payments.

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 40% penetration rate in towns and cities and a 65% penetration in the rural areas. The numbers below show two additional scenarios – lowering the penetration rate across the board by 5% (60%) or raising the penetration rate by 5% (70%).

	65%	60% Penetration		70% Penetration	
	Breakeven	Base	Breakeven	Base	Breakeven
Asset Costs	$ 54.4 M	$ 53.9 M	$ 53.9 M	$ 54.8 M	$ 54.8 M
Grant	$ 37.0 M	$ 37.0 M	$ 38.0 M	$ 37.0 M	$ 32.5 M
Equity	$ 3.0 M	$ 3.0 M	$ 2.8 M	$ 3.0 M	$ 2.8 M
Bank Debt / Bond	$ 16.8 M	$ 16.8 M	$ 15.7 M	$ 17.0 M	$ 15.7 M
Total Financing	$ 56.7 M	$ 56.7 M	$ 56.5 M	$ 57.0 M	$ 56.5 M
Cash after 10 Years	$ 0.88 M	$ 0.59 M	$ 0.61 M	$ 1.72 M	$ 0.61 M
Cash after 20 Years	$ 2.56 M	($ 0.04 M)	$ 1.04 M	$ 5.23 M	$ 1.04 M

The above results show the following:

- The asset line shows the change in network costs due to installing different numbers of customers.
- The analysis shows that a 5% lower penetration rate would increase the amount of grant funding needed for breakeven from $37 million to $38 million.
- If the penetration climbs to 70% in the rural areas, the needed grant funding drops from $37 million to $32.5 million.
- The above numbers show the importance of understanding potential market penetration rates. But this also shows how making the project smaller means that all of the variables have a much smaller impact on cash flow.

Other Scenarios

We also looked at alternate business structures.

Operator for Hire

In the operator for hire business plan, the County would finance and build the fiber network and would hire an ISP to operate the business. The ISP operator would have no ownership in the business but would also make no investment into the business. Operating an ISP is a huge amount of effort, and an operator is going to want to make some a profit for the hard work of fully operating the business. I've estimated that an ISP would likely want to make at least $1 million per year for the effort expended. It's not an unreasonable expectation because the ISP could be using that same effort to operate an ISP market where it has ownership and is growing value.

Because of the smaller size of the business to serve only the rural customers, there doesn't appear to be any scenario where there would be enough cash generated to ever afford to pay somebody else to operate the network.

ISP Leases the Network

In this scenario the County would build the network and then lease it to an ISP. The ISP would operate the business and would be able to earn any extra profits for doing so. There are a few examples of this scenario – this is similar to the arrangement between Google Fiber and the City of Huntsville, Alabama.

The biggest challenge of this business plan is to find an ISP that will guarantee the debt payments of the government. If debt payments are guaranteed, then the government takes little risk in this scenario. However, the ISP take a huge amount of risk including having to cover the cost of debt in the early years before there is enough revenue to pay the lease.

In the smaller rural footprint, the ISP has to borrow over $7 million in the first five years, and it's hard to believe any ISP would be willing to take a chance on this scenario in a rural environment.

	County	ISP
Cash after 10 Years	$ 1.58 M	($ 0.93 M)
Cash after 20 Years	($ 0.05 M)	$ 1.49 M

Open Access

The open access scenario turned out to be a loser for the County. In the open access scenario, the County would pay for all of the network up to an including customer electronics. The network would then be leased to ISPs at a rate between $35 and $55 dollars per customer per month depending upon the product. The ISP would sell to customers and would incur some small capital costs for things like WiFi routers inside customer homes.

This scenario was a huge loser for the County. In the total study area scenario, the County loses nearly $7 million over 20 years while the ISPs collectively are not very profitable due to the rural nature of the market. These losses are fairly easy to understand:

- The County would be making nearly the identical capital investment as in the retail scenarios.
- The County would still need to employ a small staff of technicians to care for the fiber network and the electronics.
- The County would collect the smaller open access loop fees instead of the much larger retail revenues. Looked at simply, the County still must cover the debt with half the revenue stream.

	County	ISP
Cash after 10 Years	($ 1.86 M)	($ 0.51 M)
Cash after 20 Years	($ 6.75 M)	$ 1.83 M

Sensitivity Analysis

We looked at the impact of changing the other various key assumptions – which we refer to as a sensitivity analysis.

Changing Broadband Prices

We looked at a scenario that changed broadband prices. Increasing broadband prices by $5 per month (changing the base rate from $60 to $65) increased cash flow over 20 years by a little more than $3.2 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $650,000. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by just under $3.2 million. This provides evidence that an ISP should be careful in lowering rates. For example, if a marketing plan suggests cutting rates to gain customers, the long-term impact of lower rates could be devastation for cash generation.

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 $950,000 over twenty years. The impact from increasing the interest rate was similar, where increasing the rate by 50 basis points lowered cash flow by $890,000.

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 there are strong rumors of increasing interest rates.

Loan Term. The base scenario assumed a 20-year loan term, which is the length of the loan. We looked at the impact of increasing the loan term from 20 years to 25 years. This increased cash over 20 years by over $2.9 million.

We also looked at decreasing the loan term from 20 years to 15 years. This scenario doesn't work. The shorter loan terms mean higher loan payments, and the ISP business doesn't generate enough revenue to cover the higher debt payments.

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 the construction contingency by 5% - this added $1.9 million to the cost of the project. This lowered cash flows over 20 years by $2.2 million. Decreasing the cost of the capital by 5% had nearly the same impact and increased cash flow by $2.2 million. The change in cash flow is due the change in the size of the annual debt payments.

The Additive Nature of the Variables

It's worth noting that the impacts of the various variables are somewhat additive. For example, if the project was able to get a lower interest rate and also spent less on capital – two changes that improve cash flow – the benefit is largely the same as adding the changes described above together.

Most of these variables have a significant impact on cash flow, which means that anybody wanting to undertake a fiber project of this size must make certain early in the financing stag to understand the likely variables. The variable that drives the biggest change is the customer penetration rate, and an ISP must feel certain they can achieve the targeted number of customers.

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 Champaign County Will Require Significant Grant Funding

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. The following tables represent the break even grant scenarios for a commercial ISP. In the full Study scenario, the penetration is shown in two parts – the first number is the expected penetration in the cities and the second is the expected rural penetration.

	Penetration Rate	Assets Needed	Grant Needed	Grant Percent of Assets
Full Study Area	35% / 60%	$161.6 M	$34.0 M	21%
	40% / 65%	$164.5 M	$22.0 M	13%
	45% / 70%	$169.5 M	$ 0.0 M	N/A
Rural Study Area	60%	$71.0 M	$41.0 M	58%
	65%	$71.7 M	$38.0 M	53%
	70%	$72.4 M	$35.0 M	48%
No RDOF	60%	$53.9 M	$38.0 M	71%
	65%	$54.4 M	$37.0 M	68%
	70%	$54.8 M	$32.5 M	59%

There are several observations to make about the need for grant funding:

- In the full study area, grant funding is needed at lower penetration rates, but with enough customers, the project wouldn't need any grant funding. This is due to economy of scale – at some point the customer revenues become large enough to cover the costs of the business, including the rural areas.
- It's also clear that the urban areas are a lot more profitable than the rural areas. This can be seen by comparing the amounts of grants required for the rural studies compared to the full study. The cities are profitable enough to subsidize the rural areas.
- Note that all of the grant amounts shown in the tables above represent the breakeven scenario. No commercial ISP would tackle a project that is only expected to break even if the ISP must invest equity. In every scenario an ISP would seek a larger amount of grant that it is needed for that ISP to reach its desired level of profitability.
- There are federal grants that might be able to fund up to 75% of the assets in the rural areas. These tables show that the needed grants are below that level, so ISPs can look at this table and understand that there should be grant funding available for most scenarios to make a business case.
- The above table should lead any ISP interested in serving the county to conduct a statistically valid survey of any area they plan to serve. The tables show that the customer penetration rate is critical to being profitable, and any ISP is going to want to understand the level of interest in buying broadband from a new fiber ISP.

The Forecasts are Sensitive to Changes in Other Key Variables

As the above table shows, the customer penetration rate seems to be the most important variable that affects financial performance. However, each scenario is also sensitive to changes in broadband rates, to the interest rate on debt, and to the term of borrowing. Any ISP thinking of tackling any of these project must be aware of how changes in these variables can change the expected results of the business plan.

Open Access Doesn't Look Viable

For all of the scenarios it doesn't look viable for the County to finance and build the network and lease connections to multiple ISPs. The following shows the amount of cash generated by year 10 and year 20 for open access with the three scenarios.

	County	ISP
Full Study Area		
Cash after 10 Years	($ 4.91 M)	$11.18 M
Cash after 20 Years	($48.62 M)	$42.97 M
Rural Study Area		
Cash after 10 Years	$ 1.68 M	$ 1.91 M
Cash after 20 Years	($ 9.76 M)	$ 8.81 M
Study Without RDOF Areas		
Cash after 10 Years	($ 1.86 M)	($ 0.51 M)
Cash after 20 Years	($ 6.75 M)	$ 1.83 M

In looking at the details of these results it's easy to see why these don't work for the County. First, the County has to make nearly the same investment for an open access network as is needed if the County was to be a retail ISP. However, the revenue stream to pay for the network is roughly half, since in open access the City would only receive the smaller open access fees than the larger retail revenues. There are some savings in expenses for the County to operate as an open access providers, but the results show that there is just not enough revenue collected from open access to cover the cost of debt.

Leasing the Network to an ISP Looks Challenging

Another common public-private partnership is for a government to fund and build a network and then lease the network to an ISP. This is a benefit to ISPs because they get to take advantage of the ability of local governments to borrow 100% of the project funding. This scenario does not look positive for the ISPs. Consider the following:

	County	ISP
Full Study Area		
Cash after 10 Years	$19.06 M	($ 7.11 M)
Cash after 20 Years	$ 6.34 M	$ 7.17 M
Rural Study Area		
Cash after 10 Years	$ 8.85 M	($ 1.62 M)
Cash after 20 Years	$ 5.53 M	$ 2.29 M

Study Without RDOF Areas		
Cash after 10 Years	$ 1.58 M	($ 0.93 M)
Cash after 20 Years	($ 0.05 M)	$ 1.49 M

The most typical way to structure these partnerships is for the ISP to guarantee to make the bond payments for government partner. In all case, the ISP would lose money for the first ten years for all scenarios. This is due to guaranteeing the bond payments in the early years before the business generates enough cash to cover debt payments.

We find it unlikely that an ISP would guarantee the early debt payment – and in that case, the above math flips and the ISPs would make money and the County would be in the hole during the first ten years – and maybe forever. There may be ways to make this work, but it would require the County and an ISP to negotiate based upon a forecast that both agree upon.

The Size of the Needed Funding

The report has mention in several places that the federal BEAD and other grants programs might fund up to 75% of the needed assets to bring a broadband solution. This might imply that an ISP must come up with 25% of the cost of the assets to make a project work. The math is not that simple, and the actual matching funds needed are larger.

- Not all assets are eligible for grant funding. Grants are generally used to build networks and connect customers. Grants generally don't cover assets like vehicles, computers, office furniture, spare inventory, and operating software. The grants can cover up to 75% of eligible network assets.
- Until the details are out from the way that states will administer the grants, we can't assume that the 75% will apply to all assets. For example, a state might decide that it will finance up to 75% of the investment in unserved areas, but perhaps something smaller in underserved areas. Even though these are federal grants, every state will have some say in how they award the funding.
- Grants also don't cover the operational losses that are inevitable from opening a new ISP market. There is significant effort required to build and launch a new market and an ISP must spend the labor and marketing money needed to launch a market. Grants do not cover operating expenses, and so the ISP will have to cover all expenses until the new market generates enough revenues to cover costs.
- To use two examples from the financial analysis, let's assume that the base case for both rural scenarios, which can be summarized as follows:

	Total Rural	Rural Without RDOF
Total Cost of Financing	$76 M	$57 M
Eligible Grant Assets	$70 M	$52 M
Broadband Grant	$53 M	$39 M
Matching Required	$24 M	$18 M
Percent Matching	31%	32%

This simple math shows that the actual amount of matching funding needed for these two scenarios is between 31% and 32% a little about 30% - not the 25% that might be assumed when somebody

hears there will be a 75% federal grant. Of course, if the grant doesn't cover 75% of all eligible assets then the percentage of matching would be higher.

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 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 invested in the business – because the business would not 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.

D. Funding for Broadband Networks

For a large percentage of broadband projects, the biggest challenge is finding the funding. This section of the report looks at the various 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.

Since one of your options is to form a public-private partnership, the following will touch briefly on the issues involved in a commercial partner finding funding. This is important since you need to understand the limitations faced by most smaller ISPs. The rest of this section will look in more detail at issues with public funding.

There are a number of different financing options to consider. Below we look at the following:

- Private Financing (loans)
- Public Financing (bonds)
- Grants
  - Federal Programs
  - State Programs
- Loan Guarantees
- Customer Financing
- Public-private Partnerships

Private Financing Options

A commercial ISP partner will rely on traditional private financing, meaning loans. Following are some key challenges that ISPs must navigate to get bank financing:

Equity: Most forms of private financing require some equity. Equity means that the borrower brings some sort of cash or cash equivalent to the business as part of the financing package. The amount of equity required will vary according to the perceived risk of the venture by the lender. The higher the risk, the more equity required.

Equity can take a number of different forms:

- Cash: Cash is the preferred kind of equity, and lenders like to see cash infused into a new business – cash that can't be taken pulled out of the business and that doesn't earn interest.
- Preferred Equity: A stock corporation (like an LLC or C Corp) can raise equity by selling some form of preferred stock that acts as equity. A buyer of preferred equity usually earns some guaranteed interest rate on the equity investment, but the payments are not usually guaranteed like 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.
- Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or another valuable asset to the business. In such a case, the contributed asset often must be assigned a market value, often appraised by an independent appraiser.

Bank Loan Basics: The banking industry generally does not like to finance long-term infrastructure projects. This is one of the primary reasons 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 their own equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and a broadband project might not generate enough cash in that time period to repay the loans.

Banks are also averse to start-ups and prefer to make loans to existing businesses that already have a proven revenue stream. It's extremely hard for a first-time borrower to be able to borrow the kind of money needed to build a broadband network.

Collateral. The biggest issue that banks have in lending to broadband projects is the requirement for 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 failed fiber networks are sometimes sold for pennies on the dollar. Fiber networks have little intrinsic value – all of the value of an ISP comes from the paying customers on the network.

