Broadband Needs Assessment and Feasibility Report

For the Springfield Sangamon Growth Alliance, for Sangamon County, Illinois

November 7, 2022

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EXECUTIVE SUMMARY

This project is the result of an RFP issued by the Springfield Sangamon Growth Alliance (SSGA) looking for a broadband needs assessment and feasibility study. Finley Engineering and CCG Consulting submit this report to be an actionable plan for understanding the current state of broadband in the County and as a roadmap for finding better broadband for the thousands of rural homes and businesses that don't have good broadband today, and who are not yet on anybody's radar to bring faster broadband.

This report has been undertaken with the goal of providing the facts that ISPs need to decide to pursue a rural broadband solution. Finley Engineering has quantified the cost of building the needed fiber networks. The report also discusses the amount of grant funding that is needed at various levels of anticipated customer penetration. Finally, the market research gives some feeling to ISPs about how the public feels about supporting better broadband. ISPs should find these findings and facts to be invaluable in deciding a pursuit of grant funding.

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 the following conclusions about the state of broadband in the county:

- This is a county with broadband haves and have-nots. The broadband speeds are good in the cities and will be getting better from promised upgrades. There are rural areas that have or will be getting fiber. But there are still many rural homes and businesses that can't buy adequate broadband today, and for which no broadband solution has been identified.
- In the broadband grant world, unserved means locations where customers can't buy broadband of at least 25/3 Mbps. One of our primary findings is that there is a big disconnect between the number of unserved homes and businesses as counted by the FCC, and those we've identified in this study. The ISPs that report broadband coverage to the FCC only show 227 locations can't buy broadband of at least 25/3Mbps, while we quantify that today at 6,457 locations. It's important for the County to set this record straight because unserved locations will get first priority in the upcoming $42.5 billion BEAD grant program.
- 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 amount of grant funding varies between 56% and 74% of the cost of building a broadband network – with the amount of grant funding reliant upon the expected customer penetration rate on new networks. The good news is that the upcoming federal grants will be offering grant funding of as much as 75%, so grant funding should be adequate – assuming there is enough grant funding to go around.
- The County faces one dilemma that we see in other counties. The FCC awarded offered subsidies under the Rural Digital Opportunity Fund (RDOF) to two ISPs – Nextlink and Mercury Broadband. This funding is aimed at bringing better broadband to 1,180 rural passings. The dilemma is twofold. First, the FCC is giving ISPs a relaxed implementation timeline, and some of the folks in these areas might not see faster broadband until 2028. The second dilemma is that both ISPs plan to bring faster broadband using a mix of fixed wireless technology and fiber. Many other counties are not happy to see fixed wireless technology as a permanent broadband solution, and many prefer fiber. The County needs to grasp the impact of these awards and decide if you want to take any action to try to speed up the timeline or to lobby for fiber instead of wireless.
- 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 a U.S. home 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. Any broadband network built must be capable of providing the bandwidth needed today and also for the decades to come.

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

Immediately following is a Findings section that describes most of the key findings and facts about broadband in the county. After that is section labeled Strategic Considerations, where we discuss the big issues the County must tackle in deciding to find a broadband solution. As an example, you'll need to consider if you are willing to commit ARPA funding to help lure an ISP partner or partners to build the needed networks. We think the County can play a big role in choosing the ISP partners that you want to serve the rural areas.

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, possibly challenging the FCC broadband maps, 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. AT&T, Frontier, Consolidated Communications, and CASSCOMM are the incumbent telephone companies in the county. The companies primarily provide DSL broadband over copper wires, although CASSCOMM has begun converting to fiber. Sparklight, Mediacom, Comcast, and CASSCOMM are the incumbent cable companies that operate hybrid fiber coaxial networks (HFC). Bother CASSCOMM and i3 Broadband have built last-mile fiber in the county. Several fixed wireless providers claim coverage in the county, including A.C.T.S., King Street Wireless, PWR-net, Rise Broadband, Royell Communications, and Veloxinet. Some rural customers receive broadband from cellular companies using cellular hotspots or the newer FWA fixed cellular technology. Many rural homes and businesses can buy satellite broadband from Viasat, HughesNet, or Starlink.

Existing Broadband Prices. As might be expected with so many different ISPs, broadband prices vary widely. Following is a summary of the primary broadband prices charged by the 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.

- Comcast charges $80 for its 100/5 Mbps service and $120 for 1200/35 Mbps on its cable network. Comcast charges $14 monthly for its modem and has a 1.2 TB data cap on its products. Comcast charges $10 for each additional gigabyte of data, with a maximum of $50 extra per month.
- Mediacom charges $79.99 for its basic 200/10 Mbps product that comes with a 1 terabyte data cap. Mediacom charges $129.99 for its 1000/50 Mbps product with a 6-terabyte data cap. Mediacom charges $10 for 50 gigabytes of additional data after reaching the cap. Mediacom charges $13 per month for a modem.
- Sparklight sells 200 Mbps for $65 per month with a data cap of 700 gigabytes. Sparklight charges $80 for its 300 Mbps product with a 1.2 terabyte data cap and $110 for the gigabit product with no data cap. The company charges $10.50 per month for a router.
- AT&T sells DSL for $60 per month for 5 Mbps and $65 per month for speeds up to 25 Mbps. AT&T charges $10 for a DSL modem. AT&T Fiber starts at $60 for 100/100 Mbps up to $80 for gigabit service.
- Frontier charges $54.99 for DSL. Frontier fiber products include $54.99 for 500/500 Mbps and $154.99 for 1/1 Gbps.
- i3 Broadband charges $54.99 for 250/250 Mbps, $64.99 for 500 Mbps, and $89.99 for 1 Gbps service. i3 Broadband charges $7 per month for a modem.
- CASSCOMM charges $74.95 for 4/1 Mbps on its DSL network. CASSCOMM charges $59.99 for 10/2 Mbps and $99.95 for 50/5 Mbps on its cable network. The company charges $59.95 for 75/75 Mbps and $149.95 for 1/1 Gbps on its fiber network.
- Veloxinet charges $49 for 50/25 Mbps and $45 for 25/10 Mbps on its fixed wireless network.
- PWR-net (Shelby Electric) charges $39.95 for 1 Mbps, $69.95 for 10/2 Mbps, and $99.95 for 15/2 Mbps on its fixed wireless network.
- Royell Communications sells 3/1 Mbps service for $37.95, $54.95 for 10/1 Mbps, and $79.95 for 25/5 Mbps on its fixed wireless network.

- Rise Broadband provides up to 15 Mbps for $42, 25 Mbps for $47, and 50 Mbps for $57. Each product comes with a 250-gigabyte data cap; each additional 10 gigabytes is $5.
- A.C.T.S. charges $20 for 10 Mbps, $50 for 50 Mbps, $80 for 100 Mbps, and $125 for 200 Mbps on its fixed wireless network.
- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds are up to 100 Mbps.
- Verizon's new fixed cellular plan costs $55 for existing Verizon customers and $75 for non-Verizon customers. Speeds are not guaranteed.

The Study Areas. The study looks at the cost of bringing fiber broadband to the rural parts of the county where residents and businesses cannot buy broadband of at least 100/20 Mbps.

Market Demand Assessment

Residential Survey. We conducted an online residential survey that attracted 1,349 responses. Following are the key results of the survey:

- 92% of survey respondents buy broadband at home. 7% of respondents have no home broadband, and 1% of respondents only get broadband from a cell phone.
- Residents use a wide variety of broadband technologies today. 51% of survey respondents buy broadband from a cable company. 18% of respondents use DSL technology from a telephone company. 6% of respondents have fiber at home. 9% use fixed wireless, 5% use satellite broadband, and 3% use a fixed cellular broadband.
- There is a moderate level of dissatisfaction with ISPs 27% of respondents are unhappy with download speeds. 36% are unhappy with ISP customer service. 48% of respondents are unhappy with the value received for the price paid for broadband. 37% are unhappy with the reliability of the broadband connection, and 36% are unhappy with the reliability of their ISP.
- 85% of respondents use home broadband for more than a few hours per day.
- 70% of respondents said that somebody is working from home at least part-time. This includes 20% of households that have somebody working from home full-time. 38% of respondents said they would work from home more with better broadband.
- 26% of respondents have school-age children at home. 36% of these households said that home Internet was not good enough to support homework.
- 29% of respondents don't have good cellular coverage at home.
- The average price being paid for standalone broadband is $83 per month, which is higher than the more normal $75 price paid elsewhere.
- 66% of respondents support the idea of funding a better broadband solution. Another 33% might support better broadband but need more information. Only 1% of respondents do not support the idea.
- 39% of respondents said they would definitely buy broadband from a new network if it was faster and at the same price. Another 29% 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 and stakeholders in depth. 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 with drastically different broadband situations at home and the office.

We heard from small businesses that now use the Internet extensively. As an example, we heard from two restaurants/bars that use broadband for credit card processing, point of sale software, payroll, gaming for customers, online telephone service, reservation systems, and purchasing. Many businesses in the county are now completely reliant of broadband to function. Even small businesses are crippled when the Internet is slow or goes out.

We also heard from several farmers. Some farmers struggle with the combination of poor broadband and poor cellular coverage. Most farms are using fixed wireless or cellular broadband, and a common complaint is that the speeds are not adequate for the demands of modern farming. Every farmer has a list of things they could do more efficiently with faster broadband.

We heard numerous stories about the contrast between home broadband and work broadband. We talked to business owners who live in rural areas who can't take work home. We heard from rural business owners who live in a city and who must take work home to be completed.

Speed Tests. As part of the study, we solicited speed tests from residents using the Ookla speed test (speetest.net). We've summarized the results by ISP, and by technology, to create the following table. The speed test data shows that only cable companies and fiber ISPs are delivering download speeds faster than 100 Mbps.

Provider	Technology	Download (Mbps)	Upload (Mbps)	Latency (ms)
AT&T	DSL	19	7	116
AT&T	Fiber	397	360	16
CASSCOMM	Fiber	100	94	8
CASSCOMM	Cable	40	15	37
Comcast	Cable	208	26	29
i3 Broadband	Fiber	421	410	16
Mediacom	Cable	276	28	29
Sparklight	Cable	198	18	13
Rise Broadband	Fixed Wireless	28	9	95
Royell Communications	Fixed Wireless	7	0.9	48
Satellite	GEO Satellite	24	2	810
Starlink	LEO Satellite	54	9	74
T-Mobile	Fixed Cellular	43	17	223

Broadband Gaps. Sangamon County has a significant broadband availability gap and is a story of broadband haves and have-nots. The cities are served by cable companies. Several telephone companies are now building fiber, but many rural customers have only slow broadband options available. Probably the most important finding is that the demand for household broadband has been growing at an explosive rate, which puts pressure on all broadband networks. Consider the nationwide average monthly usage for households just in recent years:

1st Quarter 2018	215 Gigabytes
1st Quarter 2019	274 Gigabytes
1st Quarter 2020	403 Gigabytes
1st Quarter 2022	514 Gigabytes
2nd Quarter 2022	491 Gigabytes

Like most places, there are also other broadband gaps in the county, such as an affordability gap, a computer gap, and a computer training gap. The report discusses ways that the County might 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 which can be served from a broadband network. Perhaps the biggest finding of this study is the degree to which the FCC mapping has overstated broadband coverage in the county. Below are three different counts of unserved, underserved, and served passings in the county, described as follows:

- The FCC passings come from the current FCC mapping data. The ISP reporting to the FCC shows that only 227 homes in the county don't have access today to broadband of at least 25/3 Mbps.
- Our analysis dug deeper into the real broadband solution, and we show that 6,457 homes and businesses can't buy 25/3 Mbps broadband today. We made a number of adjustments in coming up with the higher number. One of the changes was to fix the edge issue, where Census blocks near to cities show that cable broadband is available to everybody when it's not. But the biggest change comes from reflecting the real speeds being delivered by rural ISPs that are slower than the speeds claimed to the FCC.
- Final passings reflect the FCC awards of the RDOF subsidy made to Nextlink and Mercury Wireless where the companies are funded to bring faster broadband to 1,180 passings.

	Speeds	FCC Passings	Current Passings	Final Passings
Unserved	Less than 25/3 Mbps	227	6,457	5,277
Underserved	From 25/3 to 100/20 Mbps	6,082	352	352
Served	100/20 Mbps or faster	85,910	85,410	86,590
Total		92,219	92,219	92,219

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

- The network was designed to pass every unserved and underserved home and business.
- 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.

Asset Costs. Below is a summary of the cost of the needed assets to support the two fiber options we studied. The network investment varies by the number of customers served, and the numbers below represent the needed investment at a 60% and 70% customer penetration.

	60% Penetration	70% Penetration
Fiber	$37,189,682	$37,195,137
Drops	$ 2,787,708	$ 3,238,990
Electronics	$ 2,739,701	$ 3,018,377
Huts	$ 910,000	$ 910,000
Operational Assets	$ 219,057	$ 221,449
Total	$43,846,158	$44,583,953
Passings	5,629	5,629
Cost per Passing	$ 7,789	$7,920

The study notes that the supply chain in the telecom industry is under stress. There have been substantial price increases for fiber, electronics, and labor over the last year, and the 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. We created financial forecasts that predict how an ISP might fare if it financed and built the fiber solution. 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 it 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:

- Most scenarios assume that an existing commercial ISP would build the solution. Costs would be higher for a newly formed ISP.
- The financial projections were made on an incremental basis, meaning we only considered new network costs, new operating expenses, and new revenues.
- We arbitrarily chose a starting market penetration rate of 60%. We don't know how many customers a new fiber business might attract, and we picked this penetration rate as slightly conservative compared to what we see in other rural markets.
- The base models assumed financing with loans at 6% interest for 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 on non-fiber technologies.
- 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.

All Scenarios Require Substantial Grant Funding. We expected when we started the analysis that grant funding would be required to help fund fiber to rural parts of the county. This was validated when we saw the high cost per needed assets per customer and per passing.

Our analysis allowed us to quantify the amount of cash infusion that would be needed for each scenario. Cash can be infused with either grants or ISP equity – the mix of the two would likely be determined by the lender that financed the project. As expected, the amount of grant/equity required varies significantly depending on the expected customer penetration rate. The following tables represent the breakeven scenarios for a commercial ISP. Breakeven means an ISP would need to infuse the amount of cash shown to just break even. No ISP will want to tackle these opportunities if the best they can do is break even, so ISPs would seek some more grants than assumed in this table.

	Penetration Rate	Assets Needed	Grant Plus Equity Needed	Percent of Assets
Rural Study Area	50%	$43.1 M	$31.7 M	74%
	55%	$43.5 M	$29.9 M	69%
	60%	$43.8 M	$28.1 M	64%
	65%	$44.2 M	$26.6 M	60%
	70%	$44.6 M	$25.0 M	56%

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

- The amount of grant/equity required drops with higher customer penetration rates. This is due to customer revenues being able to cover the costs of the business – the higher the penetration rate, the higher the customer revenues.
- There are federal grants that might be able to fund up to 75% of the assets in rural areas. These tables show that the needed funding is less than the 75% funding maximum, so ISPs might should interpret this table as showing a reasonable opportunity to build in the county using grant funding.

The Fiber Business is Sensitive to Other Key Variables. While the 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, and prices. The report quantifies and describes these impacts.

Other Operating Models. The analysis shows that it doesn't look feasible to create an open-access network in the rural areas. However, it might be possible to create a public-private partnership as long as sufficient grant funding is found that would enable that the local government and ISPS are made whole.

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, which will distribute $42.5 billion through the states to build broadband infrastructure. 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 grants will provide $2.5 billion in grants to tackle digital literacy and to get more computers into households.

Other Technologies. Section II.C. of the report looks at the broadband technologies in use in the market today and a few technologies that are on the horizon.

Ownership Models. Section III.A. of the report looks at the pros and cons of various ownership models.

Finding an ISP Partner. Section IV.A. of the report discusses the most common process we see being used for identifying and creating partnerships with ISPs to bring better broadband.

STRATEGIC CONSIDERATIONS

The creation of the $42.5 billion BEAD grant program has changed the trajectory for finding rural broadband solutions. 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 problem.

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.

The study highlights a challenge faced by the County. The current FCC mapping shows only 227 homes in the county that can't buy broadband today of at least 25/3 Mbps (the speed that grants consider to be unserved). Our analysis shows that this number is badly understated, and we believe that there are 6,457 rural homes and businesses today that are unable to buy a 25/3 Mbps broadband connection. This difference is important because the federal BEAD grants will first be used to bring broadband to unserved areas before being awarded to other areas. As will be described in the Next Steps section of the report, we recommend that the County get involved in the process of validating the FCC maps.

The County faces a second, more subtle issue. The FCC recently made awards to Nextlink and Mercury Wireless in the RDOF subsidy program to bring faster broadband to 1,180 of the unserved locations. The RDOF program gives these carriers until 2028 to bring a broadband solution to all of the households – an extraordinarily long lead time. The RDOF awards create a technology dilemma for the County. The two RDOF award winners are both wireless ISPs today but tell the FCC that they will satisfy the RDOF obligations with some combination of fixed wireless and fiber technology. We are skeptical that these ISPs can deliver the fast fixed wireless speeds of up to a gigabit that were promised to the FCC. The dilemma is that many other counties are viewing the construction of wireless technology as being inferior to fiber. A fiber network built today is likely to still be functioning by the end of this century, with a few electronics upgrades. Wireless technology will likely require a half dozen major electronics upgrades by the end of the century, and many rural communities are concerned about the sustainability of the wireless technology.

The County needs to come to grips with how you feel about the RDOF awards. At a minimum, you should be actively lobbying the two RDOF winners to bring the upgrades faster than the slow FCC timelines. We don't think the folks in the RDOF areas will be happy if they don't see a broadband solution until 2027 or 2028. You also might want to lobby the ISPs to build more fiber and less wireless technology. Some other counties are considering trying to lure another ISP to bring fiber to at least some of the RDOF areas.

As part of this study, we talked to most of the existing ISPs serving the county and several of them are interested in expanding fiber networks into rural areas. It looks like the large telephone companies, including AT&T and Frontier are likely to pursue BEAD grants. It's also possible that ISPs from outside the county might want to pursue the upcoming grant funding - a $42.5 billion grant program is drawing a huge amount of interest.

The County can't just sit back and assume that somebody is going to solve your broadband gaps by pursuing grants to build fiber in all of these areas because it's also possible that nobody asks for the funding in some or all of your rural areas. Most of the other counties in Illinois and nearby states have the same kind of broadband gaps as Sangamon County, and there may be more opportunities globally than the ISPs can reasonably pursue.

This report discusses the process of finding an ISP partner. Many counties are leery of having broadband grants going to the big telephone companies. The big telephone companies carry a lot of the blame for the poor condition of broadband in rural areas. The companies started to abandon 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. 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. By contrast, the smaller telcos in the region are upgrading to fiber. The question that communities are wrestling with is if they should trust the big ISPs again. What's to stop the big companies from taking federal grants, building just enough to meet the letter of the law, underfunding maintenance going forward, and starting the cycle over again? If a new fiber network is not properly maintained, it will begin to show problems in a decade and could start becoming a paperweight in two decades.

The purpose of this discussion is to point out that the County can play a significant role in influencing which ISPs will win the grants to serve the remaining 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 federal grant awards. Grant programs encourage and reward local collaboration and local skin in the game.

This is not to say that an ISP or ISPs the County might back will be an automatic grant winner. If some large, well-financed ISP promises to serve a seven-county area that includes Sangamon County, that big ISP may still win instead of the County and your 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.

We think your biggest strategic decision to make is if you should take an active role in trying to make sure that all rural areas get better broadband. If the County does nothing, it's possible that an ISP you don't want or a technology you don't want could get funded. Even worse, it's possible that nobody will win grant funding for parts of 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 enough to solve all of the rural broadband needs in the country. If the County doesn't find a broadband solution in the upcoming grants, there might not be another chance for a long time.

The bottom line of this discussion is that the County should strongly consider partnering with one or more ISP partners to pursue grant funding. In recommending this, we aren't precluding partnering with a large telephone company – we're just cautioning to go into such a partnership with your eyes wide open. If you don't take an active role, 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.

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 that don't. This boils down to being willing to invest in a broadband solution.