It's important to understand the implications of collateral. Communities often ask an ISP operating nearby to come build fiber in their town. What they generally fail to realize is that the ISP might have to pledge their entire business as collateral in order to secure the loan – meaning that if the new venture fails, the ISP can lose the whole existing business.

Return on Bank Equity. Banks don't only consider the interest rate when making loans. A bank concentrates on its return on equity and will consider a combination of factors like interest rates, upfront and monthly loan fees, the likelihood that a borrower will pay a loan off early or default on a loan, etc. A bank will look at a dozen financial parameters before making an offer of interest rate and term – based upon meeting the banks targeted return on bank equity. There is a misperception that interest rates are negotiable, but the same project offered to multiple banks is likely to get a nearly identical financing package offered by all banks.

Federal Loans

Rural Utility Service (RUS): This is a part of the Department of Agriculture and is the only federal agency that makes direct loans 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 over 20,000. The RUS acts much like a bank and follows similar lending practices. I like to describe the RUS as a bank from the 1950s because 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). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan, excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may be reimbursed only if they are 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 non-profit or for-profit and can be one of the following: corporation, limited liability company (LLC), cooperative or mutual organization, Indian tribe or tribal organization as defined in 25 U.S.C. 450b, or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

To be eligible to receive a loan under this program, the entity must:

- Submit a loan application. 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, RUS loans are administered as follows:

- 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 they will require enough equity so that the projected revenues 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 often not possible.

This makes the RUS a very unlikely funding source for a municipal venture or for any start-up venture. The RUS rarely loans to municipalities and even more rarely to start-up ventures.

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 an applicant has to wait a long time to find out if the RUS will fund a project. Very few existing companies are willing to wait that long unless they are certain they will be funded. It's extremely challenging to coordinate RUS loans with other forms of financing. The loans are awarded using a detailed checklist and rating system. This system gives a big preference to making new loans to existing RUS borrowers.

However, the RUS loan fund is often large and there have been many times over the last decade when the balance to be lent sat at more than $1 billion. Congress generally adds additional funds to the RUS pot each year. The RUS also has some discretion and they have it within their 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 set 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.

Servicing an RUS loan requires a significant paperwork effort for drawing 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. First, the term of the bond can match the expected life of the assets, and it is not unusual to find bonds for fiber projects that stretch 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 traditional source of public money used to finance telecom projects is 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.

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 other future projects. So, to some degree, most governments feel obligated to pay back failed revenue bonds since there is a big penalty in terms of credit rating 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; 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 of bonds can outweigh the interest rate in the effect on the bottom-line cost of repaying a bond issue. Because of market reluctance to buy revenue bonds, they often have higher interest rates than general obligation bonds, but they also can incur the following costs:

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 five 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.

In recent years, the interest rates on municipal 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. 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 pledge revenue source, such as property or sales tax, would have to be used to make the bond payments.

Many states require a referendum to approve general obligation bonds. Most states have a few exceptions for things like economic development bonds that don't require a referendum. Local government sometimes hold a referendum anyway just 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 VRDO is a bond where the principal is paid in a lump sum at maturity. The borrower often 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 common for other kinds of municipal needs.

VRDOs are most commonly structured using 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 which 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, and 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 have several drawbacks over other types of available financing. The interest rates on CABs are typically higher than both the fixed-rate bonds and VRDOs. 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. 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 debt payments.

- Bonds can be used to finance 100% of a project, meaning there is no need for cash or equity to fund the new business. Bond financing avoids the cash equity hurdle that stops a lot of commercially-financed projects..
- Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the creditworthiness (bond rating) of the borrower as well as the perceived risk of the project.
- 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.

Comparing Bond and Bank 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 as insurance to be used if the project has trouble making bond payments. 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 number 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 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 drawn from the bank. Bonds generally borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one. Construction loans also means that a borrower will only draw funds that are needed, 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 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's hard imagining the construction of fiber networks in rural areas without some grant support. This study shows that grants will be required to build to the rural parts of the county.

Federal Broadband Grants: There are several permanent federal broadband grant programs that might benefit this project.

ARPA State and Local Fiscal Recovery Funds (SLFRF)

This is the $350 billion of funding that is going directly to states, counties, cities, towns, and townships. This is the fund that your members used to fund the 3% fee.

The purpose of this funding is to provide state and local governments with the necessary resources to:

- Fight the pandemic and support families and businesses struggling with its public health and economic impacts,
- Maintain vital public services, even amid declines in revenue, and
- Build a strong, resilient, and equitable recovery by making investments that support long-term growth and opportunity.

While the funds can be used for a number of different types of programs, they must address one of the following four categories:

- Replace lost public sector revenue
- Support the COVID-19 public health and economic response
- Provide premium pay for eligible workers performing essential work
- Invest in water, sewer, and broadband infrastructure.

The final rules eliminate any consideration of existing broadband speeds. The final rules allow broadband to be constructed to reach households and businesses with an identified need for additional broadband infrastructure investment. There still must be a justification that the project addresses a problem highlighted by the pandemic. But rather than relying on speed as the justification, localities can consider broadband reliability, affordability, or access to a connection that meets or exceed symmetrical 100 Mbps. Localities can document this need using any available data, including local speed tests, federal or state data, interviews with residents and businesses in the affected areas, and just about any other way that proves there is an existing broadband need.

In addition to broadband infrastructure, the funds can be used to expand internet access and digital literacy. The final rules provided the following examples of ways the funding can be used:

- Affordability programs such as subsidies that address the cost of internet service
- Digital literacy programs
- Programs that provide devices and equipment to access the internet such as tablets, computers, or routers.
- Services that expand internet access without constructing new networks, such as the expansion of public wi-fi networks or free WiFi in public housing communities.
- Programs that support the adoption of internet service where service is available

For infrastructure spending, the rules require recipients to address affordability while building new broadband networks saying, “a project cannot be considered a necessary investment in broadband infrastructure if it is not affordable to the population the project would serve.” Treasury outlines two ways recipients should address affordability:

- Lack of affordable broadband can be used to define areas eligible for investment with SLFRF funds.
- If a project provides internet service to households, the ISP must participate in the Affordable Connectivity Program.

ARPA Capital Project Fund Grants

The American Recovery Plan Act allocated the $10 billion Capital Projects Fund[28] that will go directly to states. that will be distributed to states for broadband.

States will administer the grants and make awards to specific projects. Each state will need a grant program that follows the federal rules for this money. Since these new rules are different than the rules governing many existing state grant programs, the states will have to quickly adjust to follow these rules for at least this money. In some states, this might require the legislature to change current grant rules.

Communities and States can define the eligible grant areas. These grants do not use FCC mapping in determining eligibility. A grant area must only be shown to not have reliable 100/20 Mbps broadband in order to be eligible – that is a very loose test. Treasury provides amazing leeway in defining eligible areas, and almost any reasonable form of proof of poor broadband can suffice to prove an area is eligible. Of course, states will have some say in defining eligible areas, and I foresee a huge tug-of-war over this issue between state grant offices and communities.

Grant projects must be able to provide symmetrical gigabit speeds. There is going to cause confusion all over the industry as different grant programs have different speed requirements. This might also require legislative changes in some states.

A project must meet all of the following requirements: A project must be spent on infrastructure that will enable work, education, or health monitoring. Projects must address a critical need that results from or was made obvious during the pandemic. Projects must address a critical community need.

Treasury wants a priority for last-mile infrastructure. States can request middle-mile projects, but Treasury must approve. Some money will be allowed for devices, but the state must retain ownership of devices. Money can go for improvement to government facilities that meet all of the eligibility rules.

Treasury allows states to fund projects 100%, with no matching. But states might require matching to spread the grant benefits to more projects.

Project costs back to March 1, 2021, can be funded under some circumstances. This might cover costs like a feasibility or engineering study.

[28] The full rules are at: https://home.treasury.gov/system/files/136/Capital-Projects-Fund-Guidance-States-Territories-and-Freely-Associated-States.pdf

The rules do not mandate paying Davis-Bacon wages, but it encourages projects to pay a living wage.

Projects must be completed by 2026, although Treasury has the ability to grant extensions.

ReConnect Grants

In the 2017 Farm Bill, Congress created a grant program called ReConnect[29]. The program awarded $200 million in grants, $200 million in loans, and $200 million in a combination of grants and loans in 2019. Congress reauthorized an additional $600 million to be awarded in 2020.

There is a new round of ReConnect grants currently underway in 2022 that will award $1.15 billion in funding, with grants due in February 2022. It appears there will be an additional round of ReConnect grants in the summer of 2022 for an additional $2 billion. Following is a highlight of the rules for latest ReConnect grants.

- Speeds. This is the first federal grant program that will consider as grant-eligible any area not served today by 100/20 Mbps broadband. But note that there is a big grant scoring penalty for serving areas with existing speeds greater than 25/3 Mbps. This means the grant allows serving areas with existing speeds greater than 25/3 but penalizes an applicant for doing so. The grants do not automatically adhere to FCC mapping data, but an applicant needs to be prepared to demonstrate why an area is eligible. To challenge the FCC mapping requires an opinion from an engineer who has examined technology in the field or a rigorous online survey that demonstrates slow speeds.
- Eligible Entities. Almost anybody is eligible, but a big preference is given to tribes and to "local governments, non-profits, and cooperatives as applicants and additional points to those applications (including for projects involving public-private partnerships where the local government, non-profit, or cooperative is the applicant)."
- Must be Rural. Grant-serving areas must be rural and remote. There is a ReConnect mapping tool[30] that will tell you if an area is eligible. To be eligible for funding, the grant area must be "15 minutes or more from an urban area of 2,500-9,999 people; 30 minutes or more from an urban area of 10,000-24,999 people; 45 minutes or more from an urban area of 25,000-49,999 people; or 60 minutes or more from an urban area of 50,000 or more people." Additionally, there is a density test.
- Pandemic Matters. Applicants must demonstrate how the grant area was hit particularly hard by the pandemic.
- Economic Need. The grants favor bringing broadband to Socially Vulnerable Communities. On first reading, this looks like it's going to take some effort to meet this test.
- Prefers Open-access. Retail rates must be affordable and non-discriminatory. There are grant points awarded to those willing to offer "wholesale rates," which is another way of describing open-access.

[29] https://www.usda.gov/reconnect

[30] https://ruraldevelopment.maps.arcgis.com/apps/webappviewer/index.html?id=1e82a64056fc46e4a28361c5e9447246

- Strong Labor Standards. While the grant doesn't require Davis-Bacon prevailing wages, there are grant points awarded for agreeing to pay the prevailing wages or higher.
- Net Neutrality. Applicants must be willing to adhere to net neutrality.
- Can be Used in RDOF Areas. This is one of the more confusing rules and will need clarification. It seems likely that this will allow somebody already getting RDOF to use these funds if it accelerates the construction timeline.

HUD Community Development Block Grants (CDBG)

Grants under this program can be used to build fiber or wireless networks in areas lacking broadband access. Any grant application must meet all three of the following objectives:

- The project must benefit low- or moderate-income neighborhoods
- The project must eliminate "slums / blight."
- The project must demonstrate urgent need.

The last criterion is fairly easy to demonstrate in any community without adequate broadband – years ago, this was a hard challenge for using this money for broadband. The big hurdle for many grant applicants is the second objective of eliminating blight. We've seen an argument made that improving broadband improves incomes, which ultimately improves impoverished communities. For example, luring tenants to closed storefronts with good broadband meet this test.

The CDBG grants have wide latitude in considering grant applications and can be used in the following ways that benefit broadband:

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes the placing underground of new or existing distribution facilities and lines.
- Digital literacy classes as a public service.
- Economic development – grants/loans to for-profit businesses, particularly businesses that focus on broadband/Internet access and technology.

It's worth noting that the CDBG program also makes block grants to states which then can administer grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

It's hard to use this money to support a widespread network that serves different neighborhoods, but it can be useful to supplement other grants by using this money for the low-income areas.

Broadband Equity, Access, and Deployment Program (BEAD) Grants

This is the official name of the $42.5 billion grant program approved by Congress in November 2021. This grant program was established by the Infrastructure Investment and Jobs Act. Congress established the following high-level requirements for this grant program. These rules will be refined with more details by NTIA during 2022.

- No Specified Starting Date. The best guess in the industry is sometime in early 2021. The NTIA has a number of steps to complete before these grants are awarded. This funding will flow between the NTIA and States, and the States will choose grant winners. The Act gives the NTIA 180 days to come up with a plan for inviting states to apply for the funding. After the NTIA approves a state's plan, the state will have to develop and announce the specific grant program and timing.
- Large Amount of Funding. States will get at least $100 million each, with the rest distributed based upon the number of unserved households in each state, the overall population, and the percentage of low-income residents. The average state will get $800 million, so this is by far the largest broadband grant program ever.
- Definition of Broadband. Grants must adhere to two key definitions of broadband. Unserved are places with broadband speeds under 25/3 Mbps. Underserved are areas with speeds between 25/3 and 100/20 Mbps. Grants must first go to unserved areas before being used for underserved areas. Funding for anchor institutions is only allowed after serving underserved areas.
- Technology Must be at Least 100/100 Mbps. Anything built with the network must deliver speeds of at least 100/100 Mbps – but there are waivers to build infrastructure that meets 100/20 Mbps.
- 5-Year Funding Period. States have five years to disperse the funds. We don't know what that means. It could mean a series of grants funding rounds over a few years, or it could mean one giant grant process at the beginning, with payments stretched out over time. Each state is likely to have a different solution.
- Other Uses of the Grants. Grants don't have to all go for broadband to unserved and underserved areas. Grants can be made to connect eligible community anchor institutions. States can use the money for data collection, broadband mapping, and planning. Funding can go to serve qualifying multi-family apartments with WiFi or low-cost broadband.
- Eligible to All. BEAD doesn't give priority to any class of grant recipients. The grants can't exclude cooperatives, non-profit organizations, public-private partnerships, private companies, public or private utilities, public utility districts, or local governments from eligibility.
- Several Grant Priorities. States must give priority to grants that are deployed in counties with persistent poverty. Projects that will deliver more than the minimum speeds will be given priority. Projects that are shovel-ready will be given priority. Projects that pledge to pay Davis-Bacon wages will get priority.
- Challenge Process. Incumbent ISPs can challenge the validity of a grant area. Interestingly, the NTIA can override states in these challenges.
- Grants up to 75%. Grant applications must provide at least a 25% matching for the cost of the project. Matching may include CAREs funding and ARPA funding. Matching can also come from state grants.
- Requires Two 9's Reliability. Deployed technology must only meet two 9's reliability – meaning that it can be out for two days per year and still be considered adequate.
- Construction Must Complete in Four Years. A grant recipient must cover every home in a coverage area within four years of receiving the grant.
- Low-Price Option. Grant recipients must provide at least one low-cost broadband option for eligible households. The NTIA is expressly forbidden to regulate rates in any manner.