We know the County is unable to shoulder the whole financial burden to fund fiber. The analysis shows that the funding needed to bring broadband to the rural areas is around $44 million.

Our analysis shows that bankers are likely to require significant equity from any ISP seeking the BEAD grants. Those awards are capped at 75%, and the ISPs will have to pay a minimum of 25% of the cost of any grant project, probably more. That's still a large investment to make in a rural market, and we're seeing ISPs favor projects where the local governments help to offset some of that cost.

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 we think you should consider setting 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 or use tax revenues as matching funds to attract a broadband solution.

Think About the Digital Equity Gap

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 local stakeholders are realistically willing and able to tackle. The County's role might be as simple as finding local non-profits willing to tackle the effort and working with them to secure the grant funding to pay for it.

Middle-Mile Fiber Grants

One of the engineering findings is that the County doesn't have as many middle-mile fiber routes in and out of the County as we'd hope to see. Most of the existing fiber routes follow highways 55 and 72 and don't extend well into some of the unserved areas. Having multiple fiber routes into and out of the County provides protection that new fiber networks don't go dark every time somebody cuts a fiber route two counties away.

We know the State is considering having middle-mile grants in addition to last-mile grants, and we encourage you to work with local ISPs to participate in these discussions to make sure that the County is included in any State plans and grants.

RECOMMENDED NEXT STEPS

The section above discussed the big 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. 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. We've seen many efforts to get better broadband that fizzled when nobody was dedicated to taking the needed steps. 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 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. 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 Sangamon-to-Sangamon 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 most 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. We can provide these maps to ISPs in the digital formats they'll need.
- 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 a viable business case 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 on 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 the 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.A. 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 areas 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.

Get Involved in the FCC Map Challenge Process

As noted earlier, the latest FCC mapping data only counts 227 homes and businesses in the county that are unable to buy broadband of at least 25/3 Mbps – much lower than our count of 6,457 passings. It's vital that the FCC mapping records get corrected before the upcoming BEAD grants. Those grants will prioritize funding to unserved areas first.

There is a two-step challenge process to the FCC mapping. The first challenge process just got started and is a challenge to the mapping fabric. That's a new acronym being used to describe the FCC map that purports to show all of the locations eligible for a grant. There have been early comments made that there are a lot of errors in the fabric developed by CostQuest – the mapping vendor chosen by the FCC. There are places where too many passings have been identified, such farms where there are multiple buildings, most of which are not candidates to buy a broadband subscription. There are also apparently a lot of passings that are missing from the map.

One of the biggest hurdles to the fabric challenge is that the FCC mapping fabric data is not widely available for the public to examine. CostQuest has provided free access to localities like the County to review local data, and the County needs to gain access if you haven't already done so.

Unfortunately, the contract between CostQuest and local governments restricts the use of the data only for purposes of challenging the fabric data. It seems a local government can't disclose details about the fabric to its citizens or use the information in any other way.

The County should compare your GIS data to the CostQuest mapping fabric to see if it has properly portrayed the rural locations in the County. If not, there is a specific process for challenging the FCC mapping fabric.

There will be a second challenge coming after the FCC releases its first broadband map using the new mapping method that was first used by ISPs in September. This data will show how the FCC is now classifying broadband speeds. As mentioned earlier, the most recent FCC mapping only counts 227 locations as unserved. If the new mapping doesn't come closer to reality, the County should also challenge the speed data, or work with the ISPs operating in the county to correct it. We don't know the process for this second challenge yet, but it will likely include the State broadband office.

Educate the Public

The surveys and interviews indicate a lot of interest from the general public in 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 it is kept 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

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

are aimed at educating the public on topics related to broadband and also keeping 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.

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. Sangamon 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.D. 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. This might mean identifying and working with local non-profits to seek funding. It's also possible for the County to directly seek funding, but which would first require developing a detailed plan for using the funding.

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

AT&T, Frontier, Consolidated Communications, and CASSCOMM are the incumbent telephone companies in the county. The companies primarily provide DSL broadband over copper wires, although CASSCOMM has begun converting to fiber. Sparklight, Mediacom, Comcast, and CASSCOMM are the incumbent cable companies and operate hybrid fiber coaxial networks (HFC). Bother CASSCOMM and i3 Broadband have built last-mile fiber in the county. Several fixed wireless providers claim coverage in the county, including A.C.T.S., King Street Wireless, PWR-net, Rise Broadband, Royell Communications, and Veloxinet. Some rural customers receive broadband from cellular companies using cellular hotspots or the newer FWA fixed cellular technology. Many rural homes and businesses can buy satellite broadband from Viasat, HughesNet, or Starlink.

Following is an analysis of the broadband prices being charged in Sangamon County today. We know from experience that prices vary widely by customer for many ISPs. Some ISPs include products in bundles that can vary widely by customer. Many ISPs have special rates for new customers or for customers willing to negotiate rates. Some customers are grandfathered into old rates and old products that don't change as long as they keep the original product. The wide variance in rates charged in the community means there is no one rate that can be considered a standard price for broadband in the market. Nevertheless, it's important before considering the viability of expanding broadband to understand the base prices in the market today.

Incumbent Telephone Companies

AT&T. AT&T is the incumbent landline telephone provider in the central part of the county. AT&T still sells traditional telephone service and legacy DSL broadband under the AT&T brand name. For many years the company sold broadband under the AT&T U-verse brand name, but in March 2020, the company rebranded everything as AT&T again. The big news is that AT&T announced in October 2020 that it would no longer connect a new DSL customer. For now, existing customers can keep DSL, but nobody can add the product.

It's been hard recently to understand AT&T's business plan. In 2020, the company spun off its cable TV business that included DirecTV, AT&T TV, and U-Verse. The business went to a newly formed company that will be owned 70% by AT&T and 30% by TPG Capital. AT&T received $7.8 billion in cash, which values the new business at $16.25 billion. This represents a huge loss for AT&T, which originally paid $67 billion to acquire DirecTV in 2015. That's over a $50 billion loss after six years of purchasing DirecTV.

AT&T also sold WarnerMedia to Discovery Inc. in 2020. This means AT&T will no longer own HBO and other programming that it was using as a lure for bundling. The sale netted $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 lost $42 billion after only five years. The two sales will allow AT&T to pay down about $51 billion of debt, but a significant amount of the debt from the original purchases is still on the books.

At the end of the second quarter of 2022, the company had over 15 million broadband customers. AT&T added over 1 million customers on fiber in 2021. AT&T has built fiber to pass 16 million passings (potential customers) and is planning on passing 3 million new potential customers in 2022.

AT&T said it will offer a revamped cellular broadband product in rural areas that is the supposed replacement for rural DSL. However, that product has not been made available in many places where AT&T is the incumbent telephone company, and the company is not claiming to provide this service in the county.

AT&T is clearly in the process of shedding the legacy business of selling DSL over copper and cable TV. It would not 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. AT&T Internet DSL uses two copper pairs that result in twice the speed.

DSL	Download Speed	Price
Basic 5	5 Mbps	$ 60
Internet 10	10 Mbps	$ 65
Internet 25	25 Mbps	$ 65
DSL Modem		$ 10
AT&T Internet		
Internet 50	50 Mbps	$ 65
Internet 75	75 Mbps	$ 65
Internet 100	100 Mbps	$ 65
DSL Modem		$ 10

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

Fiber Broadband. Following are the residential prices for AT&T broadband on fiber. AT&T has built fiber in some neighborhoods of Springfield.

Fiber	Download Speed	Price
Internet 100	100 Mbps	$ 60
Internet 300	300 Mbps	$ 65
Internet 1,000	1 Gbps	$ 80
Internet 2,000	2 Gbps	$110
Internet 5,000	5 Gbps	$180

Modem rental is included.

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. At the end of the second quarter of 2022, the company had 2.8 million broadband customers.

Frontier has struggled financially in recent years and filed for bankruptcy protection a few years ago. The company emerged from bankruptcy in 2021 and says it has plans to expand fiber. The company announced it reached 1 million fiber passings in the first quarter of 2022, and said it plans to continue to aggressively build fiber to reach 10 million passings by 2025.

Frontier is an incumbent telephone provider and is considered a provider of last resort, meaning it must make a reasonable effort to provide telephone service to somebody within its defined service area.

Frontier DSL. Frontier offers broadband using DSL served on copper lines.

	Speed	Price
Frontier Internet	Fastest Speed Available	$ 54.99

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

Frontier Fiber. Frontiers offers fiber in some markets.

Frontier FiberOptic	500/500 Mbps	$54.99
Frontier Gig	1000/1000 Mbps	$79.99
Frontier 2 Gig	2000/2000 Mbps	$154.99

Telephone Rates

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

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

Frontier charges by the minute for long-distance. This means that free calling is generally only available to those living close to the serving area, while there is an extra fee to call anywhere else. For all telephone lines, Frontier charges an additional $6.50 for Subscriber Line Charge and up to $1 for an Access Recovery Charge (ARC). There has been a proposal at the FCC to abolish the Subscriber Line Charge, in which case Frontier's rates would likely drop by $6.50

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

CASSCOMM[2] was founded in 1898 as Cass Telephone Company and was rebranded in 1996 as CASSCOMM. CASSCOMM provides video, voice, and broadband services. In Sangamon County, CASSCOMM provides DSL service in the northwest corner of the county.

In 2006, CASSCOMM purchased Green County Partners and began providing cable broadband and video services. CASSCOMM provides cable broadband in the cities of Pleasant Plains, Sherman, Williamsville, Spaulding, and Riverton. It appears that CASSCOMM is offering an older version of technology, probably DOCSIS 2.0.

CASSCOMM is currently upgrading is networks to fiber. CASSCOMM has built fiber networks in Sherman, Williamsville, Spaulding, and Riverton. CASSCOMM has built fiber in the northern part of Pleasant Plains and to two census blocks in the northwest corner.

Residential DSL Broadband		
4/1 Mbps		$ 74.95
Residential Cable Broadband		
Speed	10/2 Mbps	$ 49.95
Speed Plus	25/3 Mbps	$ 59.95
Speed Deluxe	50/5 Mbps	$ 99.95
Residential Fiber Broadband		
Speed	75/75 Mbps	$ 59.95
Speed PLUS	150/150 Mbps	$ 74.95
Speed DELUXE	300/300 Mbps	$ 99.95
GIG Plus	1/1 Gbps	$149.95
WiFi Pod		$ 3.95
Cable TV		
NetPak Cable	20 Channels	$ 41.45
Broadband Vision	63 Channels	$116.45
Settop Box		$ 10.95
HBO		$ 17.55
Cinemax		$ 12.35
Showtime/TMC Package		$ 15.95
Starz/Starz Encore		$ 12.95
Voice		
Digital Phone		$34.95

[2] https://home.casscomm.com/

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

Residential DSL Broadband	
Up to 10 Mbps	$31.95
Up to 25 Mbps	$47.95
Up to 50 Mbps	$50.95
Modem	$10.00

Cable Companies

Comcast Xfinity[3] is the incumbent cable TV provider in central Sangamon County. Comcast markets and bills using the "Xfinity" brand name. The company offers the traditional triple play of cable TV, broadband, and voice services. Comcast is the largest cable TV company in the US with 2021 revenues of $116 billion, and the second largest cable company in the world. It is headquartered in Philadelphia. At the end of the second quarter of 2022, the company had 32.1 million broadband customers and 17.1 million cable customers.

In addition to providing triple-play services, the company owns a number of media assets like NBC, Telemundo, MSNBC, CNBC, USA Network, The Golf Channel, Syfy, numerous regional sports networks, Universal 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.

Stand-Alone Internet

Comcast offers significant promotional 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 stand-alone internet.

Connect	50/5 Mbps	$ 60.00
Connect More	100/5 Mbps	$ 80.00
Fast	300/5 Mbps	$ 90.00
Superfast	600/15 Mbps	$100.00
Ultrafast	900/20 Mbps	$110.00
Gigabit	1200/35 Mbps	$120.00
Gigabit Pro	6000/6000 Mbps	$299.95
WiFi Modem (for all products)		$ 14.00
WiFi Modem (Gigabit Pro)		$ 19.95

Comcast has announced in some markets, mostly where there is competition, that the minimum basic speed of broadband is now 200 Mbps download. The company doesn't offer identical speeds

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

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 raised all broadband rates by $3 in January 2022, with an identical price increase a year earlier. Industry analysts expect prices to continue to increase annually.

Comcast has data caps. That vary between 1 and 1.2 terabyte of total data per month. A terabyte is 1,000 gigabytes. When customers exceed the cap for a given month (the usage adds together both download and upload data usage), Comcast bills $10 for each additional 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 broadband was:

50 Mbps	$30.00
100 Mbps	$40.00
300 Mbps	$55.00
600 Mbps	$70.00
900 Mbps	$75.00
Gigabit	$80.00

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 the special pricing 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 in their price list. We think they direct customers to the Comcast cellular service for those wanting unlimited calling.

Cable TV

The following prices are for stand-alone cable TV. The Limited Basic tier includes the network broadcast channels like ABC, CBS, FOX, NBC, and PBS. The tier also has a number of other channels such as shopping channels and a few others – varies by market. The Extra tier includes most of the popular channels that people expect from a cable subscription. Finally, the Preferred

tier adds on a number of additional channels and includes every non-premium channel offered by Comcast.

Limited Basic	$30.00
Popular TV	$70.00
Ultimate TV	$88.50
Set-Top Box	$ 7.50
DVR Service	$10.00

Comcast adds the following fees to the above prices for every cable subscriber.

Broadcast TV Fee	$22.00
Regional Sports Fee	$10.00

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 the 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 $70 broadband product and the $70 cable product and is given a $20 bundling discount and charged $120 for the bundle. If a customer drops either product, the customer loses the entire $20 discount, and the remaining product reverts to the list price.

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

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

Comcast has expanded the bundle in the last few years. Their newest offering is cellular service which is only available for customers buying Comcast broadband. The pricing is simple, and inexpensive. Customers pay the amount of data used, at $15 per gigabyte. A customer using less than 1 GB of data pays only $15 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.

Hidden Fees

Comcast has significant hidden fees. Consider the following:

- The broadcast fee is $22 per month. This is a fee where Comcast has accumulated increases in programming costs into this side fee rather than raising the basic price of cable.
- The regional sports fee is $10 per month – the fee varies by market depending upon the local sports networks that Comcast carries. Again, the company has shuttled rate increases into this fee to hold down the advertised price of cable TV.
- Comcast also charges $7.50 extra for a settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $30 basic cable product from Comcast could get the first bill for almost $70 – a startling difference.

Comcast also has what most in the industry consider as hidden fees for broadband. The company charges $14 per month for a WiFi modem. The biggest surprise for a new customer is the Comcast data cap on broadband. The company charges $10 for each 50 GB of data over the data cap limit.

The hidden fees are controversial. In 2018, Lori Swanson, the Attorney General of Minnesota, sued Comcast, seeking refunds for all cable customers who were harmed by the company's alleged violation of the state's Prevention of Consumer Fraud Act and Uniform Deceptive Trade Practices Act.

The suit concentrated on the Broadcast TV fee and the regional sports fee, which are charged to every cable customer. Comcast started charging separately for these two fees in 2014, but the size of the fees has skyrocketed. In recent years, the company has put a lot of the annual rate increases into these fees, allowing the company to continue to advertise low prices.

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

Mediacom provides service in several cities and the surrounding areas in the county. 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 second quarter of 2022, the company had 1.46 million broadband customers and 540,000 cable customers.

Residential Broadband		
100/5 Mbps	$ 29.99	200 GB Data Cap
200/10 Mbps	$ 79.99	1 TB Data Cap
400/30 Mbps	$ 99.99	2 TB Data Cap
1 GB/ 50 Mbps	$129.99	6 TB Data Cap
Modem w/WiFi	$ 13.00	
Installation	$109.99	

Television	
Local TV	$40.00
Essential TV	$80.00
Variety TV	$99.00
HBO + HBO Max	$18.95
Showtime	$14.95
Cinemax	$12.95
Starz/Encore	$12.00
International Channels	$ 9.99 each
Settop Box	$10.50
TiVo DVR Box	$14.95

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 Bundles at	$0.05 per minute

Hidden Fees

The Mediacom also has significant hidden fees. Consider the following:

- The broadcast fee is $21.43 per month. This is a fee where Mediacom and other cable companies have accumulated increases in programming costs into this side fee rather than raising the basic price of cable.
- The regional sports fee is $6.30 per month – the fee varies by market depending upon the local sports networks that Mediacom carriers. Again, the company has shuttled rate increases into this fee to hold down the advertised price of cable TV.
- Mediacom also charges from $10.50 to $14.95 extra for a settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $40 basic cable product from Mediacom could get the first bill for almost $80 – a startling difference.

Mediacom also has what most in the industry consider as hidden fees for broadband. The company charges $13 per month for a WiFi modem. The biggest surprise a new customer might see is the Mediacom data

cap on the 100 Mbps product. The company charges $10 for 50 GB of data for any customer exceeding the monthly data cap.

Sparklight is the brand name of Cable One. Cable One had a little over 1 million broadband customers in 21 states at the end of the second quarter of 2022. Cable One had only 221,000 cable customers at the end of the second quarter and has an unusual strategy for the industry by not fighting to keep cable customers.

The company has been growing through acquisitions. In 2021, Cable One purchased the remaining shares of Hargray Communications, giving it 100% equity control of the company. The acquisition was for $2.2 billion. In July 2020, Cable One purchased Valu-Net, an all-fiber ISP in Illinois, for $38.9 million. In 2019, Cable One acquired Fidelity Communications for $526 million. In 2018, Cable One bought Clearwave Communications. The purchase added 2,400 route miles of middle-mile fiber and approximately 2,700 business towers and data centers.

Following are the prices for Sparklight broadband:

<u>Residential Broadband</u>			
Starter 100+	100 Mbps	$ 55.00	300 GB Data Cap
Streamer & Gamer 200+	200 Mbps	$ 65.00	600 GB Data Cap
Turbo 300+	300 Mbps	$ 80.00	900 GB Data Cap
GigaOne+	1 Gbps	$125.00	1.2 TB Data Cap
Modem		$ 10.50	
Unlimited Data:		$ 40.00	
<u>Television</u>			
Economy	20 Channels	$ 42.00	
Standard	100 Channels	$ 94.50	
Digital Value Add On	24 Channels	$ 16.00	
Settop Box:		$ 7.00	
DVR Box:		$ 15.00	
<u>Telephone</u>			
Economy		$ 20.00	
Standard		$ 25.00	
Long-Distance:		Price varies by location	

<u>Bundles</u>			
Elite Package	Internet/TV/Phone	100 Mbps/100 Channels	$154
Elite 2 Package	Internet/TV/Phone	200 Mbps/100 Channels	$164
Elite 3 Package	Internet/TV/Phone	300 Mbps/100 Channels	$179

<u>Hidden Fees</u>

Sparklight also has hidden fees. Consider the following:

- The broadcast fee ranges between $12.95 and $21.77 per month, depending on the market. Sparklight also has a Broadcast TV Delivery Surcharge of $3.95 in some areas. This is a fee where Sparklight has accumulated increases in programming costs into this side fee rather than raising the basic price of cable.
- The regional sports fee is $6.89 per month for a standard cable customers. Again, the company has shifted rate increases into this fee to hold down the advertised price of cable TV.
- Sparklight also charges from $7 to $15 extra for a settop box – a fee that is not included in the advertised price.
- A first-time customer buying the $42 economy cable product from Sparklight could get the first bill for over $83 – a startling difference.

Sparklight also has what most in the industry consider as hidden fees for broadband. The company charges $10.50 per month for a WiFi modem. The biggest surprise customers might see is the Sparklight data caps that charge $10 for 100 gigabytes of data for any customer exceeding the monthly data cap – with the maximum monthly data cap fee at $50. In some markets, Sparklight charges a $2.75 Internet surcharge fee.

Fiber Overbuilders

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 Sangamon County, i3 Broadband provides service in southwest city of Springfield.

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

WISPs (Wireless ISPs)

Veloxinet is a fixed wireless provider founded in 2005 and headquartered in Springfield, IL. Veloxinet provides broadband service in rural Illinois and is currently upgrading to fiber in selected areas. In Sangamon County, Veloxinet provides fixed wireless service in the northern part of the county.