- No Middle-Mile. Interestingly, any fiber built along highways must include access points at "regular and short intervals." This money is not intended for middle-mile fiber.
- Public Awareness Campaign. Grant recipients must carry out public awareness programs in grant areas extolling the benefits of better broadband.
- Plenty of Paperwork. Grant recipients must file semiannual reports tracking the effectiveness of the grant funding.

Grants for Low-Income Apartments

There is one section of the $42.5 billion Broadband Equity, Access, and Deployment (BEAD) grants that cities should find interesting. These grants can be used for *installing internet and Wi-Fi infrastructure or providing reduced-cost broadband within a multi-family residential building, with priority given to a residential building that has a substantial share of unserved households or is in a location in which the percentage of individuals with a household income that is at or below 150 percent of the poverty line applicable to a family of the size involved (as determined under section 673(2) of the Community Services Block Grant Act (42 U.S.C. 9902(2)) is higher than the national percentage of such individuals*.

The BEAD grants are mostly aimed at solving the rural digital divide, but this is an open invitation for cities to seek grant funding to bring better broadband to low-income apartment complexes.

As is usual with most new laws, this one has one interesting incongruity. The BEAD grants establish a priority for States to follow - States should first use BEAD grants to bring broadband to unserved locations with broadband under 25/3 Mbps, then underserved locations with broadband slower than 100/20 Mbps, and finally to anchor institutions. This language inserts low-income housing into the top of that priority since the language says that grants can be used for unserved apartment buildings OR for low-income apartment buildings. This language seemingly gives low-income apartment buildings a higher priority than underserved locations. This language also implies that there is no speed requirement for low-income apartments to qualify for grant funding – the only requirement is the level of poverty.

It's going to be interesting to see how States interpret this. States with big cities could receive huge requests for broadband grants from cities that see this as the chance to solve the urban digital divide. I know that $42.5 billion is a lot of money, but it's not going to stretch as far as Congress might have believed if every major city sees this as a chance to bring fiber to low-income neighborhoods.

The language is interesting in that it allows for bringing either WiFi or reduced-cost broadband. The term WiFi suggests wireless signals that floods hallways and common areas in apartment buildings. It's a nice thing to have, but it is not the future-looking broadband that is needed looking out into the next twenty years.

e-Connectivity Grant Program

In March of 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.

Community Connect Grants[31]

This program specifically targets the poorest parts of the country and areas with little existing broadband. 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.

EDA Grants

The U.S. Economic Development Administration (EDA) has been able to make broadband grants in the past – often as part of larger economic development initiatives. EDA grants are reserved for the poorer parts of the country, based upon wages in a region.[32]

There is no EDA grant program that is specifically aimed at broadband, but rather there are several grant programs that are aimed at general economic development activity. We know localities, such as in coal country in Virginia, that have been able to get some significant EDA grants for broadband expansions.

Currently, the EDA is administering funding from the FY 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act. The EDA is currently making grants on a first-come, first-serve basis from about $150 million in broadband funding. The projects must already be shovel-ready and ready to begin immediate implementation.

Other CARES funding has been given directly to the states in the form of block grants. Some of the CARES funding specifically targets broadband relief for issues directly related to the current pandemic. For example, some states are using some of this money to provide hot spots for the general public in areas with poor broadband, are providing computers and tablets to K12 students who have to work from home and are even buying temporary wireless hotspot plans for K12 homes that need connectivity during the pandemic.

Other 2021 Grants

There are numerous grants that can be used for broadband and broadband-related areas in the community that came out of the $1.9 trillion American Rescue Plan Act (ARPA). Consider the following examples of grants made to libraries and to schools – some of which can be directed to build broadband or tackle the digital divide.

[31] https://www.rd.usda.gov/programs-services/community-connect-grants

[32] This website shows the current EDA assistance programs. The website is updated frequently. https://www.eda.gov/funding-opportunities/

Broadband Grants for Libraries. There were a number of different grants created specifically to help libraries by the $1.9 trillion American Rescue Plan Act (ARPA). This includes the following:

ARPA allocates $200 million 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.

Libraries are also eligible to apply to the $7.172 Emergency Connectivity Fund that the ARPA is funding through the FCC's E-Rate program. This program can be used to compensate for hotspots, modems, routers, laptops, and other devices that can be lent to students and library patrons to provide broadband. Just like with the school E-Rate funding, if a library follows some of the rules, at least some of this could be used to fund broadband infrastructure.

ARPA also includes $350 billion in funding for Coronavirus State and Local Fiscal Recovery Funds (SLFRF). This is the funding that goes straight to states, counties, cities, towns, and townships. Local governments are allowed to use any of this money for libraries and for local broadband in general.

There is another $130 billion aimed at offsetting the costs associated with reopening K-12 schools to be used for hiring staff, reducing class sizes, and addressing student needs. The funds can also be invested in technology support for distance learning, including 20% that can be used to address learning loss during the pandemic. This funding will flow through the Department of Education based upon Title I funding that supports schools based upon the level of poverty.

Another $135 million will be flowed through the National Endowment for the Arts and Humanities to support state and regional arts and humanities agencies. At least 60% of this funding is designated for grants to libraries.

There is also tangential funding that could support libraries. This includes $39 billion for Child Care and Development Block Grants and Stabilization Fund plus $1 billion for Head Start that might involve partnerships with schools and libraries. There is also $9.1 billion to states and $21.9 billion for local programs for afterschool and summer programs to help students catch back up from what was a lost school year for many.

Grants for Schools. Following are the major new sources of funding available to schools.

Emergency Connectivity Fund. ARPA provides $7.172 of funding through the FCC's E-Rate program. This program can be used to compensate for hotspots, modems, routers, laptops, and other devices that can be lent to students and library patrons to provide broadband. This can also be used as a supplement to the use of E-Rate funds to replace leased transport with fiber.

ARPA Elementary and Secondary School Emergency Relief Fund (ESSER III). This provides 122.8 billion for the following uses:

- Any activity authorized by the Elementary and Secondary Education Act of 1965, the
- Individuals with Disabilities Education Act, the Adult Education and Family Literacy Act, and the Carl D. Perkins Career and Technical Education Act of 2006.
- Activities to address the needs of low-income children or students with disabilities,
- Developing procedures to improve the preparedness and response efforts.
- Training on sanitation and minimizing the spread of infectious diseases.
- Purchasing supplies to sanitize and clean the facilities.
- Providing meals to eligible students, providing technology for online learning to all students.
- Purchasing educational technology (including hardware, software, and connectivity) to support remote schooling.
- Providing mental health services.
- Summer learning and supplemental afterschool programs.
- Addressing learning loss due to COVID.
- School facility repairs and improvements.
- Inspection, testing, maintenance, repair, replacement, and upgrade projects to improve the indoor air quality in school facilities.

ARPA Emergency Assistance to Non-Public Schools (EANS II). Similar to ESSDER III, but for non-public schools. Provides $2.75 billion for non-public schools. The uses are similar to those of ESSEN III.

ARPA Special Education Fund. $3 billion was allocated to support special education.

Other Infrastructure Grants There are also new possibilities from the Infrastructure Investment and Jobs Act. In addition to broadband, the federal infrastructure plan has created a big pool of grant funding to beef up the electric grid. One of the key elements of improving electric grids is to connect substations, generation facilities, and other local electric infrastructure to fiber. Any such investments can be combined with other broadband funds to help pay for a network. Another possibility out of the program is that the huge money being allocated to fixing roads could also include building conduit.

Broadband Adoption Grants

The Infrastructure Investment and Jobs Act (IIJA) created two new grant programs to address digital equity and inclusion. This section of the IIJA recognizes that providing broadband access alone will not close the digital divide. There are millions of homes that lack computers and the digital skills needed to use broadband. The grant programs take two different approaches to try to close the digital divide.

The State Digital Equity Capacity Grant Program will give money to States to then distribute through grants. The stated goal of this grant program is to promote the achievement of digital equity, support digital inclusion activities, and build capacity for efforts by States relating to the adoption of broadband. I haven't heard an acronym for this grant program – it's likely that each state will come up with a name for the state program.

The Act allocates $1.5 billion to the States for this program – that's $300 million per year from 2022 through 2026. Before getting any funding, each state must submit a plan to the NTIA on how it plans on using the funding. States will have to name the entity that will operate the program, and interestingly, it doesn't have to be a branch of government. States could assign the role to non-profits or others.

The amount of funding that will go to each state is formulaic. 50% will be awarded based upon the population of each state according to the 2020 Census. 25% will be awarded based upon the number of homes that have household incomes that are less than 150% of the poverty level, as defined by the U.S. Census. The final 25% will come from the comparative lack of broadband adoption as measured by the FCC 477 process, the American Community Survey conducted by the U.S. Census, and the NTIA Internet Use Survey.

The second new grant program is called the Digital Equity Competitive Grant Program. These are grants that will be administered by the NTIA and awarded directly to grant recipients. The budget for this grant program is $1.25 billion, with $250 million per year to be awarded in 2022 through 2026.

These grants can be awarded to a wide range of entities, including government entities, Indian Tribes, non-profit foundations and corporations, community anchor institutions, education agencies, entities that engage in workforce development, or a partnership between any of the above entities.

This will be a competitive grant program, with the rules to be developed by the NTIA. While the broadband infrastructure grant in the Act includes a long list of proscribed rules, Congress is largely letting it up the NTIA to determine how to structure this grant program.

The two grant programs create an interesting choice for entities involved in digital inclusion. They can go after funding through the state or compete nationwide for grants. I doubt that anybody can make that decision until we see the specific grant rules coming out of each program.

State Grant Programs

Illinois Office of Broadband

The Illinois Office of Broadband was founded in September 2019 and is housed within the Illinois Department of Commerce and Economic Opportunity. The Illinois Office of Broadband is in charge of administering the Connect Illinois broadband infrastructure grant program. The Illinois Office of Broadband provides broadband services from infrastructure to utilization, public funding, and private deployment. The office is used as a resource for individual customers, local communities, various state agencies, and broadband providers.

The Illinois Office of Broadband has forged strategic partnerships, including with the Benton Institute for Broadband & Society, Illinois Innovation Network, the University of Illinois Extension Services, National Digital Inclusion Alliance, and PCs for People. The Office of

Broadband also works closely with the Department of Innovation & Technology, the Department of Transportation, and the State Board of Education.

Connect Illinois

In August 2019, Governor Pritzker launched the Connect Illinois grant program. Connect Illinois includes:

- A capital investment of $400 million from Rebuild Illinois.
- The creation of the Broadband Advisory Council and Broadband Office.
- Rebuild Illinois includes $20 million for the Illinois Century Network (ICN) to repair and expand the broadband network for schools, refresh aged components of the network and expand the existing network, focusing on the K-12 portion.

The primary stated purpose of Connect Illinois is to use as competitive matching grants.

The fund already held one round of grants and awarded $50 million in 2021, with larger grants coming later in 2022. Eligible areas of the grant include unserved areas defined as fixed broadband internet service with speeds less than 25/3 Mbps and underserved areas defined as areas with current speeds of 25/3 Mbps but less than 100/20 Mbps. A grant project must provide speeds of at least 25/3 Mbps but must be scalable to speeds of 100/100 Mbps in the future. Applicants can request up to $5 million per project, with at least 50% of total project expenses must be provided as a nonstate match. Grant projects must be completed within two years.

Loan Guarantees

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks are required to offer a significantly lower interest rate.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, 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 some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

There are several federal agencies that might be willing to make loan guarantees for telecom projects. The following agencies are worth considering:

HUD 108 Program: The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the state to administer. While these loans and loan guarantees generally are housing-related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income

households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project.

Small Business Administration 504 Loan Program: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.

USDA Business and Industry Guaranteed Loans (B&I): The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

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, but in essence, there are entities around the country each year that are awarded tax credits and these entities work as brokers to allot the credits to specific project. The credits are often purchased by the large banks or other firms that invest in infrastructure.

Generally, in practice, these funds act like a mix of loans and credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the seven years of the tax credit and would then 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.

Customer Financing

When no ISP or municipality is able to finance a project, we've seen citizens to step up and agree to somehow directly fund some or all of a broadband project. When you consider that the cost of building rural fiber, getting some assistance directly from potential customers is sometimes the only solution that can attract the rest of the needed funding.

Property (or Other Kind of Tax) Revenues. It is possible to obtain some or all of the cost of a broadband network through a pledge of future tax revenues. That pledge can then support a bond. This is different than most bonds for a broadband network where the network would be secured by revenues of the broadband venture. But a pledge of some other kind of tax revenue is one of the easiest ways to get a bond. 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. The project is a win/win for citizens. Property taxes increased about $25 per month per household. The township provides inexpensive access to the network to the cooperative which is offering attractive customer rates.. This area had no broadband before the project.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Many of the member towns have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of their fiber network using a federal grant awarded from the Stimulus funding program in 2008. The county held a referendum and used a sales tax increase to finance bonds to pay for the matching funds needed to build the project.

Direct Customer Contributions: It's also possible to pay for some of a broadband project through direct contributions from potential customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware 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 to a fiber network if they 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 are what makes 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 in the long run a bond makes a project cost more in terms of cash. The safety of a bond in the first few years can be very attractive.

Combining Public and Private Financing. There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes from 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 can work 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 hits 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 projects, and the required funds can easily exceed the ability of a local government to fund it 100%.

Following are two examples of this type of PPP, both from Minnesota:

- RS Fiber: RS Fiber is a new 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, MN: 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.

IV. OTHER ISSUES

A. Community Engagement Plan

This section of the report will discuss a community engagement strategy. This strategy will cover three different aspects of community engagement:

- Bringing the public and elected officials into the process. If the community is going to tackle the various aspects of the broadband gaps and the digital divide, then it will be important to engage the public to support the effort.
- Finding the resources to accomplish broadband goals. Almost any broadband solution is going to need some local effort to accomplish the needed tasks.
- Ongoing Deployment Efforts. Finally, the report will look at any possible ongoing deployment efforts.

Consumer Education

One important aspect during both phases of community engagement is to provide useful information to help the public better understand broadband issues. We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not many people will wade the whole way through a report of this size it's been written for anyone in the community to read.
- Hold Public Meetings. Public meetings can be held to explain the results of this study, or meetings could be more generic and be aimed at explaining broadband issues. It's important to have elected officials at public meetings so they can directly hear the kinds of issues that households and businesses have with existing broadband. It's vital to advertise heavily to drive attendance at meetings. CCG has been to a community meeting with only one attendee, and to others that were standing room only in a large room.
- Broadband Web Site / Social Media. Many communities create a broadband web page or accomplish the same thing using social media. 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." Such a website can also inform the public about upcoming events or other things the government wants to advertise.[33]
- Gather List of Broadband Proponents. One important resource is to create a database of local broadband proponents – citizens who say they support broadband. Having a list of emails, home addresses, and phone numbers will be useful when it's time to gather support for public actions.
- Broadband Newsletter. Communities often create a newsletter dedicated to broadband. A good newsletters should be aimed at educating the public on topics related to broadband, and 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 organization outreach. This means sending a spokesperson to meetings of the local organizations to talk about broadband issues and to answer questions. This could be all types of local groups – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time

[33] An example of an effective community broadband website can be found at https://falmouthnet.org/. This is a community that is still in the process of trying to fund and build a fiber network.

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 or who have specific knowledge about broadband.

Engaging with Public Officials

The process of bringing public officials into the process is something that is generally unique to every community and is something that most communities already know how to do since local governments tackle numerous other topics that are as complicated as broadband. Some of the steps we see communities take with elected officials are:

- Basic Education. This involves the same kinds of steps used to inform the general public. That might include a presentation of the results of this study and making this report available.
- More In-depth Workshop. Elected officials often conduct workshops where elected officials can hear more about and ask questions about topics. These typically are sessions where no votes are taken.
- Engagement on Specific Tasks. Many communities get active engagement from elected officials in the process of investigating broadband. For example, it's not unusual for a few elected officials to participate in a broadband tasks force or committee.

Staffing for Community Engagement

Both phases of community engagement require some level of staffing to be successful. Both phases require a focused and persistent effort, so it's important to identify the staffing needed to be successful. We've seen many efforts to get community buy-in fizzle when nobody was dedicated to the community engagement tasks. We've seen the following ways that communities have staffed the effort.

- Dedicated Government Staff. The most expensive option, but one of the most effective, is to dedicate government staff to concentrate on broadband community engagement. That requires a commitment by elected officials to fund the effort. This would typically not be a permanent position, but rather somebody dedicated to the effort for some fixed time. This is also not a 9 to 5 job since interfacing with residents and organizations often means evening meetings.

  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 top priority. This economic development leader spearheaded the first phase of the process – educating the public on the issue of broadband. This particular area had towns with okay broadband from a cable company and rural areas with little or no broadband. The economic development director met with everybody imaginable in the area, including other city governments, county governments, state representatives, and every civic and social group imaginable. After two years of tireless work by this one staff person, the communities in parts of two counties agreed on a broadband solution. This would never have happened without this one dedicated staff position.

  It's worth noting that this is a function that could be funded through the ARPA funds received by communities. Planning for implementing a broadband solution is a legitimate use of those funds. There are also other federal and state broadband adoption grants that could be used for the same purpose.

- Volunteers. Volunteers are also an important part of this effort. Every community seems to have some people who really hate the state of the existing broadband and who are willing to volunteer time to hunt for a solution. In the example given above, the economic development director assembled a group of active volunteers to help with the effort to engage with and educate 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 have some structure and is working with a staff person can make sure such a group stays focused. If a community decides to engage volunteers, there should still be a commitment to providing some funding. In the case of the Minnesota effort, local governments funded the effort required to canvass and survey the communities. This included several rounds of mailing postcards asking homeowners to pledge support for broadband.

- Broadband Task Force. Another approach is to create a formal committee or task force to explore the issues around community broadband. These task forces are generally composed of both citizen volunteers and a few elected officials. Such a group is going to be moist effective if tasked with solving specific projects. It's normal that such a group would report back regularly to the government about their progress. Such a group can collectively take on some of 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 additional volunteers.

  Such groups are usually given a budget but also restrained by needing to have expenditures pre-approved. We could write pages on the dos and don'ts of operating a successful citizen's advisory group. Most communities are familiar with the idea through having used similar groups for other community efforts. The main key for success is to make sure that the group has a specific agenda, a specified budget, and the specified authority to meet their goals. A task force can accomplish great things if they are properly directed to do so – but can stray if not given good direction.

Deployment Efforts

There are many areas where community engagement can turn into actionable results through the good use of full-time staff, tasks forces, or community volunteers. Following are some of the key tasks that might be accomplished through the community engagement process.

Setting Broadband Goals and Policies.

We have found that it is extremely useful for any local government that wants to move forward with broadband to first establish clear goals for getting better broadband. Specific goals are needed, for example, before a community can decide if it's better to build broadband, look for a partner, or look for an ISP to bring a turn-key solution. Without specific community goals, it's going to be hard to analyze any offers made by potential partners. A well-thought-out set of goals provides the framework needed to provide a basis for making decisions about broadband.

We would add one word of caution in that a broadband task force is going to tend to be composed of those who are totally gung-ho on getting a fiber solution. It's important to bring other community opinions into

the process of setting final goals. But getting this process started is something that can be asked of a task force or other kind of volunteer group.

Gather a List of Broadband Supporters. If there will be any organized citizen outreach, it will prove to be worthwhile to begin assembling a list of citizens who support getting better broadband. Many grants require a significant showing of public support, so gathering a list of supporters provides a way to quickly get letter or support needed for grants.

More importantly, gathering a list of supporters provides a way to start demonstrating to an ISP that there is demand for better broadband. To give an example, the City of Bristol, Virginia was one of the first municipalities to build a fiber network. The City had no idea how many customers it might get, so a year prior to starting construction, the City put a sign-up logbook in the lobby of the utility and put a simple interest form on its web site. The City didn't advertise these efforts other than employees telling customers about it. By the time construction started, the City had gathered interest from over 30% of households who were interested in buying fiber if the City built the network. It turns out that nearly every home on the list bought fiber when it was offered.

At the time, the City didn't have a name for this effort, but we'd now call this pre-marketing. We don't think you would have tackled this feasibility study with a strong sense that people want better broadband. Gathering non-binding commitments from households is one of the most powerful tools that can be tackled during the community outreach phase of the project. It's a lot easier to attract an ISP partner (or decide to tackle this yourself) if you have specific evidence that many homes are ready to buy better broadband.

Making It Easier to Build Fiber

Many communities have developed processes for working with existing utilities that can be a hindrance for somebody trying to build a widespread network. The processes that affect building a new fiber network include things like gaining access to rights-of-way, permitting, identifying existing buried facilities, construction rules, and post-construction inspection.

It's not unusual that some of these processes in place were developed over the years in response to behavior of a cable company, a telephone company, the electric company, or others. Existing utilities rarely tackle major construction projects, but instead made small incremental changes to infrastructure to respond to changing demographics. Rules that might be reasonable for the electric company might be a barrier to somebody wanting to build fiber everywhere. As an example, one of my clients went to build in a town and was told that it had to submit a separate permitting request for each pole in the network. This greatly slowed down the permitting process and the whole project. We can only imagine at some time in the past that somebody in the city had changed the process in response to getting a permit request for a lot of poles. Likely this change was implemented by staff at a lower level than the city council – but informal policies implemented by staff tend to become hard and fast rules over time.

Most communities have not seen a citywide utility construction project since the cable companies built in the 1970s. We strongly recommend that the local government review these policies for reasonableness before the start of any major broadband project. After all of the work to attract better broadband, the local governments should not have any impediments in place to enable the construction of a new network. We would caution that any changes in policy made to accommodate a large construction project will also

apply to other utilities. Most communities that have done this review realize that processes over time have drifted from the ideal.

This is the kind of review that can be given to a few technical volunteers who might compare your processes to those in a few other communities that have built fiber. Ultimately, it's likely that a few ordinances might be needed to update the processes.

If the County Might Become the ISP

The RFP didn't take the possibility of the County being an ISP off the table. If you decide that the best solution is to find an ISP partner or partners, there is a section below in the report that describes how other communities have gone about that process of finding ISP partners. However, if you want to further consider the government-owned network approach, there are some natural next steps that you should consider that are similar to what an ISP would consider if contemplating coming to your market. Most of the next steps towards becoming an ISP ought to be tackled by staff, but there are a few tsks that ware well suited to tackle as part of community outreach.

Statistically Valid Surveys. The survey for this project was conducted on-line and is not statistically valid. That doesn't it's not valuable, because they surveys told us a lot about how the public feels about broadband. However, the most important thing that anybody contemplating becoming an ISP wants to know is the potential market penetration rate – how many people might buy service on a new network. That can only be quantified with a statistically valid survey. An early next step for any ISP would be to tackle a survey.

It's a challenge conducting a valid telephone survey in a rural area because it's often impossible to get a list of telephone number for the folks living only in the areas that will get new broadband. An alternative is to conduct a door-to-door survey with volunteers. It's important that a survey be conducted randomly, but there are techniques that can be used to get a valid sample when knocking on doors.

Canvass. A canvass is similar to a survey but has the goal of reaching as many people as possible in the proposed service area. A canvass can be conducted in many ways through mailings, phone calls, knocking on doors. We've seen communities engage groups like the PTA and service organizations to get people to participate in the canvass. We've worked with communities where volunteers were able to reach out to almost everybody in a planned broadband areas.

A canvass is even better than a survey if it's done well and gets to a large percentage of households. The primary reason for undertaking a canvass be to get residents and businesses to pledge to buy broadband if a network is built. Such pledges are typically non-binding but can provide good support when the community is looking for funding. A canvass is also effective to let the public know what the county is considering.

Collaboration

One of the most interesting things about the current federal broadband grants is that they give a preference to partnership and collaboration. This means that a grant request from a standalone ISP or a local

government is not going to get as much consideration as a grant that involves a wider collaboration of stakeholders.

By collaboration, these grants are not talking about just getting letters of support – which is still important. Collaboration means creating groups of stakeholders that together take a role in finding, funding, and operating a broadband solution.

Collaboration means bringing in stakeholders like utilities, schools, libraries, health care facilities, non-profits, and the business community. Collaboration also could mean working with neighboring counties or communities to bring a solution to a larger geographic footprint. Collaboration also could mean the creation of public-private partnerships or public-public partnerships.

There are several reasons why collaboration is important. First, some of these entities have access to grant funding that can help with a larger broadband solution. As an example, schools are now allowed to apply E-Rate funding to build fiber if doing so can reduce the long-term cost of a broadband solution. Local utilities might be able to get some smart grid or smart water funding to help pay for a larger broadband network.

Following is more discussion on some of the more important collaboration partners to consider.

Collaboration with Major Stakeholders

Electric Utilities. Rural electric companies almost all see the value of connecting electric substations, generation facilities, and other key infrastructure to a private fiber network. This means that the local electric company can be an important key customer of a new rural fiber network and is probably willing to provide funding to help pay for the new fiber. Finding the matching funds for grants is often a challenge and getting unexpected matching from an electric company can be a game changer in affording to build a network.

Electric companies learned a valuable lesson thirty years ago when much of the country suffered significant and widespread power outages – some that affected as much as half of the country. They learned that outages were made worse because the utilities were not closely monitoring the local power grid and didn't have any systems in place that could react quickly enough to pinch off rolling blackouts and brownouts. In many cases, the remedial actions needed must happen within seconds or minutes – and electric utilities realized that means having their own communications networks separate from the typical ISP networks.

The newest concept for electric grids is being labeled as smart grid. Smart grid technology started over 25 years ago when utilities asked customers for the ability to turn off power-consuming devices like air conditioners during days when the electric grid was under stress. The first-generation technology was basically not much more than an on/off switch for the air conditioners or heat pumps that could be activated remotely by the electric company. This was one of the innovations that was put into place to reduce electrical demand which contributed to the big rolling brownouts.

Over time smart grid has grown to be a lot more sophisticated. For example, electric companies now offer smart thermostats where the electric company will help customers save money while also providing for

the original function of acting as a safety valve for turning off devices during network stress. The smart thermostat is not really smart and the brains that control the device are in the cloud and controlled by the electric utility. A smart meter can perform a range of cost-saving activities. For instance, the technology can automatically turn the temperature down when residents go to work or sleeping and turn it back up when people are active in the home.

Smart grids are also becoming necessary to integrate customer-generated electricity from solar and other alternative energy sources. Those sources of energy are a major disruption for the power grid, and managing alternative energy is a complicated endeavor for even small electric grids.

Electric utilities are introducing new technologies to control their costs even further. Some are selling battery storage for homes and businesses that can store power from solar panels or even from the grid. The utility can dip into the stored power when needed rather than buy power externally and can save a lot of money. The utility can also use excess power at times when power costs are at the lowest to charge the storage devices.

Water Utilities. Water utilities have the same needs to monitor key locations in their network. They want to be able to communicate with pumps, water towers, waste treatment plants, and any other key locations where the utility wants to track water flow, wants to monitor the performance of facilities, or wants to control devices like pumps. Placing monitors throughout the system can solve a few problems that water systems typically have:

- Some percentage of water meters on most systems are inaccurate and are underbilling for water. Monitoring and comparing the amount of water billed versus what is delivered to various parts of town can help to identify where meters might be faulty.
- All water systems lose water through leaks into the ground. A monitoring system can be used to quickly identify big water leaks. Cities can easily identify big above-ground leaks but often don't know about underground leaks. More insidious are slow steady leaks, and it's not unusual for older water systems to lose 20% or more of water per year to slow leaks. A well-designed monitoring system that compares flows per route can identify routes with these problems.

Loss of water leakage into the ground is becoming an important and expensive problem in many communities. It has become apparent that underground water leaks can cost a utility huge amounts of money, and so water companies have been expanding the use of flow meters to be able to pinpoint the location of new water leaks.

Gas Utilities. Gas company monitoring is similar to what's done with water systems, except that there is a host of additional sensors in the system checking to identify gas leaks. Gas utilities not only measure gas pressure and flows, but they generally have sensors that can 'sniff' leaked gas at key locations.

Schools. All of the schools in the county have fiber broadband. However, like most schools, broadband is purchased from ISPs. Schools typically buy gigabit or larger broadband connections, which are relatively expensive. Broadband costs for schools have two components – transport and bandwidth – with the expensive component usually being transport. Transport is paying for the miles of fiber needed to reach the schools. School systems often connect each school back to a central hub, and this connectivity can mean a lot of miles and a lot of cost.