[4] https://i3broadband.com/

Residential Broadband	
25/10 Mbps	$45
50/25 Mbps	$49

PWR-net is the brand name for the Shelby Electric Cooperative's broadband service. PWR-net was launched in 2008 and provides fixed wireless broadband service to Shelby Electric Cooperative's service area. In Sangamon County, PWR-net provides its services in the eastern part of the county.

Residential Broadband	
1 Mbps/256Kbps	$39.95
4/1 Mbps	$54.95
10/2 Mbps	$69.95
15/2 Mbps	$99.95
Installation	$99

Royell Communications is a fixed wireless provider in Sangamon County. Royell Communications has plans to upgrade some of its service areas to fiber. In Sangamon County, the company serves the western part of the county on its fixed wireless network.

Residential Fixed Wireless Broadband	
1 Mbps/ 512 Kbps	$29.95
3/1 Mbps	$37.95
6/1 Mbps	$46.95
10/1 Mbps	$54.95
15/2 Mbps	$69.95
25/5 Mbps	$79.95

Residential Fiber Broadband	
50/50 Mbps	$39.95
200/200 Mbps	$49.95
500/500 Mbps	$59.95
1/1 Gbps	$69.95

King Street Wireless provides internet access and high-speed 4G LTE service on its spectrum across the United States. Cellular service is offered in conjunction with its partner, UScellular. King Street Wireless is headquartered in Alexandria, Virginia. In Sangamon County, King Street Wireless provides service in the northwestern part of the county.

Residential Broadband
Customers must contact King Street Wireless for pricing and speed quotes.

Rise Broadband[5]. In 2015, Skybeam, Digis, T6, Prairie Net, and Rhino Communications were rebranded under the Rise Broadband name. Rise Broadband was founded in Englewood, Colorado, in 2005 and

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

provides fixed wireless broadband and VoIP services. The company claims to have coverage throughout the county.

Residential Internet		
Up to 5 Mbps	$42	250-Gigabyte Data Cap
Up to 10 Mbps	$42	250-Gigabyte Data Cap
Up to 15 Mbps	$42	250-Gigabyte Data Cap
Up to 20 Mbps	$47	250-Gigabyte Data Cap
Up to 25 Mbps	$47	250-Gigabyte Data Cap
Up to 50 Mbps	$57	250-Gigabyte Data Cap

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

Telephone	
ActivePhone (Broadband phone)	$25.00

A.C.T.S.[6] is a fixed wireless provider in Sangamon County. A.C.T.S. started in 2012 as a computer repair company and, in 2018, began selling broadband services. Currently, the company is building fiber in Assumption, Macon, Moweaqua, Stonington, Blue Mound, Bethany, Dalton City, Findlay, and Pana. A.C.T.S. provides fixed wireless in western Sangamon County. A.C.T.S. has not upgraded its service areas to fiber in the county as of the time of this report.

Residential Fixed Wireless Broadband	
10 Mbps	$ 20
50 Mbps	$ 50
100 Mbps	$ 80
200 Mbps	$125

Residential Fiber Broadband	
50 Mbps	$ 20
250 Mbps	$ 50
500 Mbps	$ 80
1 Gbps	$125
Installation	$100
Router	$7.50

Cellular Data

Cell Phone Broadband

All three primary cellular companies advertise unlimited data plans for cell phones. The plans for AT&T and Verizon are not actually unlimited and have monthly data caps in the range of 20 - 25 gigabytes per month of downloaded data. T-Mobile advertises unlimited data but begins throttling customers to slower

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

speeds after 50 gigabytes of data usage in a month. There are customers in the county who get all broadband from their cell phone. There has been reports of Verizon disconnecting rural customers who use too much data on these plans. The cellphone plans have limits on how much data can be used when tethering from a cell phone to connect to other devices.

In addition to the three primary cellular carriers, Sangamon County is also served by U.S. Cellular. Most of the country should be seeing cellular coverage over the next few years from Dish Networks. The company's first markets were just launched in June 2022.

Hotspots and FWA Broadband.

In recent years the cellular plan for home broadband have been marketed 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 a carrier has upgraded cellular cell sites to use the new spectrum, but also where the new product is opened 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.

UScellular is the new brand name for U.S. Cellular, which was founded in 1983 by TDS and is headquartered in Chicago, IL. The company is the fourth-largest cellular provider, with a little over four million customers at the end of the second quarter of 2022. The fixed cellular products are sold by the amount of broadband provided for a month rather than by speed. The company recently announced plans to offer a faster FWA fixed cellular broadband product.

Residential Internet	
25 GB of data	$ 55
55 GB of data	$ 75
75 GB of data	$100
105 GB of data	$130
150 GB of data	$160
Modem	$5.95

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 of data	$ 20
50 GB of data	$ 40
100 GB of data	$ 90
150 GB of data	$110

When a customer hits the data cap ceiling, the speeds revert to 3G.

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

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.

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 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 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 shown in the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault announced recently that the average U.S. home used 491 gigabytes of data per month in the second quarter of 2022. 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 up to 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 and pay a fee of $15 per remaining month if a customer breaks the 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 Gigabyte Plan	$ 59.99
20 Gigabyte Plan	$ 69.99
30 Gigabyte Plan	$ 99.99
50 Gigabyte Plan	$149.99

Low-Orbit Satellite. There has been a lot of recent news concerning the three new low-orbit satellite companies that will be offering broadband. Where the older satellite companies park satellites at over 20,000 miles above the earth, these companies are putting satellites between 300 and 600 miles above the earth.

Starlink is owned by Elon Musk. The company has been in beta test mode and has been selling broadband across the U.S. for $110 per month, including a $599 one-time fee for the receiver. The company has gotten infamous for having a year-long waiting list of customers that have made a $99 deposit. The company has over 2,300 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.

OneWeb is owned by the British government and various large private investors. The company says it is testing broadband in the far northern hemisphere in early 2022 and plans to cover the world by the end of the year. This might only be made available for governments, cell towers, the military, and large businesses.

Project Kuiper is owned by Jeff Bezos. The company hasn't launched any satellites but has reserved all of the upcoming space launches from several rocket companies starting at the end of 2022 and beyond. The company is being fully funded by Bezos and Amazon and is expected to catch up to the other two providers.

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.

Comcast Internet Essentials

Comcast has a low-income program called Internet Essentials that provides broadband to qualifying households. Comcast delivers 50/5 Mbps speeds for $9.95 per month. The program was created as a condition by the FCC for the purchase of NBC Universal in 2011. For a long time, the program was lowkey, and the company barely advertised it to customers. But over the years, the company has embraced the program, and in August 2019, 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 current eligibility covers families that participate in Medicaid; live in public housing; participate in SNAP, TANF, SSI, National School

Program, Headstart, LIHEASP, or WIC; attend college using a Pell grant; receive a VA pension; or receive various kinds of tribal assistance are eligible for the program.

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.

Federal Lifeline Program

Frontier, CASSCOMM, Consolidated Communications, and Rise Broadband participate in the FCC Lifeline program, which is a part of the Universal Service Fund. With the program, a customer can receive a discount in 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 the $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.

In Sangamon County, Frontier, Comcast, Mediacom, Sparklight, CASSCOMM, Consolidated Communications, i3 Broadband, PWR-net, Rise Broadband, and Verizon participate in the ACP Program.

B. Surveys / Interviews / Speed Tests

Results of the Residential Survey

As part of the study, we conducted an online residential survey. Online surveys are not statistically valid, meaning that the survey cannot be used to reliably predict numerical responses like the percentage of homes that will buy broadband from a new ISP. The primary reason for this is that an online survey is not conducted randomly and may not reach enough of the homes that don't have broadband. Instead, the folks that respond to an online broadband survey are more likely those who are interested in the topic.

With that said, an online survey is useful for measuring sentiment. For example, an online survey is great at telling us how residents feel about current broadband and existing ISPs. We can still gain great insight into how people might react if a new fiber network was built – we just can't fully rely on any statistics.

The survey was conducted online using Survey Monkey during the summer and fall of 2022. The County advertised the survey on social media and other channels. The survey was well-received by the public and we got 1,349 responses to the survey.

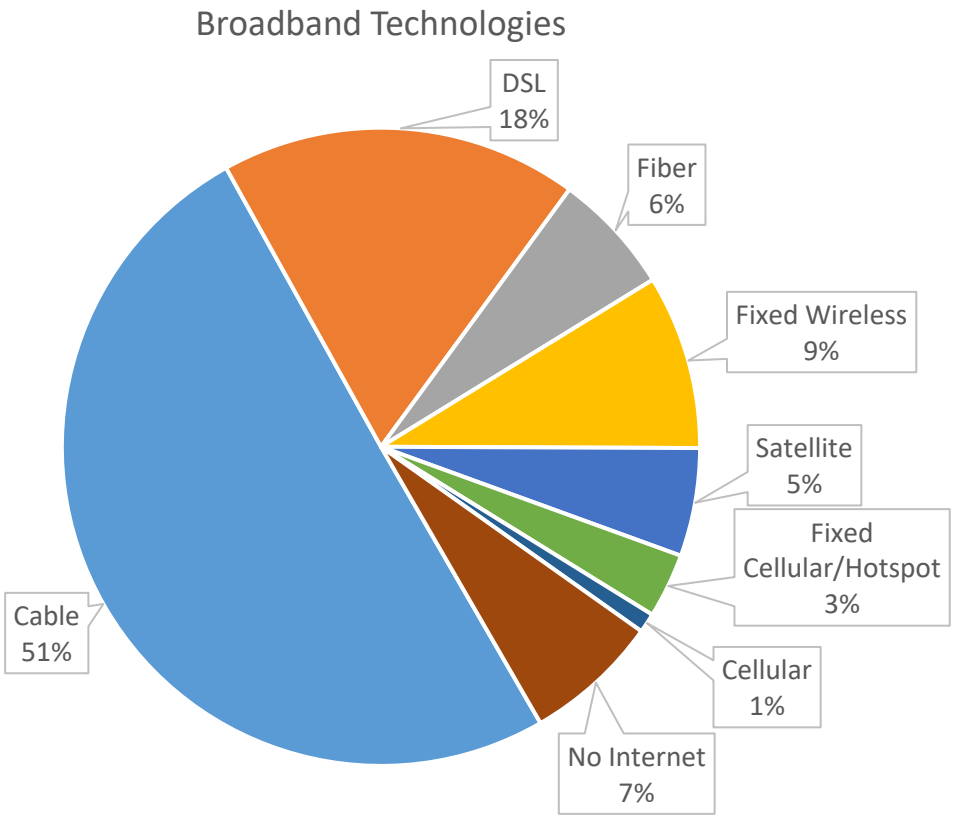
Survey Results

A copy of the survey questions and a summary of the responses is included in Addendum I of this report.

Here are highlights of the survey results:

<u>Broadband Customers</u>

92% of the respondents have a home broadband connection today – with 8% saying they don't have home broadband. The 8% includes 1% of respondents who only get broadband from their cellphone. We got a great cross section of the county and received responses representing customers of seventeen different ISPs. The following pie chart summarizes the broadband usage of survey respondents summarized by the technology used to bring broadband.



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

- 51% of the respondents buy broadband from a cable company. 44% use Comcast, 5% purchase service from Mediacom, 2% use Sparklight (Cable One), and less than 1% use CASSCOMM.
- 18% of respondents buy DSL broadband from a telephone company. 3% use Frontier, 13% use AT&T, 2% use CASSCOMM, and less than 1% use Consolidated Communications.
- 6% of respondents have home broadband served by fiber. 5% use i3 Broadband, 1% use AT&T, and less than 1% use CASSCOMM.
- 9% of respondents buy fixed wireless from a WISP.
- 5% of respondents use satellite broadband.
- 3% use cellular hotspots or the newer FWA cellular technology for home broadband.
- 1% only use their cell phones for home broadband
- 7% of respondents do not have home broadband.

Around 87% of all homes nationwide have a home broadband connection. If we are to believe the survey, the percentage of broadband purchased in the county is higher, at 92%, than the national average. We doubt that is the case and it's likely that the online survey didn't reach as many folks without broadband as would have been found with a statistically valid survey.

We asked why respondents don't have a home broadband connection. 65% said that broadband is not available at their home, 26% said that broadband is too expensive, 6% said they don't have a computer, 2% said they do not know how to use the internet, and 1% said they had no need for home broadband.

We note that 64 respondents claimed that broadband is not available at their home. We've always interpreted this to mean that there is no functional broadband. Many of the homes without broadband have likely tried DSL, satellite broadband, or cellular hot spots in the past and rejected those technologies as not worth the cost.

Cable TV Penetration

58% of survey respondents report the purchase of traditional cable TV. 2% purchase from AT&T, 27% from Comcast, 1% from Mediacom, 1% from CASSCOMM, 1% from i3 Broadband, 1% from Sparklight, and 25% households from satellite – meaning DirecTV or Dish Networks. The cable penetration in the county is higher than the nationwide average penetration that dropped to 49% at the end of the second quarter of 2022.

32% of the survey respondents claim to be cord-cutters who watch all content online. There is no reliable count of the nationwide market share of cord-cutters, but most estimates put it between 30% and 40%. The percentage of cord-cutters should continue to grow as the percentage of homes buying traditional cable TV continues to drop.

Another 5% of respondents use an antenna to get free TV over the air. 2% of homes claimed not to watch TV, while 3% of homes say that TV services are not available at their home. We often see that response from rural homes that are located in areas that can't receive a clean signal from the satellites.

Telephone Penetration

30% of homes report having a landline telephone. This is a little higher than the national average that is estimated to be around 25%.

Cellular Service

99% of respondents subscribe to cellular service – that's above the national average of 95%. 29% of respondents said the cellular coverage is not adequate at their home.

Customer Bills

The survey asked customers what they pay each month for the triple-play services (Internet access, cable TV, and telephone). We've found that this question always has to be taken with a grain of salt because what people say they pay is often different than what they actually pay. For example, a household might cite a $100 special price they are paying without realizing that they actually pay more due to hidden fees and additives. It's especially easy these days for customers that pay automatically with credit cards or bank debits and do not know how much they pay. With that said, here is what respondents said they are spending:

- Customers buying a bundle of services $204
- Customers buying standalone broadband $ 83
- Customers buying standalone cable TV $133
- Customers buying standalone telephone $ 90

Each of these averages is higher than what we see in the many other communities we've investigated over the last few years.

- We note that the $204 average for bundles is higher than what we see in other communities, and a more typical cost would be closer to $175. The largest bundler in the county is Comcast that include broadband, cable TV, and telephone. AT&T has a bundle that includes DirecTV.
- The average price for standalone broadband is higher than what we see in other communities – we usually see an average between $70 and $75. The high average price seems to be driven by two factors. First, the average price reported by Comcast subscribers for broadband is $80. But surprisingly, the highest prices paid for broadband are rural folks spending a lot of money on satellite and cellular hotspot plans. Bringing better broadband to the rural areas will likely bring a savings.
- The telephone price is also higher than what we see in other communities – we believe that rural households with poor cellular service are still paying for long-distance calling.
- The standalone cable TV rates is also higher than what we see in other communities.

We asked survey respondents to define affordable broadband. 11% said between $0 - $25 per month; 43% said between $26 - $50 per month; 31% responded that between $51 - $75 per month is affordable; 11% claimed between $76 - $100 per month is affordable; 3% said that between $101 –$150 is affordable; and 1% of respondents said a price over $150 per month is affordable.

What is striking about this response is that 54% of respondents hope for prices under $50 per month – a price that is not available to most of them.

Uses of Broadband

We asked respondents how often they use broadband at home. 85% said they use it for more than a few hours daily, 13% said they use it for up to a few hours daily, 1% only use it a few hours a week and 1% only use it occasionally. This is becoming a typical response where homes that use broadband are typically using for hours every day.

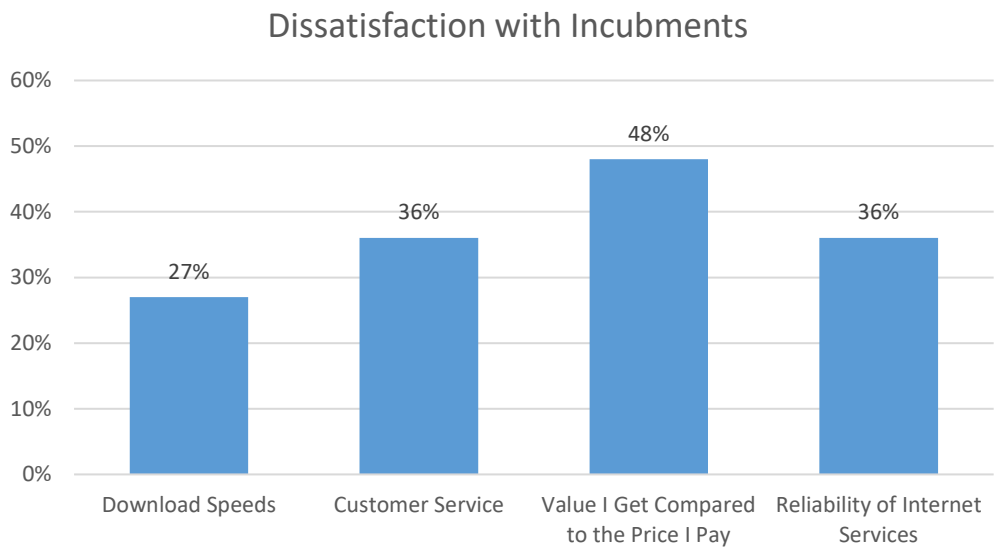
70% of respondents with home broadband said that somebody in their homes uses the Internet to work from home. That is made up of those working at home full-time (20%), those that work several days per week (28%), those that work a few times a month (9%), and those that work from home occasionally (13%). 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 broadband.

26% of respondents report having somebody in the home using broadband for schoolwork. 36% of these households said that their broadband is 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 comes from inadequate upload speeds. This is something that many people don't yet understand, and they often assume that the entire broadband connection is inadequate.

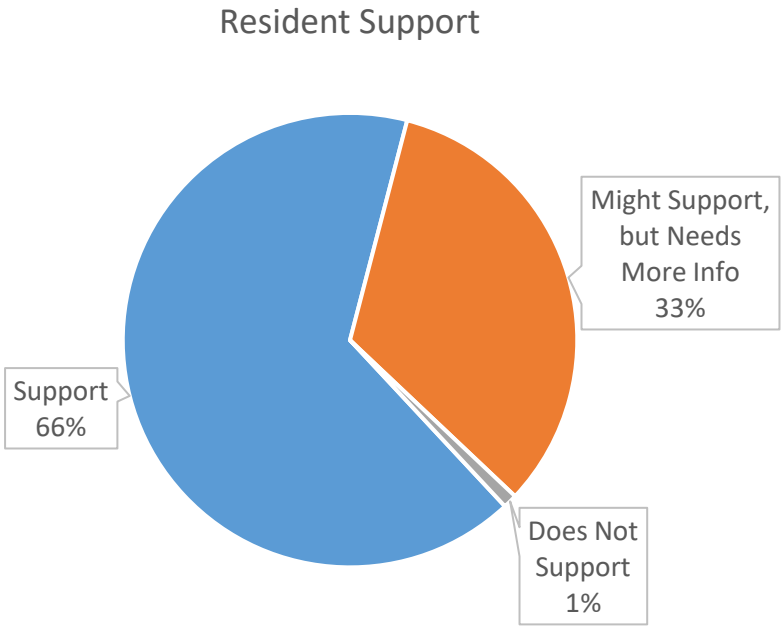
Satisfaction with Existing Broadband

Below is a graph of that highlights the percentage of respondents who are dissatisfied with some aspect of the current ISPs. The highest level of dissatisfaction (48%) is customers who don't think they are getting a good value for the price that they pay.

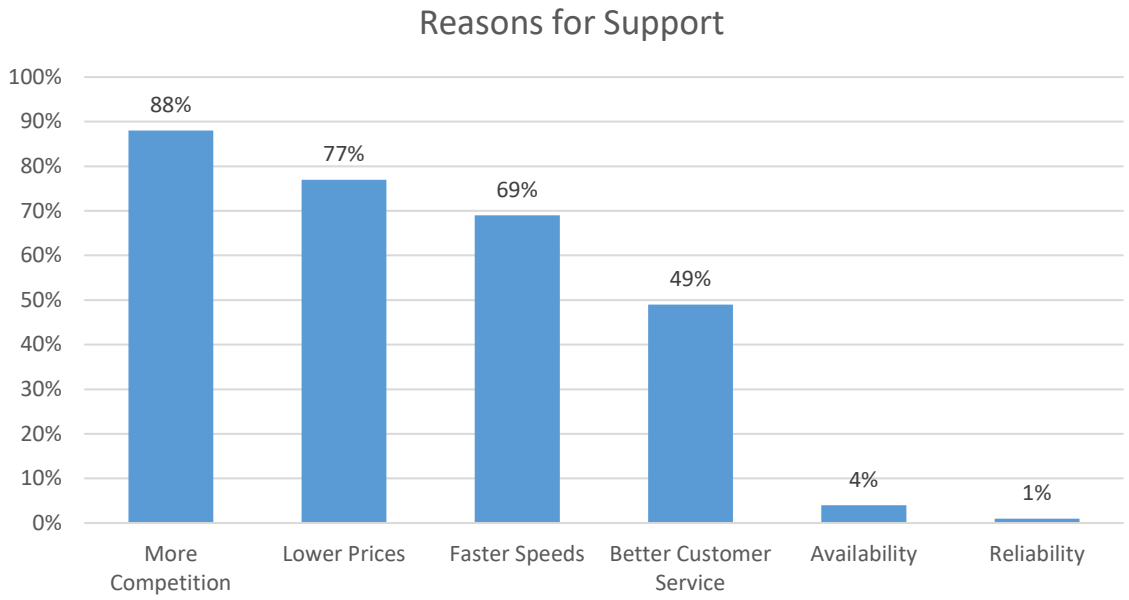


Support for a Fiber Network

One of the key questions asked in the survey is if respondents support the idea of Sangamon County working to find better Internet access. The pie chart below shows overwhelmingly positive support for the county seeking better broadband. 66% of survey respondents support a county effort while another 33% might support the effort but would like more information. Only 1% of respondents dislike the idea.

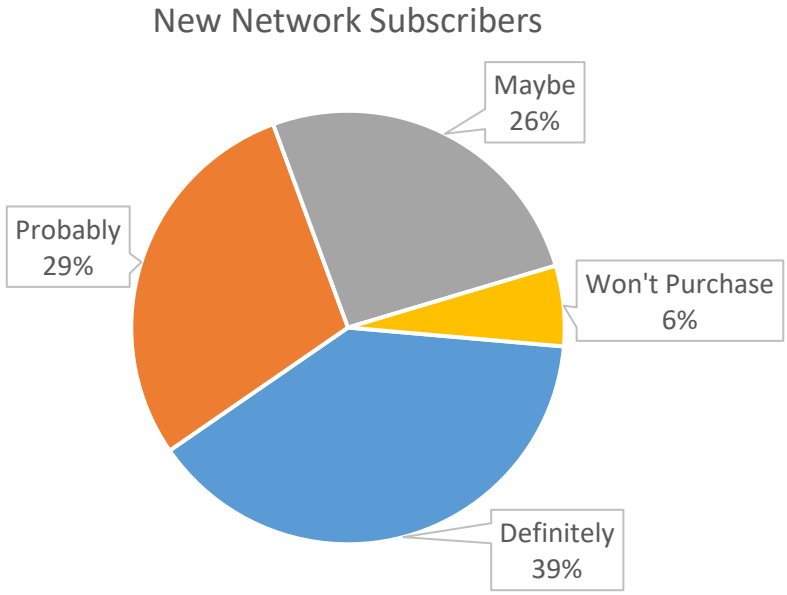


The bar chart below shows the reasons for the public support for better broadband. Respondents could choose more than one response. An overwhelming 88% of respondents want more competition. 77% of respondents want lower prices. 69% of respondents want faster speeds.

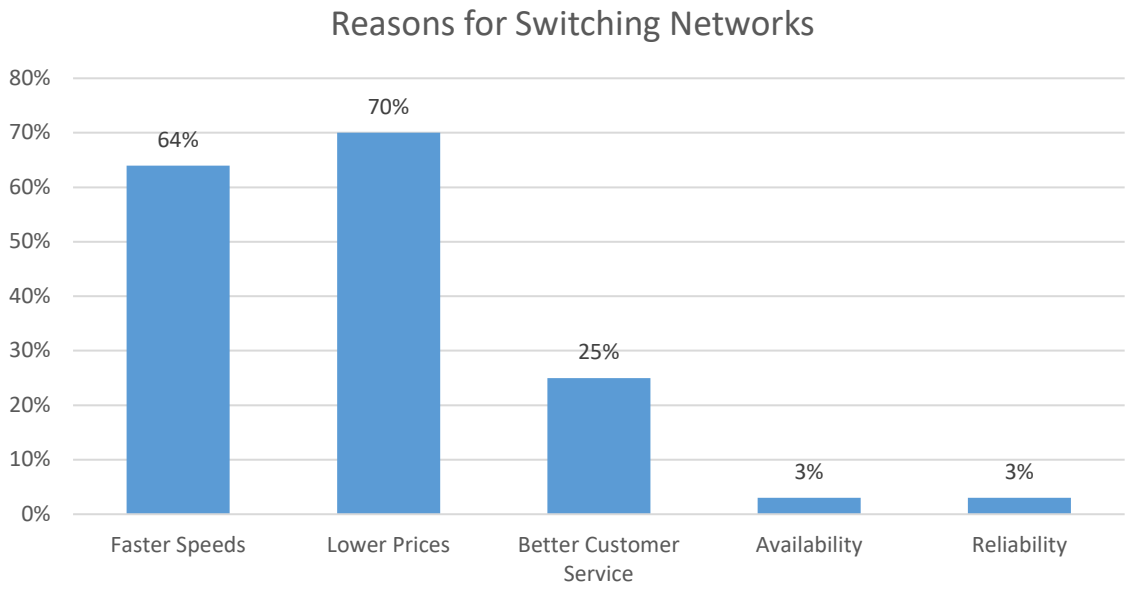


Switching Service to a New Network

In probably the most important question of the survey, we asked respondents if they would buy broadband service from a new fiber network. As seen in the graph below, 68% of survey respondents said they would definitely buy (39%) or probably buy (29%) Only 6% of respondents said they definitely would not consider buying from a new network.



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.



As we saw in earlier survey responses, the desire for lower prices (70%) and faster speeds (64%) are both of high importance to residents.

8% of respondents said they would buy a landline telephone, with another 7% saying probably and 17% said they might buy.

Interpreting the Results of the Survey

It's always a challenge to interpret online survey results. We repeat again that this was not a statistically valid survey. This means that you can't fully rely on the specific results that are expressed as a percentage. It doesn't mean that you can't learn something from such responses, just that you can't rely on the percentage of a given response too be representative of the whole county. As an example, Comcast was the ISP for the highest percentage of survey respondents at 47%. It's highly likely that Comcast has the most customers in the county compared to other ISPs – we just can't reliably say that the Comcast market penetration is 47%.

However, an online survey is great for looking at sentiment, and we can believe the survey when it highlights the issues of most concern to residents. For example, the survey shows a strong sentiment for wanting faster speeds and lower prices.

Following are our primary observations about the survey results:

Price Sensitivity. The issue with the highest importance to respondents is broadband pricing. We see ample evidence that people want lower prices. While it might be natural to assume that people everywhere want lower prices, it's not the case. There are always some people that want lower prices, but the percentage

asking for it is higher in the county than what we see in many other counties across the country. Some of the evidence that lower prices are important to residents include:

- 54% of respondents said that they define affordable broadband to be at a price of $50 or less. That's a lower price than what is available to residents today.
- 77% of residents support the idea of a new network if it means lower prices and 70% of residents said they would move to a new network for lower prices.
- The average current cost of standalone broadband cited by residents was $83, which is a lot higher than the $70 - $75 price we normally see.
- 48% of respondents are unhappy with the value they get for the price they pay – which is another way of saying they believe they are paying too much.

Desire for Faster Speeds. An overwhelming percentage of respondents want faster speeds. We were surprised to see in the details of the survey that this includes a number of cable company subscribers. There seems to be several reasons why cable company customers want faster speeds:

- A detailed look at the responses shows that 8% of Comcast subscribers, 3% of Mediacom subscribers, and 13% of Sparklight subscribers receive download speeds under 100 Mbps. This could be due to folks that are buying packages with speeds under 100 Mbps, or this could be indicative of network problems. There are numerous ways that a network can have different performance in different neighborhoods. Local network performance is determined by a long list of issues, such as the age of the cable on a given street, how often wires have been knocked down by storms, the relative number of people that are sharing the network (definitely varies by neighborhood), etc. Some of the desire for faster speeds might be the result of sections of the town where speeds aren't as good as elsewhere.
- We've found nationwide that customers might be happy with download speeds but are not happy with upload speeds. It's often hard for customers to understand the difference – if they are having trouble making a Zoom call or working from home, they are unhappy with the ISP, even though the issue might be related only to slow upload speeds. The speed test results shown below show that the cable companies and most of the ISPs in the county have far slower upload speeds than download speeds.

An overwhelming 64% said that the primary reason they would consider moving to a new network is to get faster speeds, with 69% saying faster speeds are the reason they support the network. This response varies according to the technologies that people are using. For example, over half of customers subscribing to the cable companies are happy with network performance. But a large majority of rural residents using technologies like DSL, fixed wireless, satellite, or cellular hotspots are unhappy with broadband speeds.

Competition. Another sentiment that came through strongly is the desire for more competition. 88% of respondents said more competition is the reason they would support a new network. A strong desire for more competition is not surprising for residents living in the rural parts of the county; however, many Comcast subscribers also want more competition. This indicates that the respondents living in the cities where Comcast serves feel like they have no real choice for broadband.

We can't forget that 7% of respondents have no home broadband, and a majority of them said good broadband wasn't available at their homes. For these folks, more competition means an ISP that is willing to serve them.

Support for a New Network. There is overwhelming support for a new network in the county. 66% of residents support the idea of building a fiber network in the county, with another 33% who might support the idea if they had more information.

The high support is easier to understand when looking at the reasons for the support. 88% of respondents hope for more competition. 77% of those who support a fiber network are hoping for lower prices. 69% of supporters hope for faster speeds. 49% are hoping for better customer service from the fiber network.

A level of support this high should provide justification for the County considering some of the next steps recommended in this report.

Dissatisfaction with the Incumbents. We would classify the level of dissatisfaction with the current ISPs as moderate. 27% of respondents were unhappy with download speeds, 36% of respondents were unhappy with the reliability of their service, and 36% were unhappy with customer service. The highest level of dissatisfaction of 48%, was related to getting overall value for the price paid for broadband.

However, looking more deeply at the responses shows that there is a much higher level of dissatisfaction in the rural areas compared to the cities.

Potential Customers on a New Network. One of the most important reasons to do a survey is to get a feel for the number of households that might buy broadband from a new network. This is one of the questions where it matters that the survey was not statistically valid – meaning that the answers we derive are not precise enough to use for funding a network – but they are good enough to understand the sentiment.

39% of all respondents said they would definitely buy from a new network. Another 29% said they would probably buy, and 26% said they might buy. We interpret these results as follows:

- Customers who say they will definitely buy probably will. Every county has some core of customers that don't like the incumbent providers – or in many cases don't have an adequate current broadband connection. 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, so the response in the county is higher than average.
- We've always found that as many as two-thirds of those that say they will 'probably' change usually do so. Some won't overcome the needed effort to make the change. But there is a good chance that respondents giving this response will strongly consider a new network.
- The 'maybe' respondents are just that. This is the part of the market that requires a strong marketing budget. These customers can be won by an ISP willing to explain the value propositions of a new network. Perhaps a third of these respondents will eventually buy broadband from a new network.

If this had been a statistically valid survey, we would have interpreted this result to mean that as many as 67% of the county would likely buy broadband from a new network over time. We would caution that seems optimistically higher and it's likely that a statistically valid survey would produce a lower response – but likely not a lot lower. We remind that the folks taking this survey were interested enough in the broadband question to take the online survey. That alone would tend to bias the respondents to favor better broadband a little more than a survey that reached a statistically valid cross section of county residents.

Business Survey / Interviews

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 could they do better if they got better broadband? We also interviewed a sample of businesses and other key stakeholders 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. This includes:

- Three school districts
- Other educational institutions including a career center and a preschool
- Several local government offices
- A rural library
- Three crop farmers and a horse farm
- A wide range of other businesses including restaurants, a tavern, several online retailers, a number of retail stores, an IT company, and a landscaping company.

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

- The public schools have fiber connections bringing broadband. Some of the schools in the county get funding assistance for bandwidth from the FCC's E-rate program that helps to pay for broadband in schools that have with higher-than-average numbers of students on free or reduced-price lunches.

  However, one school district reported that its broadband connection from Comcast suffered regular slowdowns and occasional outages that hurt the schools.

  The schools all reported that students struggled during the pandemic. The school deployed multiple strategies during the pandemic such as providing hot spots for students and broadcasting broadband into the school parking lots. Several school districts told us that hotspots were often ineffective because of the poor rural cellular coverage in many areas.

  We were also told that this is not a problem that disappeared when students came back to the classrooms. Students without good home broadband are at a disadvantage for doing routine homework, which now includes watching videos and entering data online into the school servers. Schools are trying various ways to make this work such as having students download a file onto a thumb drive each day before going home. To the extent possible, some schools are trying to offer a paper version of homework whenever possible, but this is clearly a different experience than for the students with home broadband.
- The general public would probably be surprised about the extent to which even what are considered as pretty basic businesses rely on the cloud for routine daily functions to operate the business. To use an example, we talked to two restaurant/bars in the county who rely extensively on broadband.

Most of the important functions of operating the businesses is done online using cloud software. This includes:

- Credit card processing. Without broadband they have to save credit card transactions and batch process them later. This increases the chance of having taken a payment from a non-valid card.
- Point of Sale. This is the software that tracks everything to do with cash. This is the software that figures out credit card fees that must be paid. It tracks every sale into the accounting ledger. It calculates sales taxes. This provides the daily running balance that allows the business to reconcile cash in the cash register.
- Payroll. Worked hours are reported online to calculate payroll, and tips due to wait staff are calculated automatically on a rolling basis.
- Gaming. Both establishments make significant revenue from online games for patrons. When broadband is down the games go dead. We were told that many patrons leave when the broadband is down.
- The telephones work on the Internet and go dead when broadband is down.
- The dinner reservation system stops working and people can't make new reservations online. (And they can't call to make one since the phones are dead).
- The systems for purchasing supplies like food are all done online.

A large percentage of businesses in the county can tell a similar story. Many everyday tasks are now done online for a wide array of businesses. Places that the public might consider as low tech are completely reliant on broadband. These two businesses told us that for all practical purposes they are shut down when the broadband goes down. This is something we hear regularly from businesses of all sizes.

- We heard mixed stories on the performance of Comcast. A few businesses didn't have any issues with Comcast broadband and were happy with the service. But most of the businesses we heard from said that they experienced fairly regular outages or slowdowns. For example, we heard from a retail store that normally had adequate broadband, but any time that the broadband connection slowed down the store was unable to process credit cards. This particular issue is related to inadequate upload bandwidth, and since the amount of bandwidth needed to process credit cards is tiny, the upload connection has to virtually disappear to block credit card transactions.

  Businesses said that outages are a problem. Sometimes outages are short, but even that disrupts a business. We also heard of a few occasions where customers were out for a few days, and in one cash almost a week.

  This item is not to particularly pick on Comcast – they just happened to the ISP for many of the businesses we talked to. But we heard about outages and slowdowns from other ISPs as well.
- We heard about what sounds like a pretty wide variance in prices. For example, we talked to businesses that had what sounded like the same product mix that were paying as little as $100 or as much as $300 for the same speed broadband. This is not unusual, and the big ISPs are well known for negotiating with each business.
- We heard from several businesses served by slow, rural broadband technologies. We talked to several businesses that are using WISPs and one using high-orbit satellite.
- We talked to several farmers. All were served by rural broadband technologies including fixed wireless and cellular. The farmers had to compromise due to the slow bandwidth. For example,

one farmer had to work from home to enter data about the farm into online software used to track the farming business. One farmer would like to have security cameras, which are not possible with the slow bandwidth. One farmer was using smart farming equipment like tractors. He had to download data to a chip from a location with good broadband and then load the chip into the equipment. He's much prefer being able to download instructions directly to the machines, which would give him instant flexibility in changing plans during a day.

- We talked to a smalltown library. The library has enough bandwidth to provide for four publicly supplied computers. But patrons often bring laptops and there is not enough bandwidth to connect many such patrons. The library provided outdoor bandwidth during the pandemic and has continued it today. It's routine to have people outside working in a vehicle.

  The librarian wished for a budget to be able to spend more time with patrons teaching them to effectively use broadband.
- A number of businesses told us that cellular coverage at the business was poor, or nonexistent. The coverage varies by carrier and is good and bad in different places depending upon the cellular company.
- We talked to a childcare center that takes care of small children in the day and older children after school. There is not enough bandwidth for older children to use computers while at the center. We were told that his is a common problem and that many of the places that do after-school care have inadequate broadband.
- We heard numerous stories about the contrast between home broadband and work broadband. We talked to business owners who live in rural areas who can't take work home. We heard from business owners who live in a city and who must take work home to be completed.

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 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 sufficient to consistently process credit card transactions. That requires almost the bare minimum of bandwidth, which speaks volumes about the quality of rural broadband in the 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.
- 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.
- 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 for each remote employee. These connections can vary between 1 – 3 Mbps per second in both the upload and download directions.
- Data Backup. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that 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

One of the most important aspects of obtaining broadband grants is that the grants are only available in areas where the existing broadband speeds are below par. Speed tests provide a way to judge the quality of broadband in a way that can satisfy those who award broadband grants.

A given speed test is not 100% reliable and doesn't always deliver a true picture of the broadband being delivered to a given address. However, we've found that when speed tests are administered in mass for a

whole community, we can gain a good understanding of the overall quality of broadband. Following are a few of the criticisms that ISPs rightfully make about any individual speed test:

- A speed test only measures the speed of a ping and a short-term connection of less than a minute between a user and the test site router used by the speed test. That doesn't necessarily indicate the speed of every activity on the web, such as downloading files, making a VoIP phone call, or streaming Netflix.
- Every speed test on the market uses a different algorithm to measure speed. As an example, the most common speed tests on the market are from Ookla and M-Labs. , which is one of the most popular speed tests. The M-Lab test tries to transfer as much data as possible in 10 seconds (both upload and download), using a single connection to an M-Lab server.
- A speed test can be slowed due to network issues within the home, such as problems with a home WiFi router or faulty wire inside a home. A slow speed test doesn't always mean that the ISP was providing a slow connection.
- Broadband speeds vary throughout the day, and anybody that takes multiple speed tests during the same day will see this. Taking only a single speed test might not tell the real story about a given customer.
- In Cibola County, we universally heard that broadband speeds bog down during tourism season, so tests taken then will show slower speeds than off-season. However, the speeds really are slower when the networks are overloaded with too many users.
- Some ISPs use something called "burst" technology. This provides a faster Internet connection for one or two minutes. ISPs know that a large majority of Internet activities are of short duration – things like opening a web page, downloading a file, reading an email, or taking a speed test. The burst technology increases the priority of a customer during the burst window, and the Internet connection then slows down when the temporary burst is over. This raises an interesting question – what's the real Internet speed of a customer that gets 100 Mbps during a 2-minute burst and something slower after the burst – there is no consensus in the industry.

As part of this study, the County asked the public to take a speed test from home. Following is a summary of the speed tests, sorted by ISP and listing the technology used by customers.