Many communities have been able to reduce these costs by building government-owned networks to connect schools. This eliminates the monthly recurring costs for transport, although bandwidth will always need to be purchased.

There are grant opportunities through the FCC's E-Rate program and elsewhere that can help to pay for the transport, particularly to rural schools and to schools with a significant portion of low-income students. We're seeing communities that are adding schools into the coalition to get a fiber broadband solution because every mile of fiber built with a funding source like through the schools doesn't have to be financed in some other way.

Libraries. Libraries have some of the same opportunity to pursue some limited fiber construction, particularly rural libraries. However, the biggest collaboration with libraries comes from the availability of a number of grant programs that can be used to buy computers and to train the public on how to use broadband.

Health Care Facilities. Rural health care facilities have some of the same possible options to fund some fiber. The main benefit of partnering with healthcare facilities as part of a coalition is that they help to form part of the key anchor institutions that any ISP wants to know is possible – this helps justify building the fiber. It's also likely that a new fiber network will result in lower broadband rates for rural healthcare facilities.

Non-Profits. With the large amounts of funding available to tackle digital literacy, it makes sense for the county to reach out to non-profits that can help to solve the digital divide issues discussed elsewhere in the study. Non-profits might be willing to seek grant funding to tackle digital literacy training, or tackle projects to get computers into homes that need them.

Housing Authorities. There is currently grant funding available to install fiber in low-income housing. This could include the fiber wiring and electronics costs inside a large low-income housing project, or the fiber used to connect buildings in a low-rise complex.

Local Government. Local governments are often surprised to find out that they are among the biggest broadband customers in rural communities. In areas that are predominantly farming and rural residents, local small towns and the county government might be the biggest buyers of broadband in an area. Local governments are usually keen to get connected to fiber, particularly if they suffer with slow broadband.

There are several reasons to bring local governments into any broadband collaboration or coalition.:

- The final American Rescue Plan Act rules make it clear that government can freely use ARPA local broadband funds almost any way that want, with the one caveat that any project must solve issues related to the pandemic. That's never a hard argument to make for building last-mile fiber. Local governments can help to fund a fiber project using ARPA money.
- Local governments can also agree to act as an anchor tenant on a new network – something that is important to an ISP that is building the network.
- Finally, local government support for winning other grants is important and needed. It's always more compelling to provide a support letter showing a collaborative solution rather than a generic letter of support.

Collaborating with Neighboring Communities

The idea of regional collaboration is relatively common in the broadband and utility world. There are numerous examples of collaborations that have been created to save on costs and to achieve economy of scale. For example, there are dozens of regional collaborations that have been created by rural electric companies. These collaborations benefit tremendously by having one administrative staff operating multiple small utilities. There are not as many such collaborations in the broadband world, but we are aware of about a dozen such collaborations where multiple small communities have joined forces to find a broadband solution. There are about a dozen collaborations where telephone companies in a state have joined forces to fund and build a middle-mile fiber network to provide connectivity into rural areas.

All of these collaborations were created to take advantage of economy of scale. That is an economics term that describes how any utility-type business will be more efficient with greater size. It's easy to understand economy of scale. If an ISP was going to be created to serve the rural parts of the county, the new business would have hire a backoffice staff like a general manager and an accountant. This same new business could also serve the county next door without having to duplicate these positions. This kind of economy of scale works through many aspects of operating a broadband business. Most functions of an ISP are more cost-effective when spread across a greater number of customers.

B. Adoption and Utilization Plan

Finding a Partner

This section of the report discusses how the County might pursue finding a partner. The steps are largely the same whether you're looking for a commercial ISP partner or a municipal ISP partner.

The Best Characteristics for an ISP Partner

Experience. We know of several investor-driven ISPs that want 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 the lack of experience by the ISP partner. In the following two examples, the ISP management team was made up of folks with industry experience but who had never worked together as an ISP 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 supposed. 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. More importantly, it took a new management team that grasped the best way to operate an open-access network.

- Another example is Lake County, Minnesota. This is one of the northernmost counties in the state and quite remote. There are 11,000 residents in 2,100 square miles. The County decided to borrow money to build a county-wide fiber network. They hired an outside firm to construct the network and run the ISP. The management team did a terrible job of managing the project. The project went far over budget and ran out of money with a backlog of almost 1,000 customers that couldn't be connected to the network.

  The project was funded through a combination of a $10 million federal grant and a low-interest rate government loan for $56 million. The county also sold over $7 million in bonds and also made direct loans to the new business. The project roll-out went disastrously, and the project ran out of money before getting many customers connected. The project went 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 must still continue to make payments on the original bonds plus repay the internal loans made to the project.

Experience Working with Municipalities. Priority should be given 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 government 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 a topic for a public meeting, waiting for a period of time, and allowing public comment on the issue. Commercial ISPs are used to making decisions quickly and 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 too quickly.

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 usually most focused on cash flow and profit margins. If an ISP has invested equity in a broadband network, it becomes unhappy if the business doesn't meet the expected 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 non-profits 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 difference between the government and a commercial ISP often surfaces when there is a discussion of rates. Cities often push back against rate increases – particularly in election years. Cities generally push partners for low rates and often want an ISP to provide subsidized rates for low-income households and even free service to groups like non-profits.

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.

Financial Strength. Municipal entities often have a hard time judging the financial strength of a partner. Unfortunately, most public/private partnerships are not made 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 company 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 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 often get stressed to the breaking point when they try to grow too quickly. It's not unusual for an ISP to somehow assume that existing middle and upper management can handle a growth scenario while still 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. I think 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, that 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 conduits, 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 forego property taxes to lure a business to locate in 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 partner and that contribution should be valued fairly. 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 one of the following 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 study) 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 probably won'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 the 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). An 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 deeper in detail and ask about the financial strength of the ISP partner and ask how they operate in other markets.

- Direct 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 worth considering these processes 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 about 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 long list of questions. Vendors 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 – such cities are willing to engage in discussions, but not in a written dialogue that creates a publicly discoverable audit trail.

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 with nothing that was discussed put into writing.

Here is the process that we have found to be effective:

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 followed by a meeting where the local government reacts.

The RFI process is a better approach if there are no local ISPs to consider. For example, we worked with a geographically isolated community where there was no local ISP candidate within fifty miles. An RFI made sense since the community didn't have a wish list of local ISPs to consider. An RFI also might make sense for larger communities. In this case, I define larger to mean that the cost of the project is large – perhaps more than $25 million. I've known communities that found an ISP partner through an RFI that they would never have otherwise found.

An RFI 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 happier if the details of their business are not put into writing at the early stage of meeting and negotiating.

I think an RFP only makes sense for larger cities – probably those with network costs over $100 million. It's not likely that a small ISP will respond to such an RFP. Even in an RFP probably shouldn't ask for sensitive financial information about the ISP – that can always be provided after the likelihood of a partnership becomes apparent.

Establishing Compatible Goals

At some point during the early 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 public-private partnerships 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 or profits. It wouldn't be unusual for an ISP partner to eventually want the option to buy the business. But an ISP might have the opposite intention and be hoping to flip and profit from the business in a few years.

It's important for a municipality to fully understand an 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 an ISP is telling you about their goals.

An alignment of goals is probably a make-or-break issue for 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 with less impact such as, "What's your process of disconnecting customers who don't pay?"

I 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 own priorities and expectations. 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?"

Questions that might disqualify a potential partner might be similar questions, again based on the specific priority and goals of a given community. Keep in mind that some of the items in this category might be subject to negotiation – something that should be asked.

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 shouldn't be addressed until it looks like both sides are serious about moving forward. You choose a partner based upon the most important aspects of the relationship – the other facts can be filled in when a partnership is on the table.

There are several techniques that are used to rank potential partners. Most rankings 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. A ranking process generally is aimed at creating a numerical value that reflects the composite opinion of those doing the ranking. Numerical rankings should not be so rigid that this is the only way to rank partners – but it's an important step.

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 the tasks needed for launching and operating the upcoming broadband business. The level of detail usually becomes readily apparent. For example, if 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 the construction the new network, issues having to do with governance, and issues having to do with operating the business.

The responsibility for each task must be assigned. 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 vendor). This kind of checklist can quickly show if the two parties are aligned and agree on the responsibilities or if there are tasks where the two sides have a different view.

Making this checklist 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 biggest challenges faced by municipalities in partnerships with ISPs is the question of maintaining some local control to ensure long-term responsiveness to local needs.

One of the best ways to tackle this question is for the municipality to make a list of aspects of the businesses where they would hope for some local control. It's likely that a list will include major aspects of operating the business such as setting rates, installation intervals, business hours, priorities of repairing customers after an outage, etc. I would then ask the municipality to change hats and look at these same issues from their perspective of the ISP, who is trying to run a profitable business. This exercise often highlights that at some tasks where ISPs can't relinquish control.

One of the stories I tell about politics and local control concerns 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 as a utility. 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 as was warned, the utility was unable to meet a bond payment due 6 months later. The city got the message and raised the rates to a higher level than the original rates to correct the shortfall. The city also changed its 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 new broadband business. Politicians might make promises to constituents on behalf of the ISP. Politicians often press the ISP 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 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 know 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-broadband 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.

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 funds the network. This is why you must ask all of the questions before creating a 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 the municipality will push the limits.

Creating A Collaboration

An earlier section of the report suggests that creating a collaboration makes it easier to get grant funding. The current large federal grant programs promote the idea of community collaboration. This begs the question of how to best build a community collaboration.

There are two distinct types of collaborations. Once is a collaboration that brings together stakeholders that are going to work together to attract the grant funding to pay for a new network. The other kind of collaboration is multiple communities joining together to create a larger broadband project.

Creating a Funding Coalition

Local government agencies often work together to seek funding, but a broadband coalition will be something new and unique because of the wide array of different stakeholders that probably have not worked collectively before. Any collaboration starts with whatever entity is going to be the ISP, be that a commercial ISP or the local government. The other stakeholders might include local governments, local housing authority, schools, libraries, the electric utility, the water utility, a gas utility, and possibly larger non-profits.

Putting together a coalition requires a lot of organizing work. We've helped to create such coalitions, and the workload involved is going to be something like the following:

> Feasibility. You'd want to start with a feasibility report like this one that quantifies the cost of the broadband network and that quantifies the amount of grant funding needed.
>
> Find Funding to Assemble the Coalition. As you'll see from the following steps, there is a lot of work involved in assembling a coalition. In our experience, this is going to require nearly a full-time person for some amount of time from a few months or longer. The first step is to identify the person that is going to tackle the coalition and figure out who is paying for the effort.
>
> Develop the Vision. Somebody needs to put together the overall vision of how the project benefits the community as a whole. This needs to then be followed by a vision of how the project benefits each stakeholder you want to join the coalition.

Selling the Idea to the Stakeholders. The next step is to sell the idea to the stakeholders and to paint a picture to them about why it's beneficial to work together. This means a lot of meetings and calls.

Pulling the Stakeholders Together. It seems likely that you'll want to have at least a few meetings where stakeholders talk about how to make the coalition work effectively. There will be a lot of communication and coordination between coalition members. If this is a temporary coalition to chase grant funding, there might not be the need to create some kind of organization for the members to join. However, if this effort will stretch over several years it's worth talking about creating some sort of non-profit entity where coalition members join more formally together.

Figuring out Grant Funding. The whole point of the coalition is to bring together multiple parties to find the grant funding. This step means digging deep into the grant opportunities for each stakeholder. How can the libraries find funding that will help? What kind of help can come from the local utilities?

Coordinate Writing the Grants. Funding is rarely accomplished with one big grant, but rather through a series of grants. Anybody who has written grants knows this will be a lot of effort.

Creating a Multi-government Collaboration. The other kind of coalition comes when multiple communities join together to create a larger ISP. Almost all existing collaborations that we know are created to achieve better economy of scale. The larger the ISP that is being created, the easier it is to make it work financially.

From what we've seen, collaborations often grow around one existing hub ISP. For example, the City of Windom in Minnesota operated a municipal cable network since the 1970s. The city upgraded the network to provide broadband over a decade ago, and eventually decided to upgrade to fiber and changed the business name to Windom.net. Some small communities around Windom decided to finance fiber and allow Windom to operate the ISP. These small towns would not have been able to afford to create an ISP on their own and saw the economic sense of the collaboration. There are similar stories associated with most existing collaborations.

There are very few examples of collaborations that were created for the purpose of building broadband that did not start with an existing ISP at the core of the collaboration. We can only think of two such collaborations, and both happen to be in Minnesota.

Southwest Minnesota Broadband Systems (SMBS) is a collaboration of tiny communities which combined have 3,600 residents. The communities all had no broadband alternatives and started meeting in 2007 to see if they could attract an ISP to serve the communities. The consortium was not formally created until the opportunity arose to win a large grant. The newly formed consortium was awarded a big grant in 2009 from the American Recovery and Reinvestment Act (ARRA). This was a one-time grant program that was created as part of the stimulus funding bills created to pull the country out of the 2008 economic recession.

The grant funding still required the communities to raise additional matching funds, but the grants provided enough cash to enable the cities to borrow the remaining funds and to create a business that could

succeed. The newly created consortium hired a management team that built the fiber network and launched the ISP. The network brought gigabit broadband to an area that had no broadband faster than rural DSL before the fiber network.

RS Fiber Cooperative is a consortium ISP that was created to serve a number of small cities and the surrounding rural areas in two rural counties in Minnesota. The consortium was formed when the mayor of one of the small towns decided that his town needed fiber and sent his economic development manager off to find a solution. It took years, but eventually, all of the small towns in the region decided that broadband was something the area needed, and they formally banded together to create a Joint Board, which is a formal government organization in Minnesota that can be created by multiple government entities to solve a common problem.

The Joint Board tried to raise the money to fully finance a fiber-based ISP. However, after almost two years of trying, it became evident that this wasn't going to work as a municipal venture. A few of the cities were unable to make the needed financial pledge to support a municipal bond issue. Even more aggravating, the city and county attorneys from the various cities, townships, and counties were unable to agree on much of anything. The whole effort fell apart.

But the Joint Board didn't give up, and CCG suggested a few alternative business ideas, which included creating a new broadband cooperative. RS Fiber Cooperative was formed by some of the remaining cities (a few dropped out from the original consortium). The plan was to raise 25% of the financing from the cities and the rest from banks. This passed muster with the remaining cities because their pledge for the bonds was much smaller, and the type of bonds changed from general obligation bonds to an economic development bond. The legal squabbling was also greatly reduced due to the change in the form of the bonds.