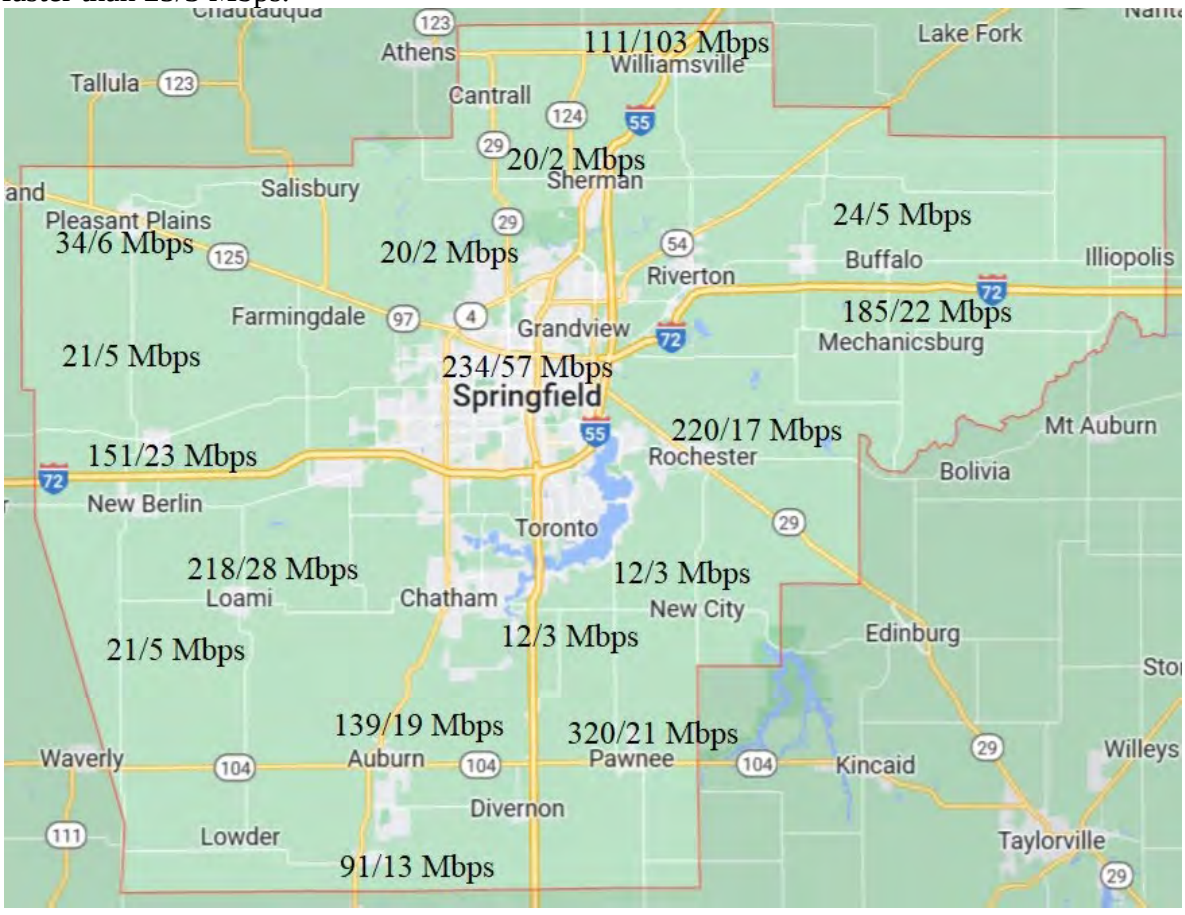
Provider	Technology	Download (Mbps)	Upload (Mbps)	Latency (ms)
AT&T	DSL	19	7	116
AT&T	Fiber	397	360	16
CASSCOMM	Fiber	100	94	8
CASSCOMM	Cable	40	15	37
Comcast	Cable	208	26	29
i3 Broadband	Fiber	421	410	16
Mediacom	Cable	276	28	29
Rise Broadband	Fixed Wireless	28	9	95
Royell Communications	Fixed Wireless	7	0.9	48
Satellite	GEO Satellite	24	2	810
Sparklight	Cable	198	18	13
Starlink	LEO Satellite	54	9	74
T-Mobile	Fixed Cellular	43	17	223

This table shows some interesting things about broadband in the county:

- As expected, the average download speeds for folks using technologies provided in the cities are relatively fast. The cable companies, except for CASSCOMM have an average download speed of around 200 Mbps or faster.
- Also, as expected, the upload load speeds for cable companies are significantly slower than the download speeds,
- The broadband speeds delivered on fiber are roughly symmetrical, meaning the upload speeds are roughly the same as the download speeds.
- Technologies that are used predominantly in rural areas are far slower than urban technologies. The speeds on DSL, fixed wireless, fixed cellular, and satellite are far slower than the urban technologies.
- Some technologies show high average latency. There is a more detailed description of latency following the speed test map below.

Ookla Speed Tests

One of the best sources of speed test data comes from Ookla, which operates the largest speed test site on the web at speedtest.net. Below are several summaries of speed test results from Ookla. The following map shows the wide disparity between cities and rural places in the county. The fastest average speeds are in Springfield and Pawnee. But the speeds in all of the cities that have a cable company are much faster than the surrounding rural areas. As can be seen, none of the rural areas shown have an average broadband speed faster than 25/3 Mbps.



Latency

The 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 a 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 the 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 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.

Latency matters to customers, even if they don't know what it is. For example, it is the low latency on fiber that makes the connection feel faster. 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 (even higher in your speed tests).

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 changing between 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 drops due to the delays.

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. It was not measured in the speed tests. The above discussion highlights problems caused by high latency, which is a measure of the average delay of data packets on a network. 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 speeds and latency reported are the actual result. In reality, the broadband signal coming into a home is incredibly erratic. From millisecond to millisecond, the amount of data hitting a 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 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 in most homes 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 an older technology like DSL performs even worse than might be expected by measuring the speed. 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 a 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 that makes a big difference in broadband performance, and 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 we know to visualize the current state of broadband in the county is through the mapping of available broadband data. This section of the report will look at publicly available broadband mapping data. As will be discussed below, we know that a lot of the FCC mapping data is inaccurate. CCG Consulting and Finley Engineering have together created maps that we think portray the real current state of broadband in the county.

This section of the report will begin with the broadband data as reported by ISPs to the Federal Communications Commission (FCC). In subsequent maps we will show known corrections that should be made to the FCC maps. Our goal with the mapping is to define the areas that don't have good broadband today and which are eligible for broadband grants.

FCC Definition of Broadband

Any analysis of the availability of broadband begins with broadband data collected by the FCC. The FCC is tasked by Congress to report every year on the state of broadband in the country. That responsibility prompted the agency to take two important steps. First, the FCC felt compelled to define broadband in order to be able to tell Congress the number of homes that have or don't have broadband. Second, the FCC began collecting data twice a year from internet service providers (ISPs) that reports on broadband deployment. The FCC requires ISPs to report broadband coverage area and broadband speeds using the Form 477 process. Since the FCC collects broadband statistics by Census blocks, it's relatively easy to translate the FCC database into maps to get a visual understanding of the deployment of broadband.

The following discussion looks at how the FCC gathers broadband data and discusses the specific broadband data for Sangamon County. We also look at the repercussions for cases where the FCC data is inaccurate.

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 Chairman Jessica Rosenworcel announced in July 2022 that the agency will consider increasing the definition of broadband to 100/20 Mbps.

The FCC defines broadband in order 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.[7] 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 also claimed that the broadband situation is improving due to actions taken by the FCC. As you will see in the following report, some of the content in the FCC reports are largely fictional and don't describe the state of broadband in places like Sangamon County.

The FCC didn't use empirical evidence like speed tests in setting the definition of broadband in 2015. It instead conducted what is best described as a thought experiment. The FCC listed the broadband-related 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 typical family.

The FCC Measures Broadband Speeds

Since the FCC is required by law to state an opinion about the state of broadband deployment, they collect data from ISPs about broadband that is sold to customers in the U.S. The FCC collects ISP data using Form 477. The FCC collects data from every ISP that sells some version of fixed home broadband. This includes landline broadband technologies as well as any fixed wireless technologies (meaning there is a connection made in the home). The FCC doesn't require coverage data from dial-up providers, satellite providers, or cell phone providers). The FCC collects the following data twice per year from every ISP.

- ISPs describe the technology being used.
- 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.

[7] 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.

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 data can be easily mapped by overlaying the data for any ISP or group of ISPs onto a map showing Census blocks. The FCC annual report to Congress has concentrated on the number of homes that can or cannot buy broadband at the 25/3 Mbps definition of broadband.

There is one unfortunate quirk of the FCC data collection process in that the fastest speed available to even one customer in a Census Block is assumed to be available to everybody in the Census block. For example, if an ISP has one customer in the corner of a Census Block who 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 coverage is often significantly overstated.

Mapping the FCC data creates some predictable distortions. For example, the availability of broadband is regularly overstated at the edge of towns and cities. Homes in the areas immediately outside of a town are often shown as having the same broadband capabilities as in 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 in 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 it had deployed fiber to 62 million residents in New York. Even after the FCC corrected for this error, the FCC still drew the 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 on broadband doesn't change the answer.

All these factors taken together mean that the FCC broadband databases and maps can be far off-base in some places, while good in others. Even in towns, the broadband speeds likely represent marketing "up to" speeds instead of actual speeds. Speeds for areas just outside of towns and cities are routinely overstated and often show broadband coverage where there is none. 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 rural Sangamon County.

FCC to Revise Maps

In March of 2020, Congress passed S.1822, the Broadband Deployment Accuracy and Technology Availability (DATA) Act which instructs the FCC to improve the broadband maps. The 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 for ISPs that knowingly or recklessly submit inaccurate mapping data. Finally, the Act requires that all federal agencies begin using the new databases before awarding any major broadband funding.

As often happens in the government, this bill didn't provide any funding to make the needed changes. The FCC started the process of formulating new rules around the Act but didn't take any action to fix the maps due to lack of funding. Congress finally provided $98 million in funding from the American Rescue Plan Act (ARPA) for the FCC in December 2020, which included $65 million to create better maps. The first new FCC map should become available in early November 2022.

The FCC maps have recently taken on extra importance since Congress dictated that the FCC maps would be the basis for deciding what areas are eligible for the $42.5 billion BEAD grant program that will likely launch sometime in 2023.

The new maps are supposed to be more accurate since the rules require ISPs to draw polygons around areas that have existing customers or where customers can be connected within ten business days. It's not clear to us that the new maps will be a major improvement. For example, the FCC is keeping one of the worst features of the old maps, and ISPs can continue to report the fastest advertised broadband speed. This is the primary problem in rural areas today, where ISPs claim speeds that are much faster than what is being delivered.

The revised mapping rules also contain a two-tier challenge process – a challenge by governments or Tribes and a challenge by consumers. The FCC was releasing the government challenge rules as we were writing this report. The challenge process is complex, and it will be interesting to see if local communities are willing to make the expensive effort to improve the maps.

The consumer challenges don't have much power. A consumer can challenge that a given ISP 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. We don't think individuals will be able to challenge speeds – which is what most residents care about.

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 when developing policies and making decisions that impact rural broadband. The FCC is fully aware of the inadequacies of the mapping data and yet still cites its 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 have been excluded from being eligible for federal grants.

FCC Data for the ISPs in Sangamon 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 the speeds that they claim to be providing.

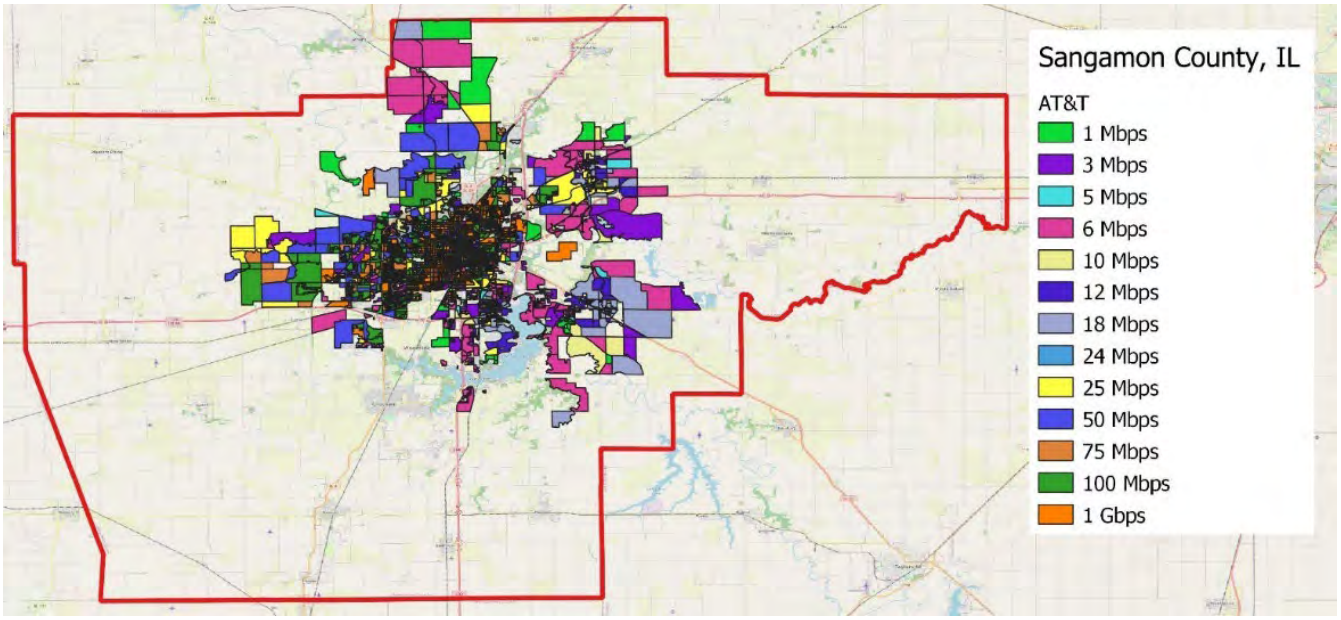
AT&T

AT&T is the incumbent telephone company in central and northern Sangamon 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, AT&T is reporting 13 different tiers of speeds in different parts of the county, with reported download speeds ranging from 1 Mbps to 1 Gbps.

- AT&T 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.
- AT&T 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 AT&T serves even one customer in a Census block using the faster technology, the FCC mapping rules require AT&T 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.
- AT&T shows some speeds faster than 48 Mbps – with Census blocks shown at 50 Mbps, 75 Mbps, 100 Mbps, and 1 Gbps. It's likely that these speeds represent fiber. Again, due to the rules for reporting speeds to the FCC, AT&T 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.

Below is the map of the FCC reporting for AT&T in Sangamon County.

Map 1 – AT&T FCC 477 Data



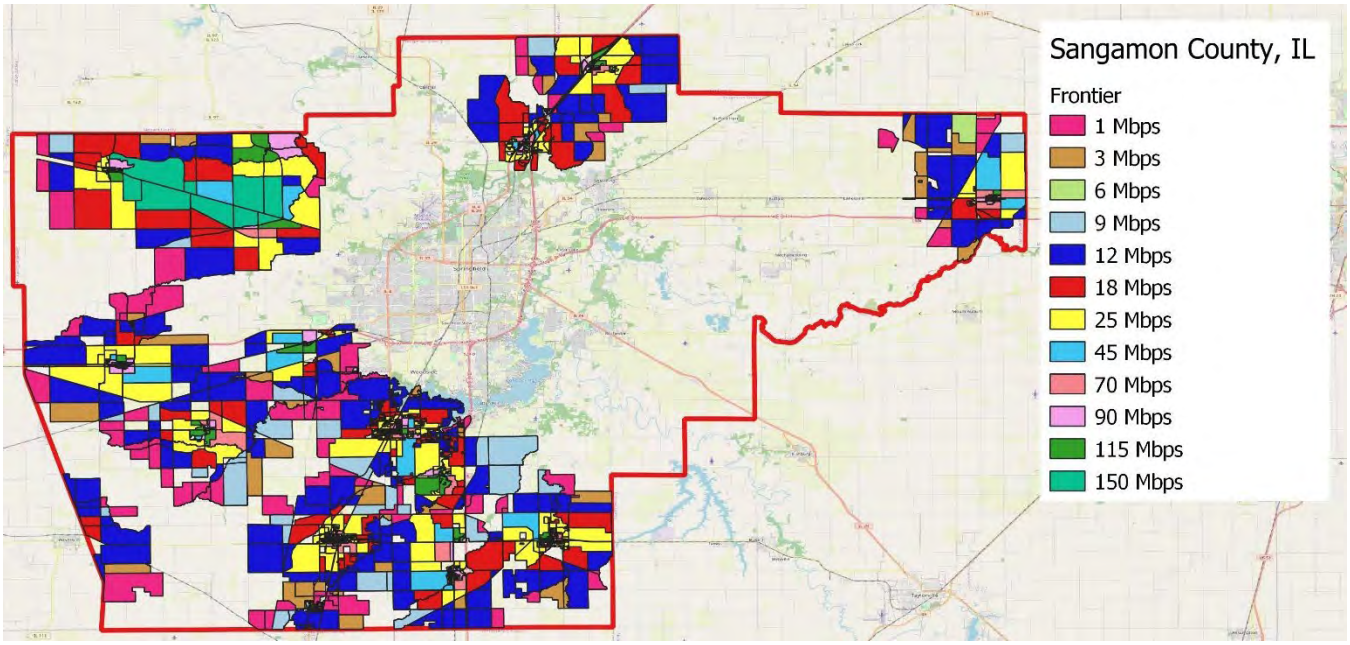
Frontier

Frontier is the incumbent telephone company servicing in much of Sangamon County. Frontier claims 12 speeds in the most current FCC 477 reporting process. The speeds claimed by Frontier are between 1 Mbps and 150 Mbps.

Frontier can provide DSL on either one copper pair or two. The speeds of 25 Mbps or under are supplied on one copper pair. For Frontier, those speeds are 1 Mbps, 3 Mbps, 6 Mbps, 9 Mbps, 12 Mbps, and 18 Mbps. Speeds above 48 Mbps are delivered on two copper pairs. Again, it is possible that a small number of customers can receive speeds that fast. The FCC allows an ISP to claim a census block as being served by a speed if it markets it to at least one customer. Many of the residents in the census blocks are likely receiving speeds much slower than what is reported to the FCC.

Frontier also claims to provide speeds of 70 Mbps, 90 Mbps, 115 Mbps, and 150 Mbps which denotes fiber. Frontier might serve a single business with fiber, but due to the FCC reporting rules can claim everybody in that Census block is able to receive those speeds. The reality is that most customer cannot receive the faster claimed speeds.

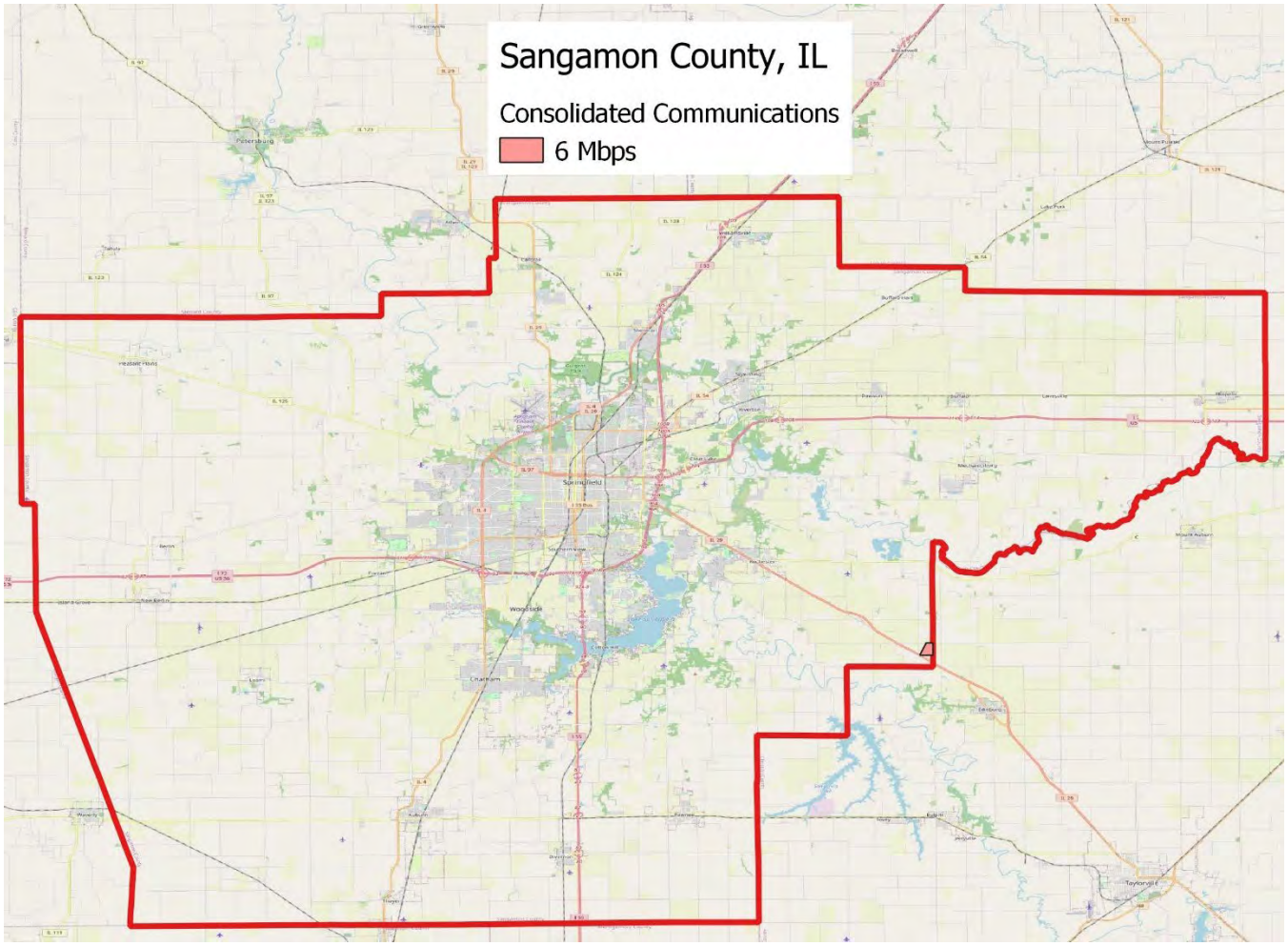
Map 2 – Frontier FCC 477 Data



Consolidated Communications

Consolidated Communications provides DSL to one census block in eastern Sangamon County. In the most recent FCC 477 reporting, Consolidated Communications claims to provide speeds of 6 Mbps.