The RS Fiber story is perhaps the best demonstration of the huge amount of work required to create a broadband consortium from scratch without an existing ISP involved. There were hundreds of meetings and hearings on the issue at the various cities, and the process took years and a huge amount of perseverance. There are not many groups of cities or towns that would have made it through the challenge.

Following are a few of the challenges involved in creating a multi-government coalition.

- Raising bond funding for multiple communities multiplies the complexity of the bond issue. Members likely all have different city and bond attorneys and just herding the lawyers is a challenge. The coordination required for each community to raise money and close financing on the same date is also a daunting challenge.
- In our experience, it's normal to have communities come and go during the process. Some cities will drop out for some reason. Other nearby communities will ask to join when they hear about the coalition.
- One of the biggest challenges for this kind of consortium is governance. Every local government is going to have differing ideas on how the new broadband business ought to work. Getting everybody on the same page for the dozens of important decisions needed to launch a broadband business is hard. The RS Fiber effort spent over a year of wrestling over the location that would house the newly formed business and staff – every community wanted the new jobs in their community. Other issues like broadband prices or the obligation of the newly formed ISP to serve low-income homes can also be contentious.

Our conclusion from the above story is that collaborations are possible but require a lot of effort. We're aware of numerous collaborations that have never gotten past the discussion and planning stage. Most communities already understand what's needed for multiple government entities to work together. Most cities and counties are already part of regional collaborations used to tackle regional problems.

C. Legal and Regulatory Review

Illinois Legislative Review

The enacted broadband legislation over the last three sessions has been fairly minor, with the most important legislation being SB 2135 in 2020, that enabled the funding of pandemic-related broadband solutions.

2021 Enacted Broadband Legislation

HB 122 The Consumer Fraud and Deceptive Business Practices Act[34]

Amends the Consumer Fraud and Deceptive Business Practices Act

- All telephone, cellular telephone, television, Internet, energy, medical alert system, or water services are subject to federal law, and regulation and cannot impose a fee for termination or early cancellation of a service contract if the customer dies before the end of the contract.

SB 919 Broadband Advisory Council Act[35]

The law amends the Broadband Advisory Council Act. It adds four members to the Broadband Advisory Council to represent underrepresented and ethnically diverse communities that are appointed by the governor, including one member from a community-based organization representing the interests of African-American or Black individuals; one member from a community-based organization representing the interests of Hispanic or Latino individuals; one member from a community-based organization representing the interests of Asian-American or Pacific Islander individuals; and one member from a community-based organization representing the interests of ethnically diverse individuals.

2020 Enacted Broadband Legislation

SB 2135 Government Emergency Administration Act[36]

- Establishes the Restore Illinois Collaborative Commission to participate in and provide input on plans to revive the various sectors of the state's economy in the wake of the coronavirus pandemic.

[34] https://www.ilga.gov/legislation/publicacts/102/PDF/102-0112.pdf

[35] https://www.ilga.gov/legislation/102/SB/PDF/10200SB0919lv.pdf

[36] https://www.ilga.gov/legislation/publicacts/101/PDF/101-0640.pdf

- Funded and directed the Broadband Advisory Council to study providing free or affordable access to broadband for all residents through the expansion of the state broadband competitive matching grant program.
- Provides for virtual public meetings for government entities and agencies
- Provides for remote witnessing and notarization
- Provides emergency powers for the governor and the Secretary of State to react to the pandemic.

2019 Enacted Broadband Legislation

HB 62 Enabling Tax-Free Bonds[37]

The legislation appropriates funds from the General Revenue Fund to the Central Economic Development Authority for upcoming fiscal year ordinary and contingent expenses.

Other 2021 Broadband Legislation Considered, But Not Enacted

In 2021 the legislature considered but did not enact some interesting broadband legislation. This included:

- Cable companies being unable to charge more than 5% above the cost of customer modems and routers over the life of any rental agreement.
- Several bills to bring funding to support broadband in low-income homes.
- A prohibition against broadband data caps.
- Creation of a tax credit for the cost of equipment needed for broadband access.

HB 841 (Re-referred to Rules Committee)

Would amend the Public Utilities Act to:

- Provides that cable or video provides shall cease charging customers for modems and routers, whether rented together or separately, when the customer has paid to the provider the wholesale cost of the modem or router, plus a reasonable markup not to exceed 5% of the modem or router's wholesale cost.
- Cable and video providers shall provide notice regarding the discontinuance of rental charges to the customer in each billing statement.
- The notice shall include a disclosure of rights and responsibilities relating to the maintenance of modems and routers.

HB 2384 (Re-referred to Rules Committee)

Would have amended the Public Utilities Act to:

- Requires the Illinois Commerce Commission to establish a Universal Broadband Service Assistance Program.
- The Program would provide a reduction of monthly charges, a reduction in installation charges, devices used in connection to the Internet, or any other alternative assistance or program to increase accessibility to broadband service.

[37] https://www.ilga.gov/legislation/publicacts/101/PDF/101-0029.pdf

- Creates a similar program for low-income residential customers of cable and video service providers.
- Extends the repeal of the Telecommunications and Cable and Video Competition Articles from Dec. 31, 2021, to Dec. 31, 2022.

HB 3275 (Re-referred to Rules Committee)

Would create the Illinois Low Income Broadband Assistance Program Act to:

- Requires the Department of Commerce and Economic Opportunity to establish an Illinois Low Income Broadband Assistance Program to ensure the availability and affordability of broadband service to low-income families to access remote learning and work platforms.
- Program Eligibility
    - No more than 150% of the federal poverty level
    - Annual household income below 135% of the federal poverty level is eligible for free broadband service.
    - Provides a $9.95 a month credit for broadband for families whose annual household income is above 135% of the federal poverty level but no greater than 150%
    - Families that have at least one member on the Supplemental Nutrition Assistance Program (SNAP), Veterans Pension and Survivors Benefit Programs, and other specified assistance programs
- The $9.95 credit can be variable, depending on the size of the family.
- Participants in the Federal Lifeline Program or any other State Internet Service subsidy program shall not be eligible to participate in the Illinois Low Income Broadband Assistance Program.

SB 513 (Re-referred to Assignments)

Would amend the Public Utilities Act to:

- Cable or Video providers shall cease charging customers for modems and routers, whether rented together or separately when the customer has paid to the provider the wholesale cost of the modem or router, plus a reasonable markup not to exceed 5%.
- Cable and Video providers shall provide notice regarding the discontinuance of rental charges to the customer in each billing statement.
- The notice shall include a disclosure of rights and responsibilities relating to the maintenance of modems and routers.

SB 1557 (Re-referred to Assignments)

Would amends the Public Utilities Act to:

- Requires the Illinois Commerce Commission to establish a Universal Broadband Service Assistance Program.
- The program would provide a reduction of monthly charges, a reduction in installation charges, devices used in connection to the Internet, or any other alternative assistance or programs to increase the accessibility to broadband service and broadband Internet access service that the Commission deems advisable subject for the availability of funds for the program.

SB 1564 (Re-referred to Assignments)

Would amends the Public Utilities Act so:

- The holder of a state-issued authorization shall not impose data caps on broadband service provided to households

SB 2229 (Re-referred to Assignments)

Would amend the Illinois Procurement Code

- The Code would not apply to the leasing of State-owned facilities by a wireless carrier

Would amend the Illinois Tax Act

- Creates credit for the cost of equipment and materials used to provide broadband services in Illinois.
- Provides the credit does not apply to equipment and materials placed in service after Dec. 31, 2024.

Would amend the Use Tax Act, the Service Tax Act, the Service Occupation Act, and the Retailers' Occupation Act

- Exempts equipment and materials used to provide broadband services in Illinois from taxation under the Acts.

SB 2247 (Re-assigned to Revenue)

Would amend the Illinois Procurement Code

- Provides the code does not apply to the leasing of state-owned facilities by a wireless carrier

Would amend the Illinois Income Tax Act

- Creates a credit for the cost of equipment and materials used in the business of providing broadband services in a county in the state with a population of fewer than 40,000 people or a township in the state with a population density of less than 50 households per square mile in a county with a population of less than 300,000 people.
- Provides that the credit does not apply to equipment and materials placed in service after Dec. 31, 2026.

Would amend the Use Tax Act, the Service Use Tax Act, the Service Occupation Tax Act, and the Retailers' Occupation Tax Act

- Exempts equipment and materials used to provide broadband services in a county in the state with a population of fewer than 40,000 people or a township in the state with a population density of less than 50 households per square mile in a county with a population of less than 300,000 people.

Illinois Telecom Regulations

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.

Telecom providers and other types of utilities are regulated under Illinois Chapter 220 rules and regulations. The law places the responsibility for regulating telecom on the Illinois Commerce Commission (ICC).

Illinois is one of the few states that still enforce a lot of historical telecom regulations. Most states have largely deregulated telecom companies and carriers, but most regulations are still in effect in Illinois.

There are a lot of regulations that apply only to incumbent telephone when serving in franchised serving areas. But many regulations also apply to competitive carriers that provide broadband, telephone or VoIP service, and cable TV. The following is a list of the specific regulations that govern telecom carriers in the state. Note that the term 'carrier' applies to both incumbent telephone companies and competitive ISPs. This footnote is a link to the full text of each of the regulations cited below.[38]

These rules could come into play depending upon the solution the county finds. If you partner with an established ISP, it should already comply with the regulations. However, if the county were to decide to somehow serve some of the new areas directly or was to partner with other communities or non-profits that are not already carriers, then the new ISP would be expected to comply with the various regulations.

A new ISP in the state needs to understand these rules. For example, the ICC expects ISPs to file tariffs listing the terms and conditions that apply to customers. The ICC expects ISPs to notify customers before increasing rates. Many of the regulations in Illinois don't apply in other states.

The Most Relevant Sections of Chapter 220 Regulations

Applicable to All Carriers

Section 13-202: Telecommunications Carrier

> Telecommunications carrier means and includes every corporation, company, association, joint stock company, or association, firm, partnership or individual, their lessees, trustees or receivers appointed by any court whatsoever that owns, controls, operations or manages, within this State, directly or indirectly, for public use, any plant equipment or property used or to be used for or in connection with, or owns or controls any franchise, license, permit or right to engage in the provision of, telecommunication services between points within the State which are specific by the user.

Section 13-203: Telecommunication Service

- Telecommunication service means the provision or offering for rent, sale or lease, or in exchange for other value received, of the transmittal of information, by means of electromagnetic, including light, transmission with or without the benefit of any closed transmission medium, including all instrumentalities, facilities, apparatus, and services (including the collection, storage, forwarding,

[38] https://casetext.com/statute/illinois-compiled-statutes/regulation/chapter-220-utilities

switching, and delivery of such information) used to provide such transmission and also includes access and interconnection arrangements and services.

- The Commission may, by rulemaking, exclude:
  - Private line service which is not directly or indirectly used for the origination or termination of switched telecommunications services
  - cellular radio service
  - high-speed point-to-point data transmission at or above 9.6 kilobits
  - the provision of telecommunications service by a company or person others with subject to section 13-202.

Section 13-301: Duties of The Commission

- Participate in all federal programs intended to extend universal telecommunication service.
- Order all telecommunication carriers offering or providing local exchange telecommunications service to propose low-cost or budget service tariffs and any other rate design or pricing mechanisms designed to facilitate customer access to such telecommunication service.
- Investigate the necessity of and if appropriate, establish a universal service fund for which local exchange telecommunications can use.

Section 13-804: Broadband Investment

- The Commission has the authority to:
  - Certify providers of wireless services
  - Register providers of fixed or non-nomadic Interconnected VoIP service
  - Require VoIP services to provide hearing and speech disability programs
  - Access information provided to the non-profit organization under Section 20 of the High-Speed Internet Services and Information Technology Act.

Section 4-401: Commerce Commission

- The Commerce Commission shall have general supervision of all public utilities, shall inquire into the management of the business, and shall keep itself informed to the manner and method in which the business is conducted.
- The Commission requires all public utilities to establish a security policy that includes on-site safeguards to restrict physical or electronic access to critical infrastructure and computerized control and data systems.

Sec 13 – 102 : General Assembly Findings

- Universally available and widely affordable telecommunications services are essential to the health, welfare, and prosperity of all Illinois citizens.
- All emergency systems must provide Next Generation 911 services by July 1, 2020.
- Completing the transition to all IP-based networks and technologies is in the public interest to promote innovation, consumer benefits, increased efficiencies, increased investment, and increased competition.

Section 13-306: Certification of Service Authority

All telecommunication carriers must have a certificate of service authority.

Section 13-404

Any telecommunications carrier offering or providing the resale or local exchange of interexchange telecommunications service must first obtain a Certificate of Service Authority.

Section 13-405: Local Exchange Service Authority

Any applicant for a Certificate of Exchange Service Authority must prove it has sufficient technical, financial, and managerial resources and abilities to provide local exchange telecommunications services.

Section 13-502: Classification of Services

- Telecommunication carriers can be competitive, non-competitive, or both.
- Competitive telecommunication carriers occur in a geographic service territory where customers can buy similar services from multiple carriers.

Section 13-505.2: Nondiscrimination in the Provision of Noncompetitive Services.

Noncompetitive services shall be under the same rates, terms, and conditions without unreasonable discrimination to all persons.

Section 13-501: Tariffs

- No telecommunications carrier shall offer or provide noncompetitive telecommunications service or telecommunications service referred to in an interconnection agreement without filing a tariff with the Commission.
- The Commission can impose an interim or permanent tariff on a telecommunications carrier.
- All telecommunication carriers must either file a tariff with the Commission or provide a written service offering that shall be available on the telecommunication carrier's website that describes the nature of the service, applicate rates and other charges, and terms and conditions of service.

Section 13-507.1

The Commission shall not allow any subsidy of Internet services, cable services, or video services by the rates or charges for local exchange telecommunication services, including local services classified as noncompetitive.

Section 4-502: Small Public Utility or Telecommunications Carrier; Acquisition by Capable Utility; Commission Determination; Procedure.

The section outlines the requirements for public utility and telecommunication carrier acquisitions.

Section 4-601: Consumer Protection Laws

The General Assembly finds that consumer protection is vital to the health, safety, and welfare of Illinois consumers.

Section 8-502

The Commission shall set reasonable and just compensation for the sharing of conduits, subways, wires, poles, pipes, or other property or equipment as long as it doesn't cause detriment to other services.

Section 13-301.1: Universal Telephone Service Assistance Program

- The Commission shall by rule or regulation establish a Universal Telephone Service Assistance Program for low-income residential customers.
    - The program shall provide a reduction of access line charges, a reduction of connection charges, or any other alternative assistance or program to increase accessibility to telephone service and broadband internet access.

Section 13-301.2: Program to Foster Elimination of the Digital Divide

The Commission shall require by rule that each telecommunications carrier providing local exchange telecommunication service notify its end-user customers that the customers can elect to participate in the funding of the Program to Foster Elimination of the Digital Divide he or she may do so by electing to contribute, on a monthly basis, a fixed amount that will be included in the customer's monthly bill.

Section 301.3: Digital Divide Elimination Infrastructure Program

- The Digital Divide Elimination Infrastructure Fund is created as a special fund in the State treasury. All monies in the Fund shall be used, subject to appropriation, by the Commission to fund:
    - The construction of facilities specified in the Commission rules adopted und this section.
    - The accessible electronic information program, as provided in section 20 of the Accessible Electronic Information Act.
- The Commission shall adopt rules under which it will make grants out of funds appropriated from the Digital Divide Elimination Infrastructure Fund to eligible entities as specified in the rules for the construction of high-speed data transmission facilities in eligible areas of the state.
- The rules of the Commission shall provide for the competitive selection of recipients of grant funds available from the Digital Divide Elimination Infrastructure Fund pursuant to the Illinois Procurement Code. Grants shall be awarded to bidders chosen on the basis of the criteria established in such rules.
- All entities awarded grant money under this section shall maintain all records required by Commission rule for the period of time specified by the rules. Records are subject to audit by the Commission.

Section 13-302

- No telecommunications carrier shall implement a local measured service calling plan which does not include one of the following elements:
    - The residential customer has the option of a flat-rate local calling service under which local calls are not charged for frequency or duration.
    - Residential calls to points within an untimed calling zone approved by the Commission are not charged for duration.
    - A low-income resident Universal Service Assistance Program, which meets criteria set forth by the Commission.

Section 13-401.1: VoIP Services

Interconnected voice-over-Internet protocol provider shall charge and collect funds from its end user customers.

Section 13-402

The Commission is authorized, in connection with the issuance or modification of a Certificate of Interexchange Service Authority or the modification of a certificate of public convenience and necessity for interexchange telecommunications service, to waive or modify the application of its rules, general orders, procedures or notice requirements when such action will reduce the economic burdens of regulation and such waiver or modification is not inconsistent with the law or purpose and policies of this Article.

Section 13-406: Abandonment of Service

No telecommunications carrier offering or providing noncompetitive telecommunication services shall discontinue or abandon such service once initiated until and unless it shall demonstrate that such discontinuance or abandonment will not deprive customers of any necessary or essential telecommunication service or access thereto and is not otherwise contrary to the public interest. This applies to both large and small non-competitive telecommunication providers.

Section 13-501.5: Directory Assistance Service for the Blind

Telecommunication carriers cannot charge customers who are legally blind for telephone numbers for customers located within the same calling area.

Section 13-503: Information Available to the Public

Telecommunication carriers shall make all tariffs and all written service offerings available to the public.

Section 13-505: Rate Changes

Competitive carriers can change rates but must provide notice.

Section 13-506.2: Market Regulation for Competitive Retail Services

The section outlines the rules for competitive telecommunication carriers to use market regulation for pricing.

Section 13-514: Prohibited Actions of Telecommunication Carriers

- A telecommunications carrier shall not knowingly impede the development of competition in any telecommunications service market.
    - unreasonably refusing or delaying interconnections or collocation or providing inferior connections to another telecommunications carrier
    - unreasonably impairing the speed, quality, or efficiency of the of services used by another telecommunications carrier.
    - unreasonably denying a request of another provider for information regarding the technical design and features, geographic coverage, information of necessary for the design of equipment, and traffic capabilities of the local exchange network except for proprietary information.
    - unreasonably delaying access in connecting another telecommunications carrier to the local exchange network
    - unreasonably refusing or delaying access by any person to another telecommunications carrier
    - unreasonably acting or failing to act in a manner that has a substantial adverse effect on the ability of another telecommunications carrier
    - unreasonably failing to offer services to customers in a local exchange
    - violating the terms of or reasonably delaying implementation of an interconnection agreement entered into
    - unreasonably refusing or delaying access to or provision of an operational support system to another telecommunications carrier
    - unreasonably failing to offer network elements that the Commission or the FCC has determined must be offered on an unbundled basis to another telecommunications carrier.

Section 13-703: Hearing Impaired Customers

The section outlines how the telecommunications carrier must provide equipment and services to customers that are hearing impaired.

Section 13-704: Billing Statements

- Telecommunication carriers must provide a customer number or telephone number of the customer being billed.
- Customers can elect for electronic bills if applicable.

Section 13-705: Telephone Directories

The section outlines the information provided within and the distribution of telephone directories.

Section 13-713: Consumer Complaint Resolution Process

The section outlines how consumer complaints will be addressed.

Section 13-802.1: Depreciation, Examination and Audit, and Agreement Conditions

- The Commission may ascertain and determine the adequate rate of depreciation of the property for a telecommunications carrier for the purpose of cost analysis.
- The Commission may examine and audit all of the accounts.
- The Commission is authorized to adopt rules and regulations concerning the conditions to be contained in and become part of contracts for noncompetitive telecommunications services.
- The Commission has the authority to engage and implement the rules from the Federal Telecommunications Act of 1996.

For Incumbent Utilities Only

Section 2-202: Policy, Public Utility Fund, Tax

- The gross revenues of Public Utilities are taxed to fund this Act
- The Public Utility Fund will cover all expenses of the Commission, with the exception of salaries, which comes out of the General Revenue Fund.

Section 4-202.1: Enforcement of Service Area Agreement Between Municipality and Electric Cooperative

The Commission shall approve, interpret, and enforce service area agreements between municipalities and electric cooperatives.

Section 5-106

Each public utility shall have an office in one of the cities, villages, or incorporated towns in this state, in which its property or some part thereof is located and shall keep in said office all such books, accounts, papers, records, and memoranda.

Section 8-301

- The Commission shall have power to ascertain, determine and fix for any public utility a suitable and convenient standard commercial unit of service, product, or commodity.
- The Commission shall provide for the inspection of the manner in which every public utility conforms to the reasonable regulations prescribed by the Commission for examining, measuring, and testing its service, product, or commodity.
- The Commission, its officers, agents, experts, or inspectors and employees have the power to enter any premises occupied by any public utility.
- All fees collected by the Commission under this Section shall be paid promptly.

Section 13-518: Optional Service Packages

- It is the intent of this Section to provide unlimited local service packages at prices that will result in savings for the average consumer. The following optional packages of other services are to be offered, with rates agreed upon by the Commission.
    - A budget package which shall consist of residential access service, and unlimited local calls.
    - A flat rate package, which shall consist of residential access service, unlimited local calls, and the customer's choice of 2 vertical services.
    - An enhanced flat rate package which shall consist of residential access service for 2 lines, unlimited local calls, and the customer's choice of 2 vertical services, and unlimited local toll service.

Section 13-701

> Notwithstanding any other provisions of this Act to the contrary, the Commission has no power to supervise or control any telephone cooperative as respect to assessment schedules or local service rates made or charged by such a cooperative on a nondiscriminatory basis.

Federal Regulations

The following is a listing of federal regulations that would apply to any ISP offering service in the county to provide broadband or telephone services. This list below does not cover cable TV regulations, and there is a long list of regulations that apply to cable companies.

FCC regulation of broadband is interesting. In 2017, the FCC under Chairman Ajit Pai cancelled the authority of the FCC to directly regulate broadband. That authority was assumed to earlier ISPs using something called Title II authority, which means a set of regulations that apply to any entity that provides telecommunications services. The FCC explicitly declared that broadband is not a telecommunications service, so any regulatory authority of broadband that was reliant on Title II authority was cancelled. The FCC went further and assigned some of its remaining authority over broadband to the Federal Trade Commission.

This did not entirely kill FCC regulation of broadband – just the regulations that were tied to Title II authority. As will be seen below, the FCC still regulates some aspects of broadband that were directly handed to the FCC through an act of Congress.

There are often specific regulations that are tied to recipients of some federal grant programs. As an example, a federal grant might require that an awardee must participate in a federal low-income subsidy program.

FCC Regulatory Requirements

Generic Regulations

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 (U.S.AC) 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 require 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 complies 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.[39]

The FCC has currently proposed tightening these rules to require for near real-time reporting of network security breaches. Under the past rules an ISP had seven days to tell customers that there had been a breach of their data, and the reporting would not be much sooner. The new rules would also require carriers to report every breach – some inadvertent breaches caused by carriers were excused under the older rules.

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 to carriers in Illinois, although the state has developed additional rules that also apply.

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 statistics from any one payroll period in January, February, or March.

Disability Access and Recordkeeping

Section 255 of the FCC rules require 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

[39] https://www.fcc.gov/document/customer-proprietary-network-information-cpni.

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.

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.[40] 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 currently in the process of modifying the method of data collection and new rules are expected some time in 2022.

[40] The 214 forms ask for a lot of information. The forms are found at this link: https://apps2.fcc.gov/form477/login.xhtml.

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 shields an ISP 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.

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 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 allow a customer to keep a telephone number when switching between providers. In most places in the country (except in some rural areas, numbers can also be ported between landline and cellular carriers.

Battery Back-up Obligation

The FCC requires that anybody that provides telephone service to offer an option for battery back-up 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 back-up equipment for sale at cost and are not required to provide battery back-up as part of the monthly rate for telephone service.

Broadband and Telephone Regulation

Federal Universal Service Program

Contributing to the USF. 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 U.S.F.

Providers must file FCC Form 499-Q quarterly to report qualifying revenues to the FCC that are subject to the U.S.F 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) subsidies 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 other ISPs often will modify practices to stay under the FTC radar.

The FTC is now responsible for the following for broadband regulations:

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 can 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.

EXHIBIT I: SUMMARY OF ONLINE RESIDENTIAL SURVEY

Champaign County
Online Residential Broadband Survey Results
Ended January 2022

1. Where do you live?

	Number	Percent
Urbana	50	14%
Champaign	101	29%
Bondville	1	<1%
Broadlands	2	1%
Crittenden Township	2	1%
Dewey	12	3%
East Bend Township	1	<1%
Fisher	14	4%
Flatville	1	<1%
Foosland	6	2%
Gifford	2	1%
Homer	6	2%
Ivesdale	2	1%
Mahomet	23	7%
Longview	1	<1%
Ludlow	1	<1%
Ogden	2	1%
Penfield	2	1%
Pesotum	7	2%
Philo	10	2%
Rantoul	36	10%
Royal	5	1%
Sadorus	2	1%
St. Joseph	16	5%
Savoy	12	3%
Scott Township	1	<1%
Seymour	6	2%
Sidney	4	1%
Thomasboro	14	4%
Tolono	11	2%

2. Do you have Internet access to your home today?

	Number	Percent
Yes	339	94%
No	23	6%

3. What would you consider an affordable price to pay for internet service?

	Number	Percent
$0 -$25 per month	9	41%
$26 - $50 per month	7	32%
$51 – 75 per month	5	23%
$76 - $100 per month	1	4%
$100 - $150 per month	0	0%
$150 or more per month	0	0%

4. What's the primary reason you don't have home Internet service today?

	Number	Percent
It's not available at my home	13	45%
It's too expensive	12	42%
Don't own a computer	1	3%
Other	3	10%

5. Who provides internet service to your home today?

	Number	Percent
AT&T	31	9%
Frontier	30	9%
Comcast	102	31%
Mediacom	55	17%
Rise Broadband	22	7%
Rising Wireless	1	<1%
Volo Broadband	19	6%
WATCH Communications	1	<1%
I3 Broadband	29	9%
Pavlov Media	6	2%
Cox Wireless	1	<1%
Gifford Wireless	4	1%
Campus Communications Group	2	1%
Netcare Internet Services	1	<1%
Earthlink	1	<1%
Satellite	11	3%
Fixed Cellular	14	4%
Only use my cellphone data	12	3%
Other	1	<1%

6. Who is your cellular carrier?

	Number	Percent
AT&T	2	22%
Verizon	6	67%
T-Mobile	1	11%

7. Please describe the product you use to connect to the Internet?

	Number	Percent
Tethered data from my cellphone	1	10%
Hotspot	5	50%
Jetpack	2	20%
Fixed Cellular	1	10%
Other	1	10%

8. Are you receiving the speed you are paying for?

	Number	Percent
Yes	77	28%
No	71	26%
I'm not sure	129	46%

9. What Internet speed are you supposed to be getting today in your home?

	Number	Percent
1 – 10 Mbps	8	7%
11 – 25 Mbps	19	17%
26 – 50 Mbps	12	11%
51 – 100 Mbps	17	15%
101- 200 Mbps	11	10%
200 + Mbps	47	40%

10. What is the actual download speed you are getting in your home?

	Number	Percent
1 – 10 Mbps	25	17%
11 – 25 Mbps	24	16%
26 – 50 Mbps	22	15%
51 – 100 Mbps	16	10%
101 – 200 Mbps	26	18%
200 + Mbps	33	24%

11. 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	37	13%
2 Dissatisfied	42	15%
3 Neutral	87	32%
4 Satisfied	56	20%

5 Very Satisfied	54	20%

CU.S.TOMER SERVICE:

	Number	Percent
1 Very Dissatisfied	46	17%
2 Dissatisfied	53	19%
3 Neutral	69	26%
4 Satisfied	53	19%
5 Very Satisfied	53	19%

VALUE I GET COMPARED TO THE PRICE I PAY:

	Number	Percent
1 Very Dissatisfied	66	24%
2 Dissatisfied	63	23%
3 Neutral	77	28%
4 Satisfied	39	14%
5 Very Satisfied	33	11%

12. Who is your current cable provider?

	Number	Percent
AT&T	11	4%
Comcast	47	16%
Mediacom	17	6%
I3 Broadband	3	1%
Satellite	77	27%
Watch only online (such as Netflix)	98	34%
Antenna/Over-the-air	17	6%
Do not watch TV	10	3%
No TV service available	10	3%

13. If you have a telephone landline, who provides your telephone service?

	Number	Percent
AT&T	27	10%
Consolidated Communications	1	1%
Comcast	12	4%
Frontier	20	7%
Mediacom	12	4%
I3 Broadband	1	1%
Don’t have a landline	192	71%
Other	6	2%

14. What do you currently pay for the following?

Bundle

	Number	Percent
$50- $75	6	8%
$76 - $100	9	11%
$101 - $125	5	6%
$126 - $150	12	15%
$151 - $200	26	34%
$201 - $250	12	15%
$250+	9	11%