Map 3 – Consolidated Communications FCC 477 Data

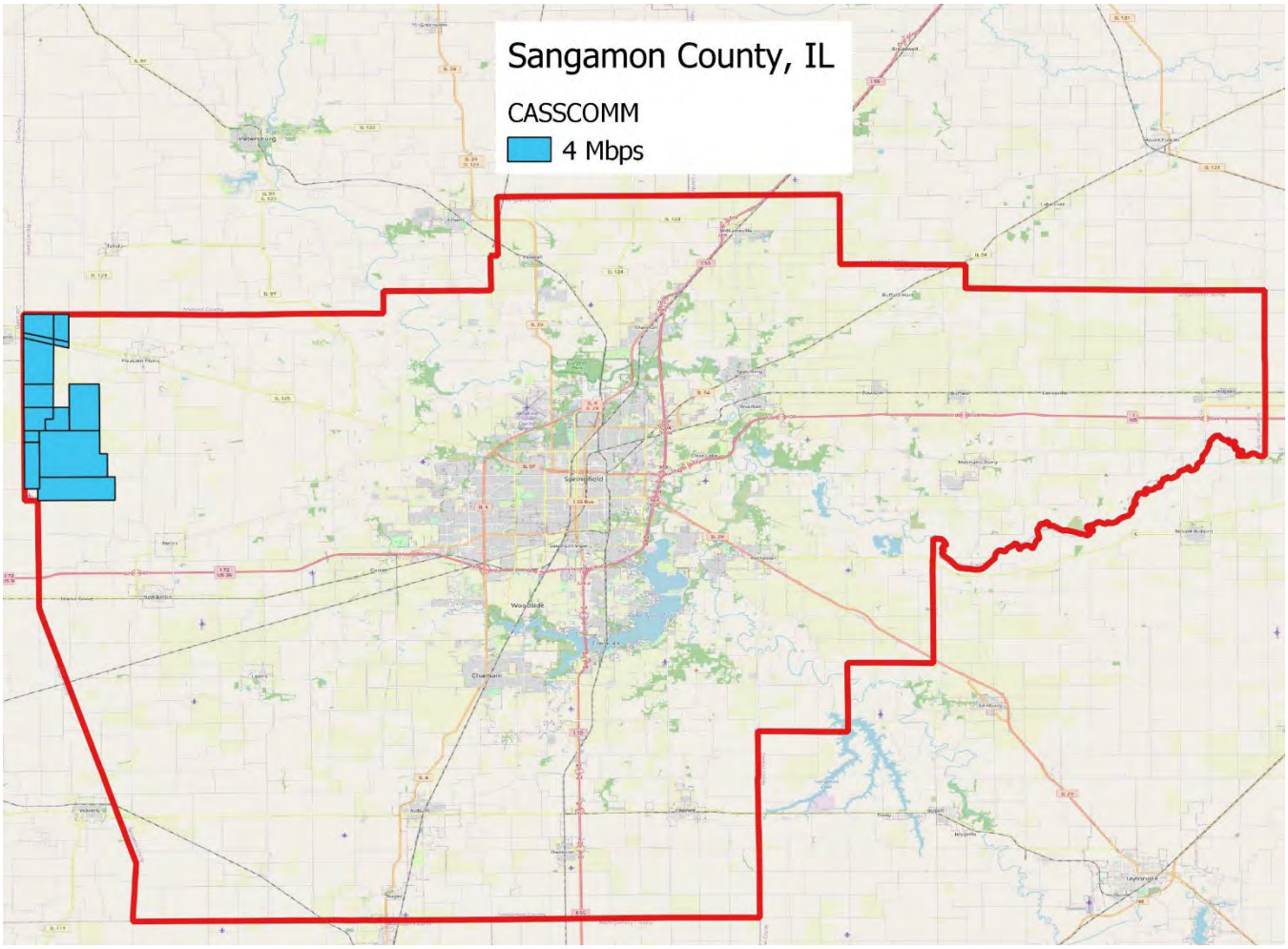


CASSCOMM (DSL)

CASSCOM is the incumbent telephone company and provides DSL broadband in the northwest corner of Sangamon County. In the most recent FCC 477 reporting, CASSCOMM claims to provide 4 Mbps for its entire DSL service territory. The speed reported by CASSCOMM indicates it uses one copper pair to provide DSL in the county.

Below is the map of the CASSCOMM DSL reporting to the FCC.

Map 4 – CASSCOM (DSL) FCC 477 Data

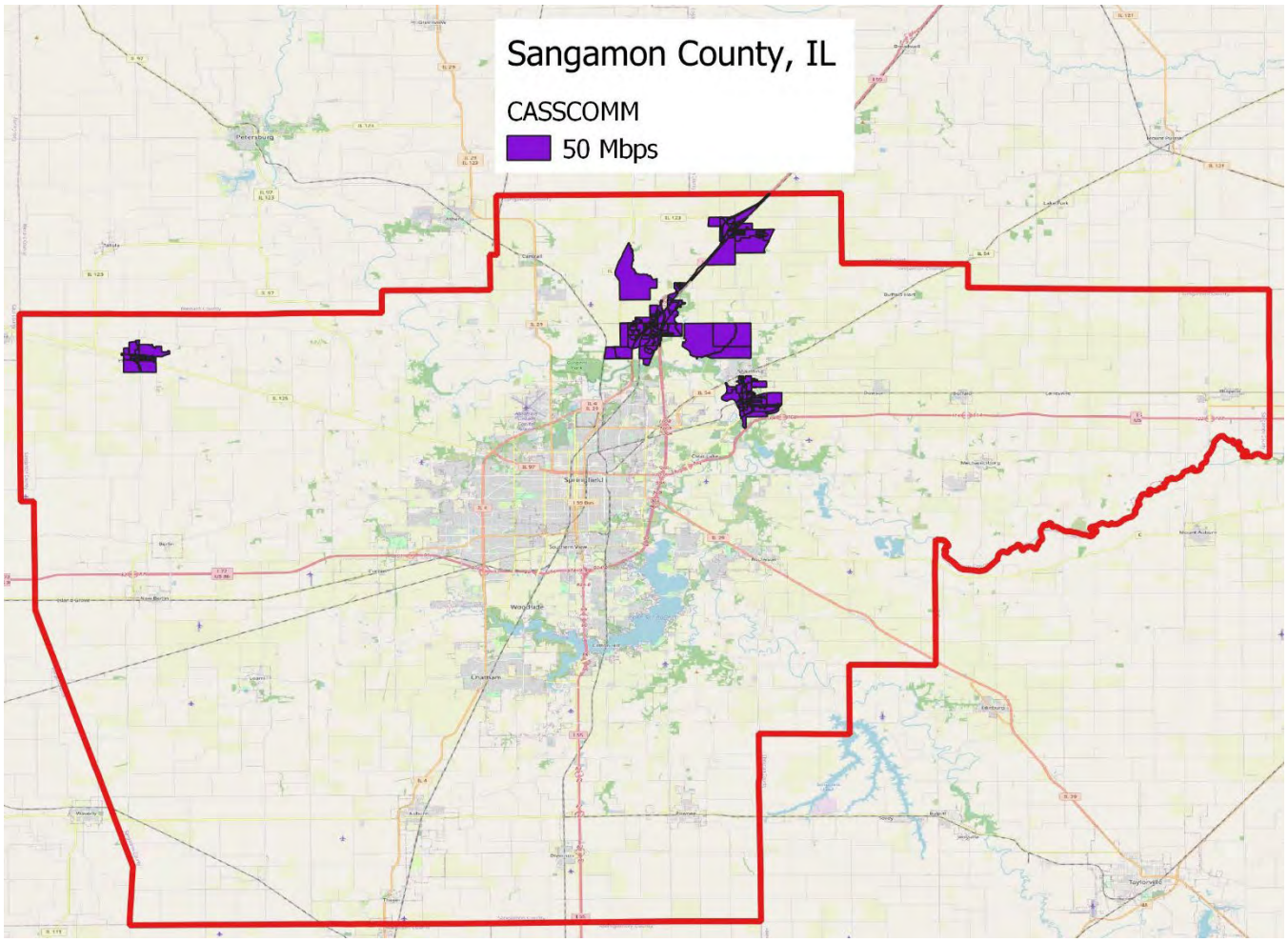


CASSCOMM (Cable)

CASSCOMM operates a traditional coaxial cable network in the cities of Pleasant Plains, Williamsville, Sherman, Spaulding, and Riverton. According to the FCC 477 reporting, CASSCOMM claims to provide download speeds up to 50 Mbps in all markets Based on the speed claimed by CASSCOMM on its cable network, it is evident the company has not upgraded to the newest DOCSIS 3.1 standard and is likely still operating with the older DOCSIS 2.0 standard.

As stated earlier, the service territories for CASSCOMM and other cable companies are exaggerated due to the FCC rule that reports speeds being available in an entire Census block even if only being provided to a few customers. As can be seen on the map below, the coverage areas shown in purple are much larger than the boundaries of the various cities.

Map 5 – CASSCOMM (Cable) FCC 477 Data

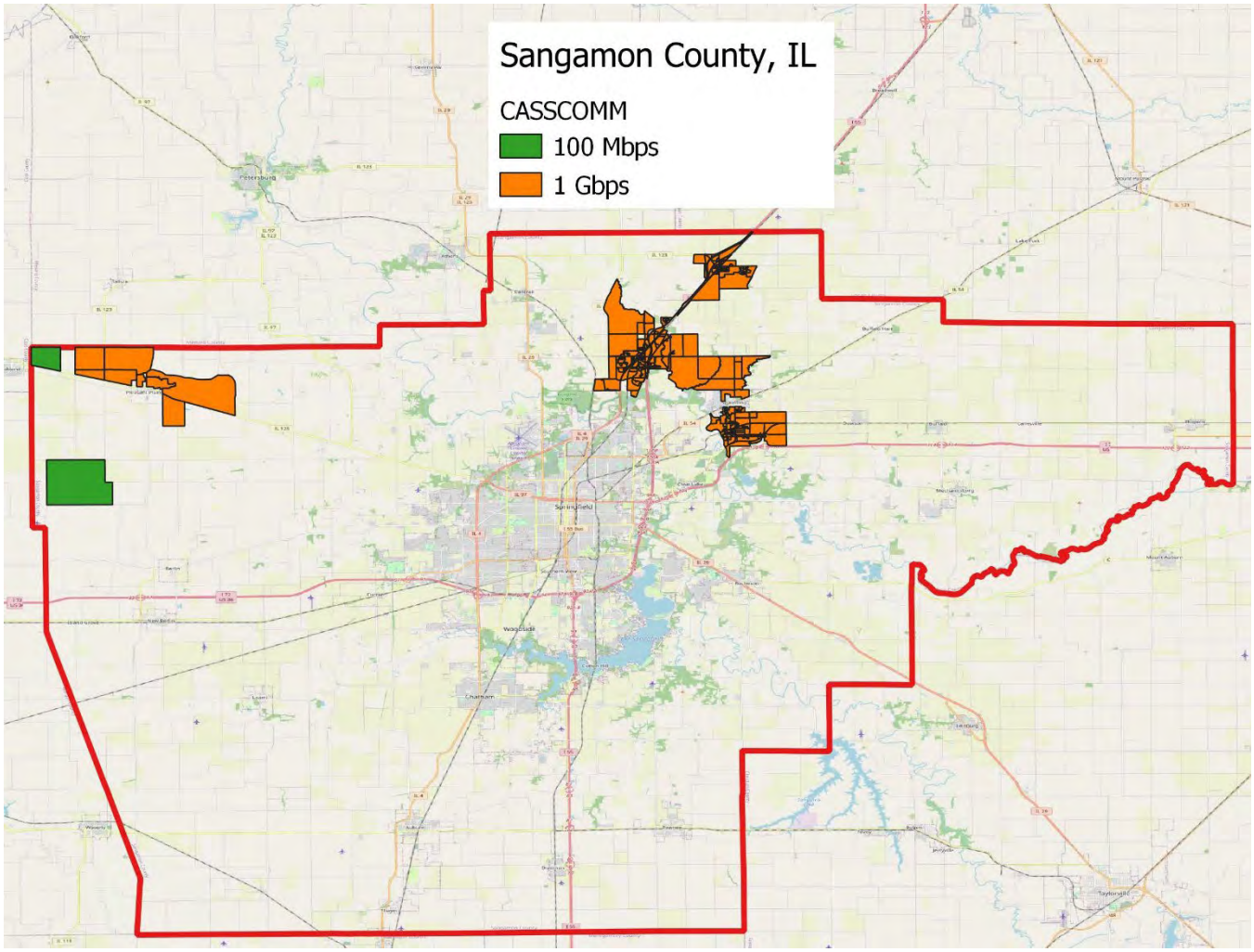


CASSCOMM (Fiber)

CASSCOMM has built fiber in the cities of Sherman, Williamsville, Spaulding, and Riverton. It has also built fiber in the northern part of Pleasant Plains and two census blocks in its telephone exchange in the northwest corner. In the most recent FCC 477 reporting, CASSCOMM claims to provide 1 Gbps to the cities and 100 Mbps to the two census blocks in the telephone exchange.

Just like with a cable company, the coverage around the fiber service areas are also exaggerated due to the FCC rules of mapping by Census block.

Map 6 – CASSCOMM (Fiber) FCC 477 Data

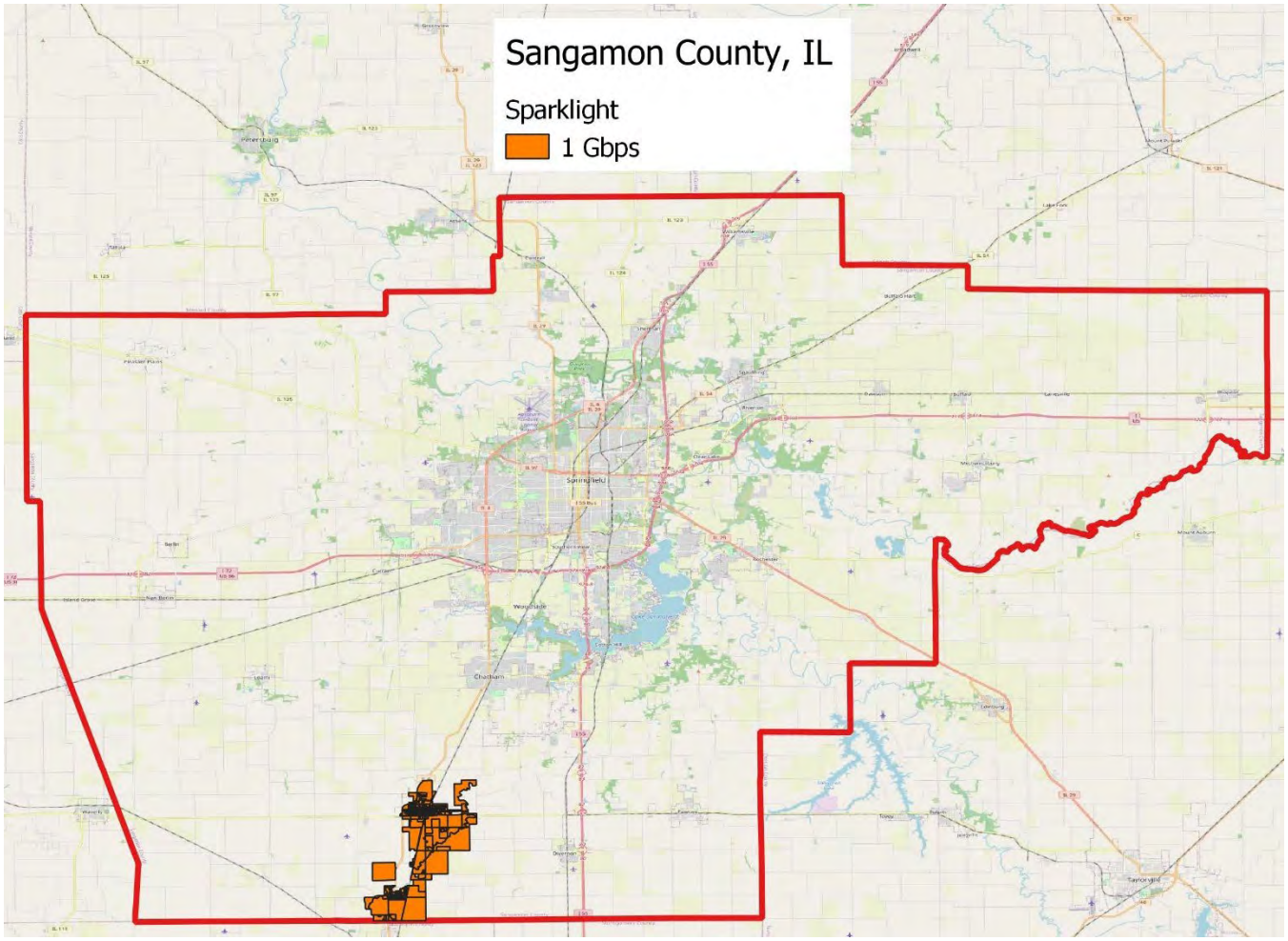


Sparklight

Sparklight (Cable One) is an incumbent cable provider in southern Sangamon County. Below is the coverage claimed by the company on the FCC Form 477 process, where the company reports coverage in the cities of Auburn and Thayer and the surrounding areas. Sparklight claims to provide 1 Gbps speeds in its service areas, shown in orange on the map below.

The service area around the cities is overstated for Sparklight due to the FCC mapping protocol that allows an entire Census block to be considered served even if there is only one customer.

Map 7 - Sparklight FCC 477 Data

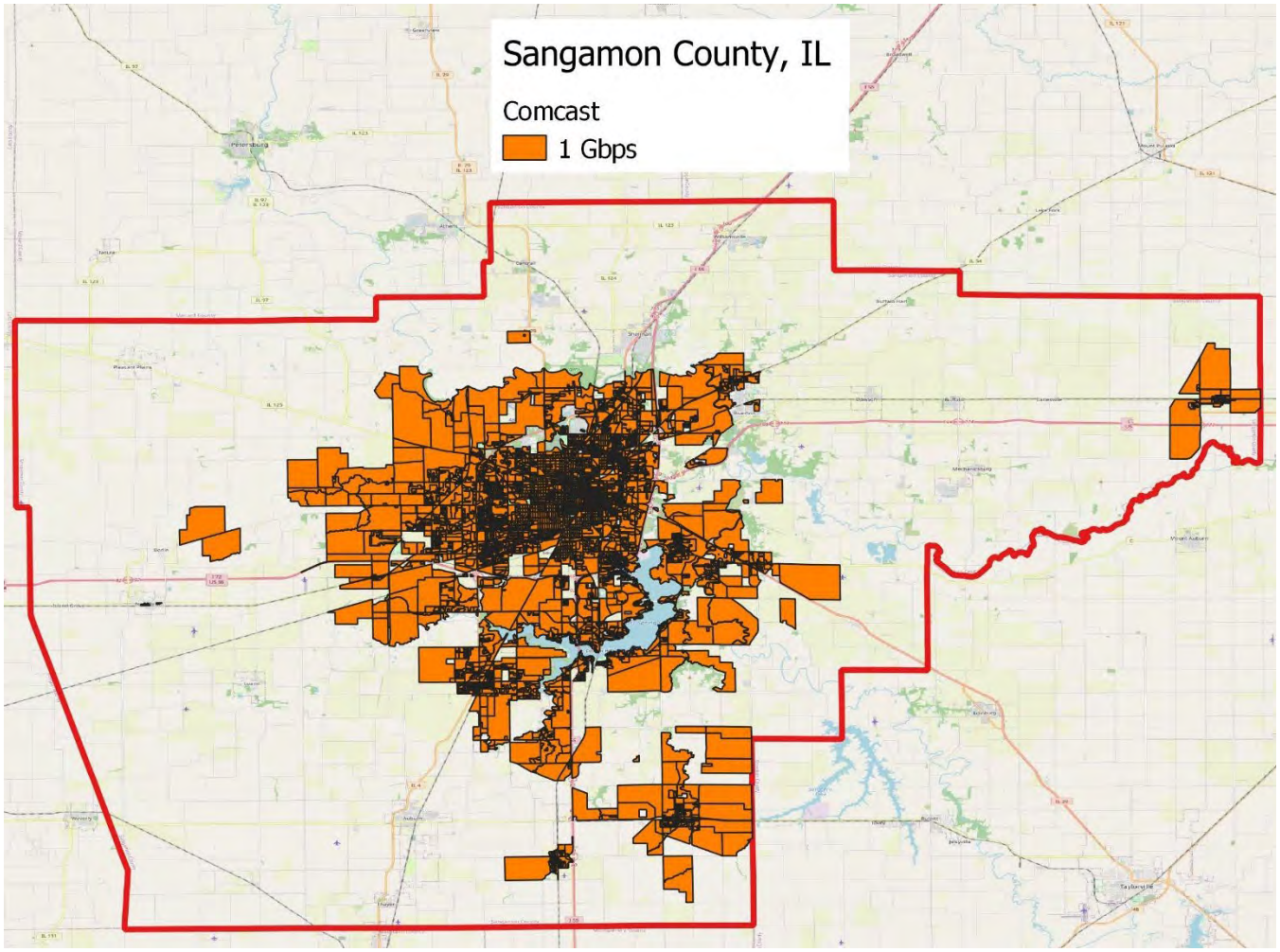


Comcast

Comcast is the incumbent cable company in in and around the cities of Springfield, Pawnee, and Illiopolis. The map below shows the company's reporting on the FCC Form 477. Comcast claims to provide 1 Gbps service, shown in orange, for its entire service area in the county. The speeds reported by Comcast indicate that Comcast has upgraded to the DOCSIS 3.1 standard.

Comcast's service area around the cities is overstated due to the FCC mapping protocol that allows an entire Census block to be considered served even if there is only one customer. We think some of the more rural pockets probably represent business, schools, or other large broadband users – Comcast is not proving broadband in rural areas.

Map 8 – Comcast FCC 477 Data

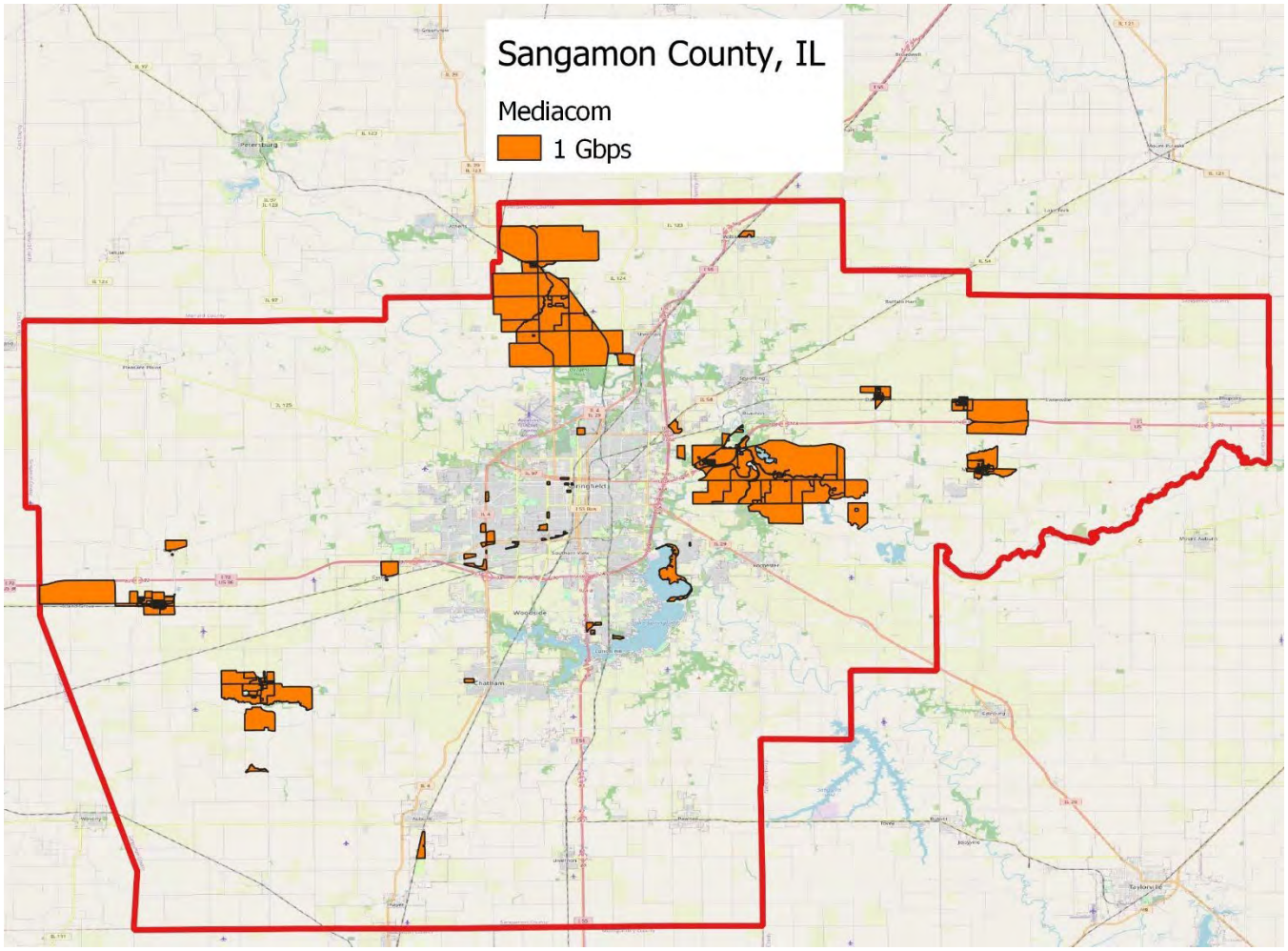


Mediacom

Mediacom is an incumbent cable broadband provider in Cantrall, Berlin, Loami, Clear Lake, Buffalo, Mechanicsburg, and the surrounding areas in Sangamon County. In the most recent FCC 477 form process, Mediacom claims to provide speeds of 1 Gbps for its entire service territory, shown in orange on the map below.

Mediacom's service area around the cities is overstated due to the FCC mapping protocol that allows an entire Census block to be considered served even if there is only one customer.

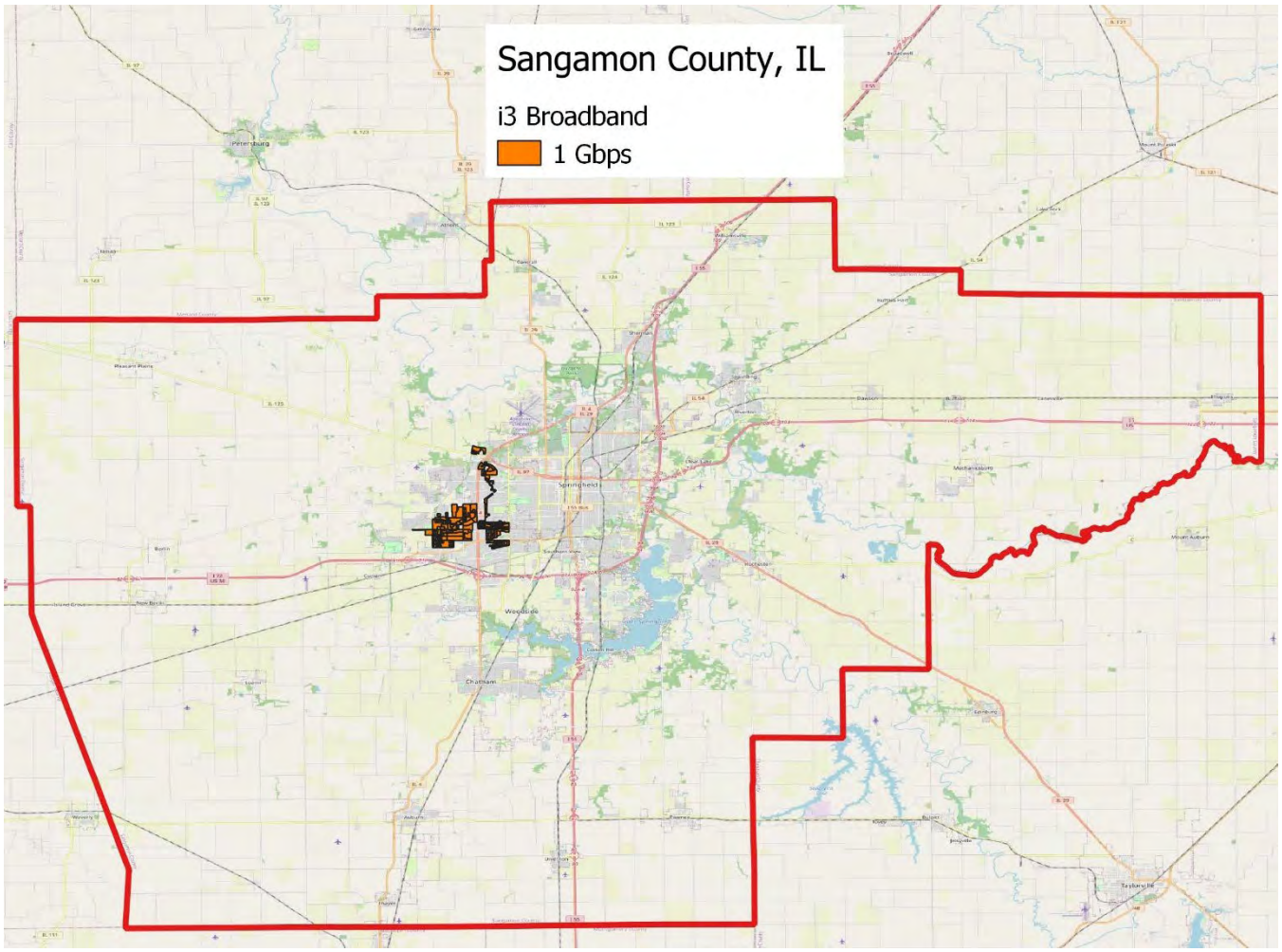
Map 9 - Mediacom FCC 477 Data



i3 Broadband

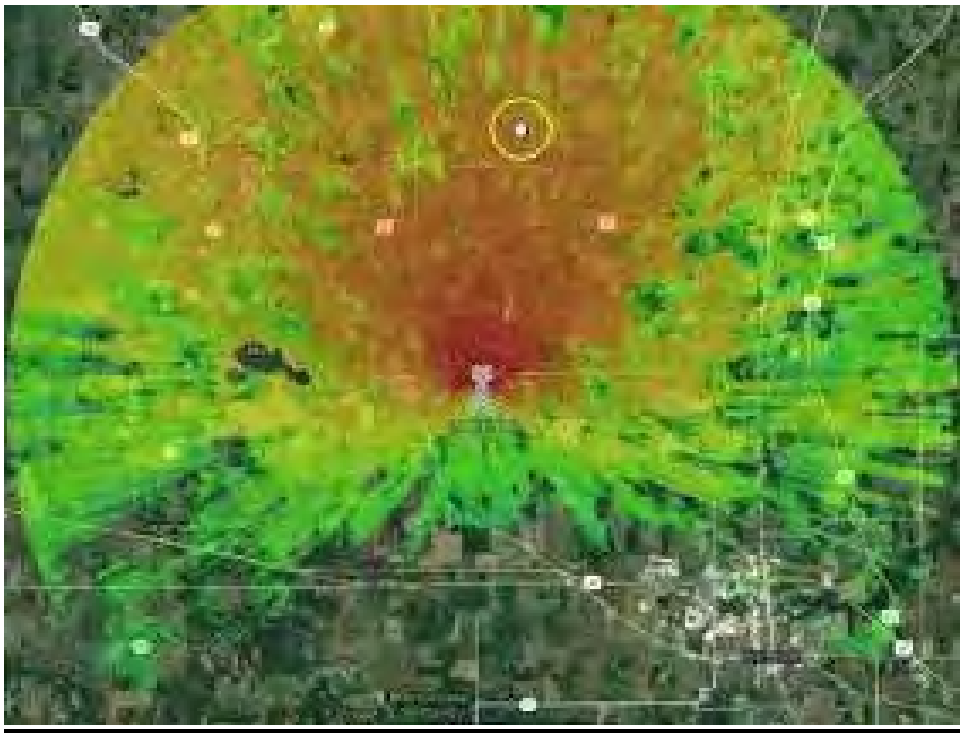
i3 Broadband provides fiber broadband in the southwest corner of Springfield. i3 Broadband claims download broadband speeds of 1 Gbps in the most recent FCC 477 process shown in orange on the map below.

Map 10 – i3 Broadband FCC 477 Data



Fixed Wireless Broadband Coverage

The following FCC maps are for the fixed wireless ISPs (WISPs) that serve in the county. The current FCC mapping does a terrible job of reflecting the speeds available from a wireless provider. Consider the following map that shows the wireless speeds from a single broadcast antenna.



The tower and transmitter is at the center of the map. This is a particularly interesting map because it shows broadband coverage being beamed to the north, but not the south. This is a common characteristic for a wireless network. Fixed wireless technology uses multiple radios on a single tower with each radio covering perhaps a 60-degree transmission area, meaning that six radios are needed to reach in every direction from a tower. This particular map shows a tower that has three of four working sectors – presumably the WISP doesn't want to serve locations to the south from this tower.

The red colors show the strength of the wireless signal. The dark red close to the tower shows the areas where the signal (and the broadband speeds are the fastest). In this map the darkest red is likely within about two miles from the tower. You can see that as distance from the tower increases that the colors fade from red, to orange, to yellow, to green. The speeds and power of the wireless signal decreases with distance, and speeds are much slower in the green and yellow areas than in the core red areas. It would not by untypical for the yellow areas on the fringe of the map to only be getting 10% to 20% of the speeds available to customers who are closer to the tower. The green areas get essentially no broadband signal – and it's worth noting that some of the green areas are relatively close to the tower. Some of the green areas are likely caused by a physical impediment like a hill that blocks coverage for those living behind the hill. But everything turns green if you move far enough away from the tower and the radio signals weakens and eventually dies.

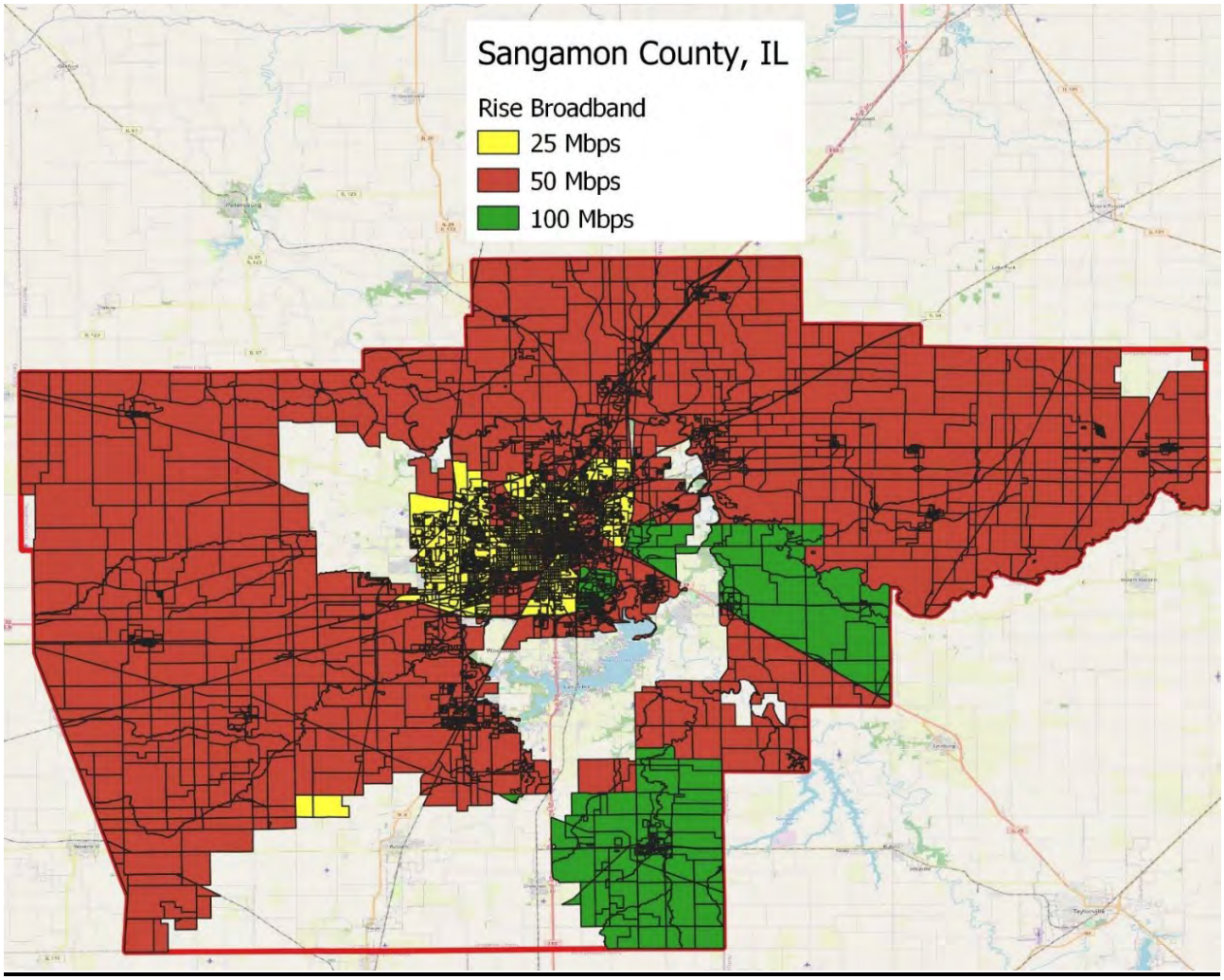
The current FCC mapping does not cover the reality of wireless coverage. In the FCC map, it would be likely that everything north of the tower would show as covered and at the speeds that are available only to customers close to the tower. The new FCC maps are supposed to get closer to something like the map above, but we'll have to wait and see if that really happens.

Rise Broadband

Rise Broadband is a fixed wireless provider throughout Sangamon County. In the most recent FCC 477 reporting, Rise Broadband claims to provide speeds of 25 Mbps (yellow), 50 Mbps (red), and 100 Mbps (green) shown on the map below.

As is discussed in the mapping discussion above, it's impossible that Rise Broadband can deliver these speeds across this large service area. Instead, there are pockets of customers that can get the fastest speed possible, customers who can only get slower speeds, and some who can't be served at all. The new FCC maps due out later in 2022 are supposed to try to more accurate show wireless coverage areas.