Standalone Cable TV:

	Number	Percent
$25 - $50	2	4%
$51 - $75	7	15%
$76 - $100	10	21%
$101 - $125	9	18%
$126+	20	42%

Standalone Telephone:

	Number	Percent
$1 - $20	5	12%
$21 - $50	13	32%
$56 - $75	15	37%
$75+	8	19%

Standalone Internet:

	Number	Percent
$10 - $25	4	3%
$26 - $50	37	25%
$51 - $75	54	36%
$76 - $100	41	28%
$101 - $125	9	6%
$126+	3	2%

15. In general how do you feel about the idea of a new broadband network in the County?

	Number	Percent
I support the idea	215	73%
I do not support the idea	2	1%
I might support the idea but need more information.	76	26%

16. What are the reasons for your support?

	Number	Percent
More competition	173	82%
Lower prices	156	74%
Faster Speeds	160	75%
Better Customer Service	105	50%

17. What are the reasons you do not support the new fiber network?

	Number	Percent
Broadband in the county is adequate	1	100%

18. 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	187	67%
Lower price than I pay today	208	75%
Same price I pay today but better customer service	66	24%
Availability	6	2%
Reliability	10	4%

19. 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	128	46%
Probably	87	31%
Maybe	54	19%
Probably not	11	4%
Definitely not	0	0%

20. Would you buy a landline telephone service from a new network in the County if they could offer affordable prices?

	Number	Percent
Yes, definitely	15	5%
Probably	30	11%
Maybe	58	21%
Probably not	83	30%
Definitely not	93	33%

21. Do you currently subscribe to cell phone service?

	Number	Percent
Yes	274	98%
No	7	2%

22. Is the cellular coverage at your home adequate?

	Number	Percent
Yes	236	86%
No	40	14%

23. How regularly is the Internet used in your Home?

	Number	Percent
Daily – more than a few hours per day	231	82%
Daily – a few hours per day	40	14%
A few days per week	2	1%
Only occasionally	8	3%

24. Does anyone in your family ever work at home using Internet access?

	Number	Percent
Yes, full-time	55	19%
Yes, a few times a week	78	28%
Yes, a few times a month	28	10%
Yes, very occasionally	36	13%
No	85	30%

25. Would you or your family member work from home more if you had faster Internet?

	Number	Percent
Yes	106	38%
No	172	62%

26. Do you have school-age children at home who use the internet to do their homework?

	Number	Percent
Yes	89	32%
No	189	68%

27. If the answer is yes, is your Internet connection good enough to support their homework?

	Number	Percent
Yes	66	68%
No	31	32%

EXHIBIT II: SUMMARY OF FINANCIAL RESULTS

	Total Study Area	Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 10 Cash	Year 20 Cash
	Commercial ISP								
1	**Base**	$164.4 M	40% / 65%	$151.4 M	$26.7 M		$178.1 M	($10.30 M)	($20.83 M)
2	**Breakeven Grant**	$164.4 M	40% / 65%	$132.4 M	$23.4 M	$22.0 M	$177.8 M	$ 0.53 M	$ 3.75 M
3	**Higher Interest Rate**	$164.4 M	40% / 65%	$134.0 M	$23.6 M	$22.0 M	$179.6 M	($ 1.64 M)	($ 3.79 M)
4	**Lower Interest Rate**	$164.4 M	40% / 65%	$130.9 M	$23.1 M	$22.0 M	$176.0 M	$ 2.60 M	$10.99 M
5	**15-Year Term**	$164.4 M	40% / 65%	$139.8 M	$24.7 M	$22.0 M	$186.5 M	($12.10 M)	($ 5.23 M)
6	**25-Year Term**	$164.4 M	40% / 65%	$128.3 M	$22.6 M	$22.0 M	$173.0 M	$ 7.21 M	$27.03 M
7	**Higher Prices**	$164.4 M	40% / 65%	$129.8 M	$22.9 M	$22.0 M	$174.7 M	$ 5.34 M	$21.70 M
8	**Lower Prices**	$164.4 M	40% / 65%	$135.1 M	$23.8 M	$22.0 M	$180.9 M	($ 4.68 M)	($15.51 M)
9	**5% Higher Contingency**	$169.8 M	40% / 65%	$137.9 M	$24.3 M	$22.0 M	$184.2 M	($ 1.52 M)	($ 2.51 M)
10	**5% Lower Contingency**	$159.0 M	40% / 65%	$126.7 M	$22.4 M	$22.0 M	$171.0 M	$ 2.27 M	$ 9.97 M
11	**5% Higher Penetration**	$169.5 M	45% / 70%	$133.6 M	$23.6 M	$22.0 M	$179.1 M	$ 7.80 M	$27.00 M
12	**5% Higher Pen Breakeven**	$169.5 M	45% / 70%	$157.1 M	$27.7 M		$184.8 M	$ 0.93 M	$ 5.67 M
13	**5% Lower Penetration**	$161.6 M	35% / 60%	$132.8 M	$23.4 M	$22.0 M	$178.2 M	($ 3.23 M)	($10.38 M)
14	**5% Lower Pen Breakeven**	$161.6 M	35% / 60%	$120.0 M	$21.2 M	$34.0 M	$175.2 M	$ 0.49 M	$ 2.62 M
	County as the ISP								
15	**GO Bond**	$164.4 M	40% / 65%	$197.0 M			$197.0 M	($22.62 M)	($49.46 M)
16	**GO Bond Breakeven Grant**	$164.4 M	40% / 65%	$149.7 M		$44.0 M	$193.7 M	$ 1.37 M	$ 4.99 M
17	**Revenue Bond**	$164.4 M	40% / 65%	$213.4 M			$213.4 M	($27.47 M)	($62.78 M)
18	**Revenue Bond Breakeven**	$164.4 M	40% / 65%	$150.5 M		$52.0 M	$202.5 M	$ 1.36 M	$ 5.95 M
19	**Operator for Hire**	$164.4 M	40% / 65%	$150.5 M		$52.0 M	$202.5 M	($ 8.69 M)	($14.25 M)

	Open Access - Rev Bond								
20	**County**	$160.6 M	40% / 65%	$146.3 M		$52.0 M	$198.3 M	($ 4.91 M)	($48.62 M)
21	**ISPs**	$ 4.1 M	40% / 65%	$ 7.7 M	$ 1.4 M		$ 9.1 M	$11.18 M	$42.97 M
	ISP Leases Network								
22	**County**	$160.4 M	40% / 65%	$131.3 M		$52.0 M	$183.3 M	$19.06 M	$ 6.34 M
23	**ISPs**	$ 4.2 M	40% / 65%	$ 27.5 M	$ 4.8 M		$ 32.4 M	($ 7.11 M)	$ 7.17 M

EXHIBIT II: SUMMARY OF FINANCIAL RESULTS

		Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 10 Cash	Year 20 Cash
	Rural Study Area								
	Commercial ISP								
25	**Breakeven Grant**	$71.7 M	65%	$31.9 M	$ 5.6 M	$38.0 M	$75.5 M	$ 0.31 M	$ 0.67 M
26	**Higher Interest Rate**	$71.7 M	65%	$32.2 M	$ 5.7 M	$38.0 M	$75.9 M	($ 0.23 M)	($ 1.13 M)
27	**Lower Interest Rate**	$71.7 M	65%	$31.5 M	$ 5.5 M	$38.0 M	$75.0 M	$ 0.77 M	$ 2.38 M
28	**15-Year Term**	$71.7 M	65%	$33.5 M	$ 5.9 M	$38.0 M	$77.4 M	($ 2.71 M)	($ 1.18 M)
29	**25-Year Term**	$71.7 M	65%	$30.9 M	$ 5.5 M	$38.0 M	$74.4 M	$ 1.87 M	$ 6.20 M
30	**Higher Prices**	$71.7 M	65%	$31.2 M	$ 5.5 M	$38.0 M	$74.7 M	$ 1.52 M	$ 5.25 M
31	**Lower Prices**	$71.7 M	65%	$32.5 M	$ 5.7 M	$38.0 M	$76.2 M	($ 0.94 M)	($ 3.92 M)
32	**5% Higher Contingency**	$74.2 M	65%	$34.5 M	$ 6.1 M	$38.0 M	$78.6 M	($ 0.53 M)	($ 2.23 M)
33	**5% Lower Contingency**	$69.2 M	65%	$29.2 M	$ 5.1 M	$38.0 M	$72.3 M	$ 1.11 M	$ 3.56 M
34	**5% Higher Penetration**	$72.4 M	70%	$32.0 M	$ 5.7 M	$38.0 M	$75.7 M	$ 1.28 M	$ 4.33 M
35	**5% Higher Pen Breakeven**	$72.4 M	70%	$35.2 M	$ 6.2 M	$35.0 M	$76.4 M	$ 0.35 M	$ 1.07 M
36	**5% Lower Penetration**	$71.0 M	60%	$31.8 M	$ 5.6 M	$38.0 M	$75.4 M	($ 0.74 M)	($ 3.12 M)
37	**5% Lower Pen Breakeven**	$71.0 M	60%	$28.6 M	$ 5.0 M	$41.0 M	$74.6 M	$ 0.20 M	$ 0.14 M
	County as ISP								
38	**GO Bond**	$71.8 M	65%	$86.1 M			$86.1 M	($22.08 M)	($53.82 M)
39	**GO Bond Breakeven Grant**	$71.8 M	65%	$37.7 M		$44.0 M	$81.7 M	$ 1.47 M	$ 0.82 M
40	**Revenue Bond**	$71.8 M	65%	$93.2 M			$93.2 M	($24.22 M)	($59.62 M)
41	**Revenue Bond Breakeven**	$71.8 M	65%	$39.4 M		$46.0 M	$85.4 M	$ 2.06 M	$ 0.71 M
42	**Operator for Hire**	$71.8 M	65%	$39.4 M		$46.0 M	$85.4 M	($ 8.04 M)	($19.44 M)

	Open Access - Rev Bond								
43	**County**	$70.3 M	65%	$31.6 M		$46.0 M	$77.6 M	$ 1.68 M	($ 9.76 M)
44	**ISPs**	$ 1.2 M	65%	$ 3.1 M	$ 0.5 M		$ 3.6 M	$ 1.91 M	$ 8.81 M
	ISP Leases Network								
45	**County**	$70.2 M	65%	$28.8 M		$46.0 M	$74.8 M	$ 8.85 M	$ 5.53 M
46	**ISPs**	$ 1.2 M	65%	$ 7.4 M	$ 1.3 M		$ 8.7 M	($ 1.62 M)	$ 2.29 M

EXHIBIT II: SUMMARY OF FINANCIAL RESULTS

		Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 10 Cash	Year 20 Cash
	No RDOF Rural Area								
	Commercial ISP								
47	**Base**	$54.4 M	65%	$53.3 M	$ 9.4 M		$62.7 M	($13.17 M)	($38.12 M)
48	**Breakeven Grant**	$54.4 M	65%	$16.8 M	$ 3.0 M	$37.0 M	$56.7 M	$ 0.88 M	$ 2.56 M
49	**Higher Interest Rate**	$54.4 M	65%	$16.9 M	$ 3.0 M	$37.0 M	$56.9 M	$ 0.58 M	$ 1.61 M
50	**Lower Interest Rate**	$54.4 M	65%	$16.6 M	$ 2.9 M	$37.0 M	$56.5 M	$ 1.12 M	$ 3.45 M
51	**15-Year Term**	$54.4 M	65%	$17.8 M	$ 3.1 M	$37.0 M	$57.9 M	($ 0.59 M)	$ 1.46 M
52	**25-Year Term**	$54.4 M	65%	$16.4 M	$ 2.9 M	$37.0 M	$56.3 M	$ 1.85 M	$ 5.50 M
53	**Higher Prices**	$54.4 M	65%	$16.5 M	$ 2.9 M	$37.0 M	$56.4 M	$ 1.86 M	$ 5.79 M
54	**Lower Prices**	$54.4 M	65%	$17.4 M	$ 3.1 M	$37.0 M	$57.4 M	$ 0.13 M	($ 0.63 M)
55	**5% Higher Contingency**	$56.3 M	65%	$19.1 M	$ 3.3 M	$37.0 M	$59.3 M	$ 0.37 M	$ 0.35 M
56	**5% Lower Contingency**	$52.4 M	65%	$14.8 M	$ 2.6 M	$37.0 M	$54.4 M	$ 1.63 M	$ 4.81 M
57	**5% Higher Penetration**	$54.8 M	70%	$17.0 M	$ 3.0 M	$37.0 M	$57.0 M	$ 1.72 M	$ 5.23 M
58	**5% Higher Pen Breakeven**	$54.8 M	70%	$21.8 M	$ 3.9 M	$32.5 M	$58.2 M	$ 0.30 M	$ 0.34 M
59	**5% Lower Penetration**	$53.9 M	60%	$16.8 M	$ 3.0 M	$37.0 M	$56.7 M	$ 0.59 M	($ 0.04 M)
60	**5% Lower Pen Breakeven**	$53.9 M	60%	$15.7 M	$ 2.8 M	$38.0 M	$56.5 M	$ 0.61 M	$ 1.04 M
	County as ISP								
61	**GO Bond**	$54.8 M	65%	$65.8 M			$65.8 M	($19.70 M)	($48.16 M)
62	**GO Bond Breakeven Grant**	$54.8 M	65%	$19.7 M		$40.0 M	$59.7 M	$ 0.75 M	$ 1.95 M
63	**Revenue Bond**	$54.8 M	65%	$71.3 M			$71.3 M	($21.32 M)	($52.61 M)
64	**Revenue Bond Breakeven**	$54.8 M	65%	$18.8 M		$42.0 M	$60.8 M	$ 1.35 M	$ 3.38 M
65	**Operator for Hire**	$54.8 M	65%	$18.8 M		$42.0 M	$60.8 M	($ 8.66 M)	($16.78 M)

	Open Access - Rev Bond								
66	**County**	$53.5 M	65%	$15.3 M		$42.0 M	$57.3 M	($ 1.86 M)	($ 6.75 M)
67	**ISPs**	$ 0.9 M	65%	$ 3.3 M	$ 0.6 M		$ 3.9 M	($ 0.51 M)	$ 1.83 M
	ISP Leases Network								
68	**County**	$53.4 M	65%	$15.2 M		$42.0 M	$57.2 M	$ 1.58 M	($ 0.93 M)
69	**ISPs**	$ 1.0 M	65%	$ 7.3 M	$ 1.3 M		$ 8.5 M	($ 0.05 M)	$ 1.49 M