Map 11 – Rise Broadband FCC 477 Data

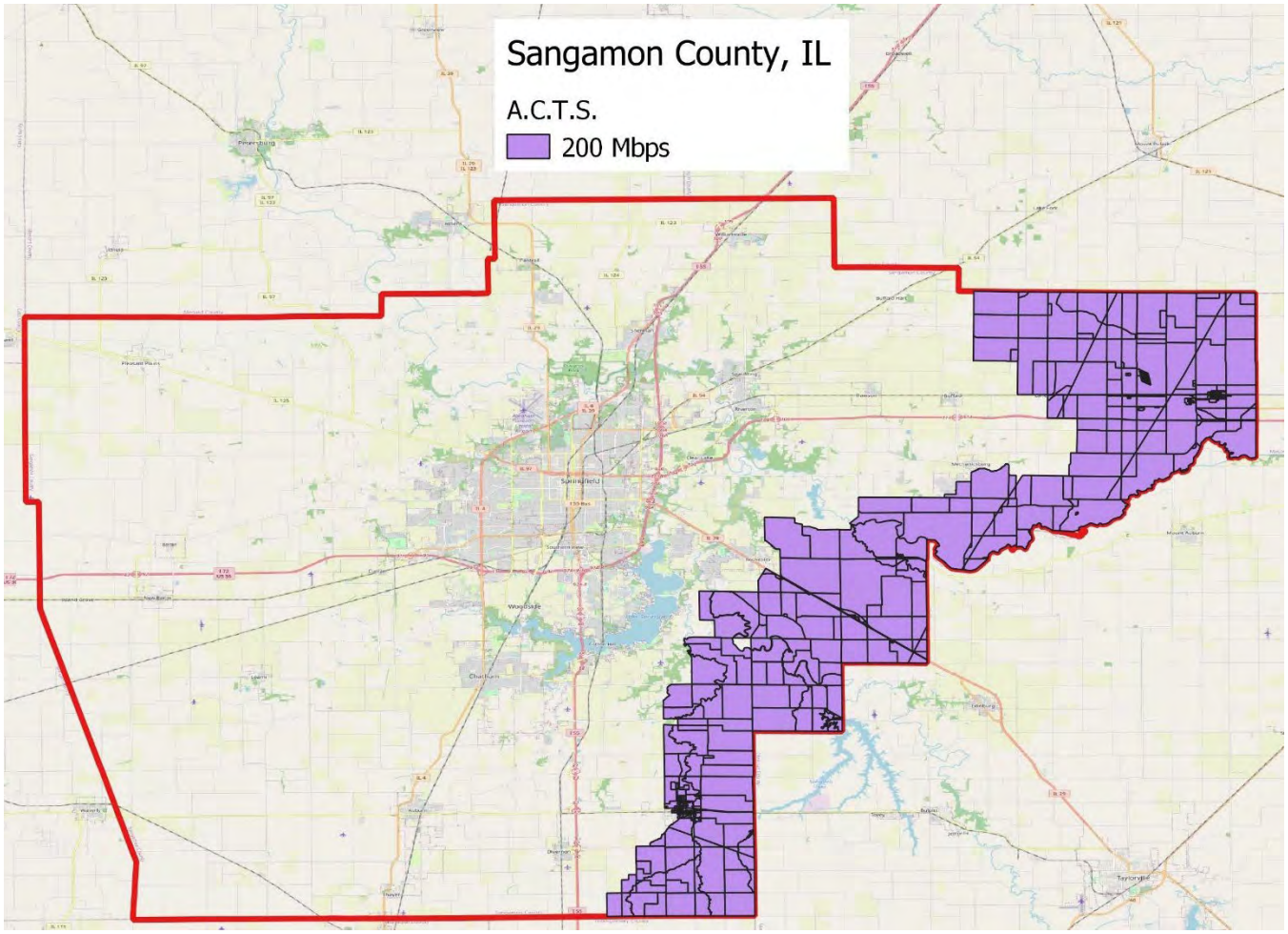


A.C.T.S.

A.C.T.S is a fixed wireless provider providing service in eastern Sangamon County. A.C.T.S. claims to provide speeds of 200 Mbps (purple) in the most recent FCC 477 process.

We find the claimed speeds to be highly unlikely, and later in the report we didn't see any speed tests even close to 200 Mbps. A.C.T.S. uses the same technology as the other WISPs in the county which all claim speeds of 40 Mbps to 50 Mbps. As we stated with the other WISPs, we also don't believe any of them can deliver the reported speeds across a large coverage area. We view the A.C.T.S. claimed speeds as an over-exaggeration. It's not impossible that a tiny of number of customers could get the claimed speed – but wireless technology cannot cover across the whole area as implied by the FCC reporting.

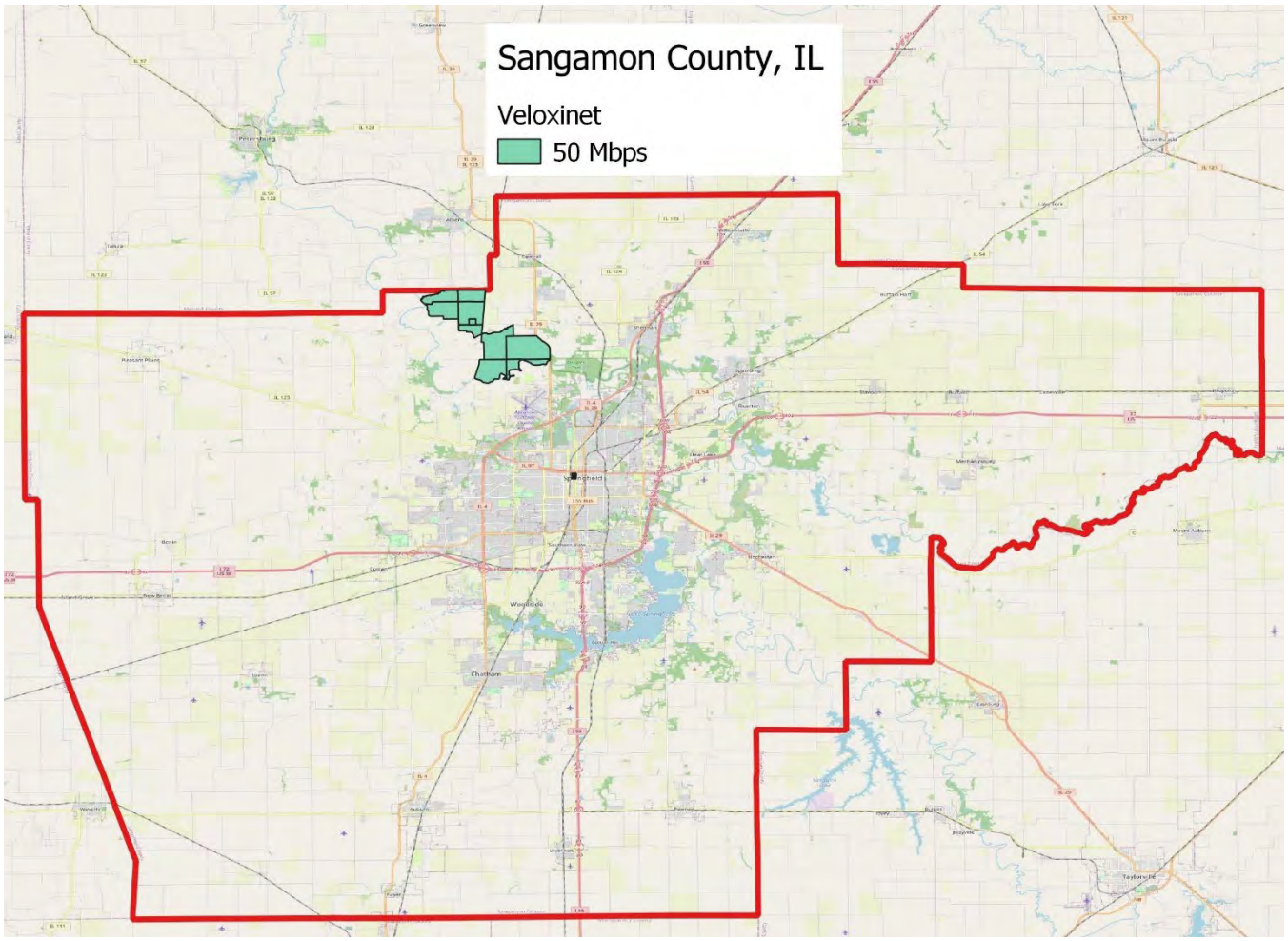
Map 12 – A.C.T.S. FCC 477 Data



Veloxinet

Veloxinet is a fixed wireless provider in northern Sangamon County. Veloxinet claims 50 Mbps download speeds for its entire service area. It is unlikely that all customers in the service territory can receive speeds of 50 Mbps.

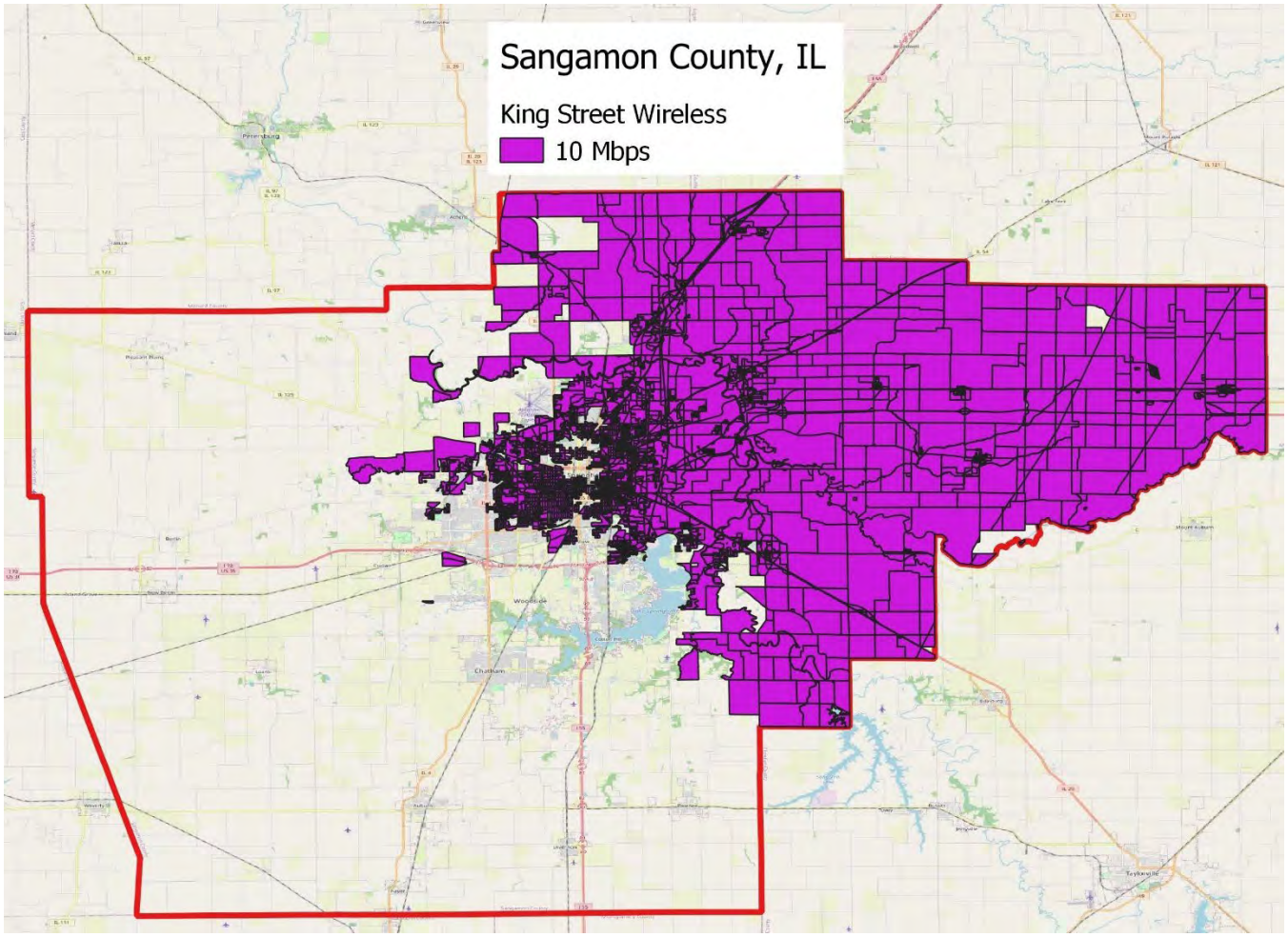
Map 13 - Veloxinet FCC 477 Data



King Street Wireless

King Street Wireless is a fixed wireless provider in the eastern half of Sangamon County. In the most recent FCC 477 form process, King Street Wireless claims to provide 10 Mbps to its total service area.

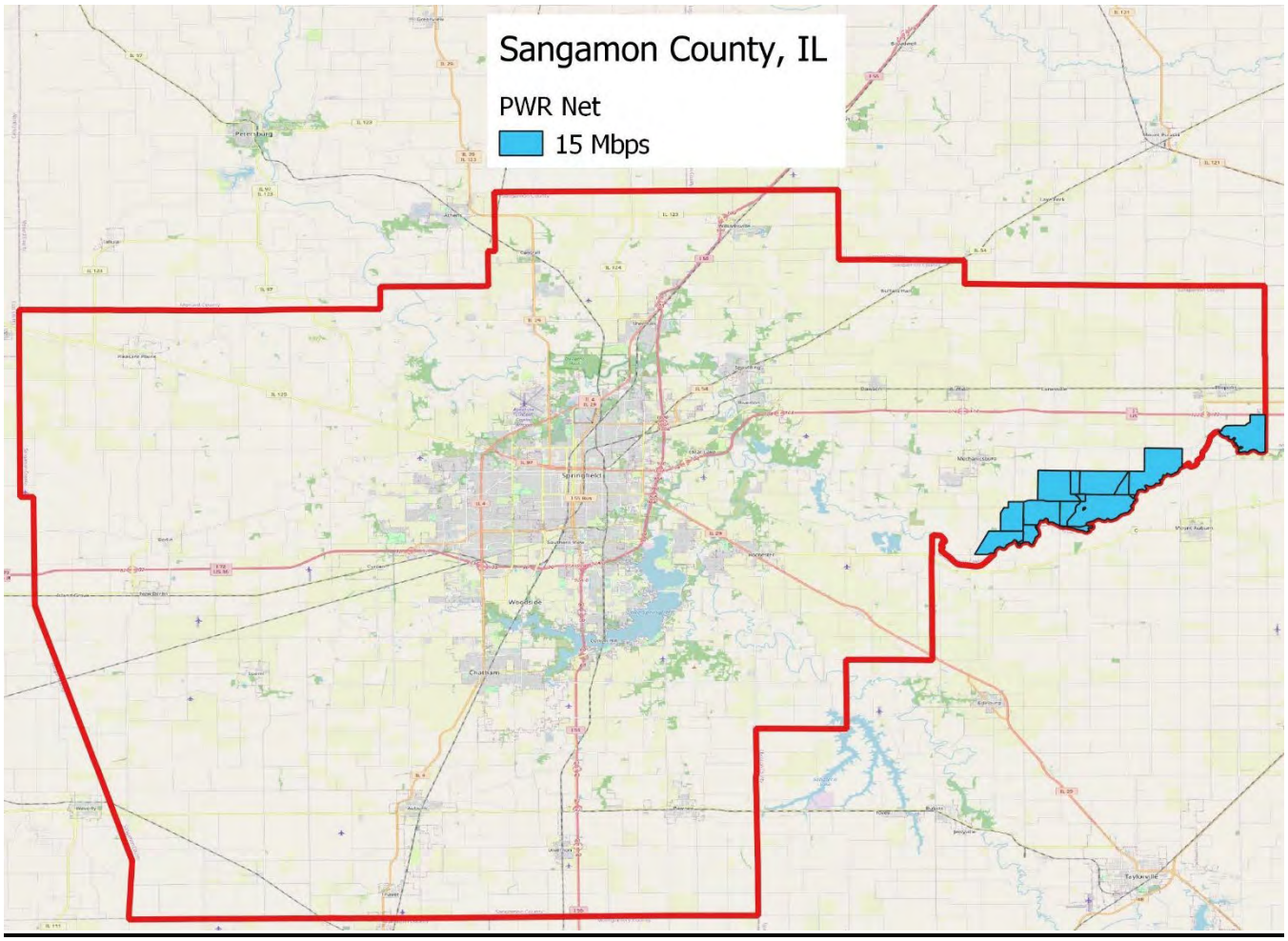
Map 14– King Street Wireless FCC 477 Data



PWR-net

PWR-net is the broadband band name for Shelby Electric Cooperative and provides fixed wireless in the eastern part of the county. In the most recent FCC 477 reporting, PWR-net claims to provide 15 Mbps for its entire service territory, shown in blue on the map below.

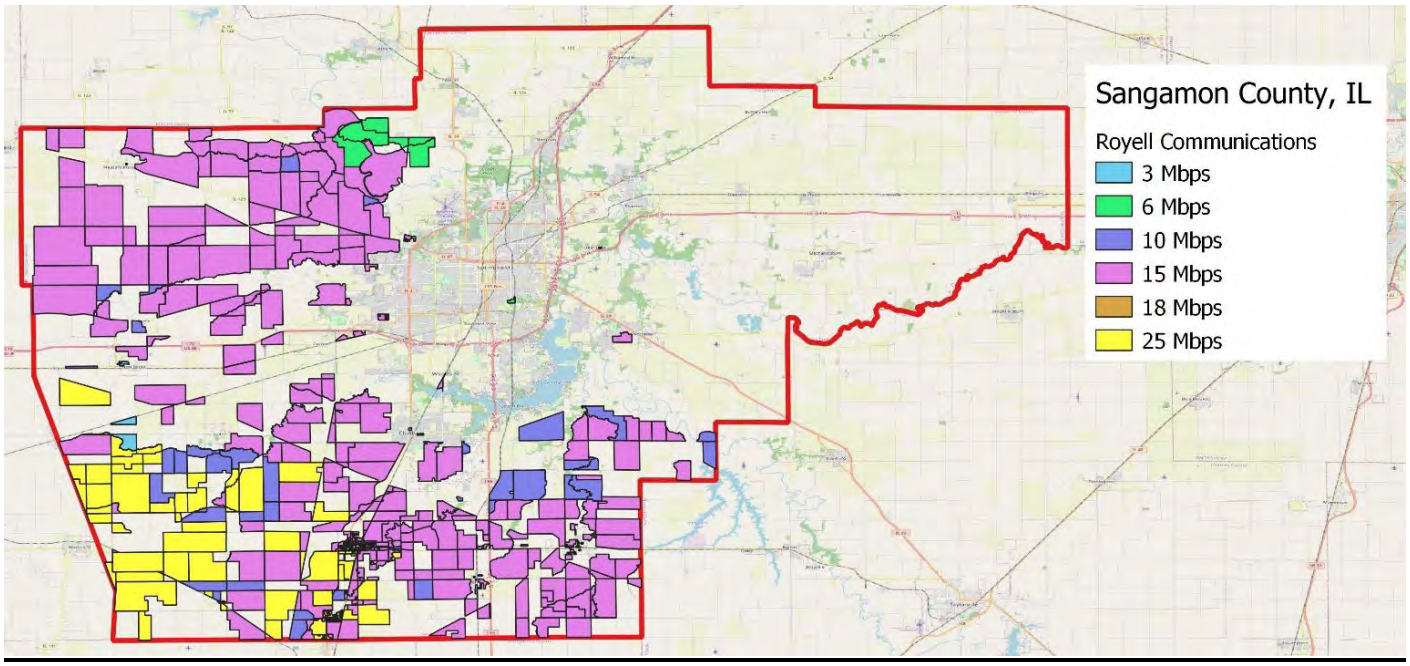
Map 15 – PWR-net FCC 477 Data



Royell Communications

Royell Communications is a fixed wireless provider throughout western Sangamon County. In the most recent FCC 477 reporting, Royell Communications claims speeds of 3 Mbps (light blue), 6 Mbps (green), 10 Mbps (purple), 15 Mbps (pink), 18 Mbps (brown), and 25 Mbps (yellow).

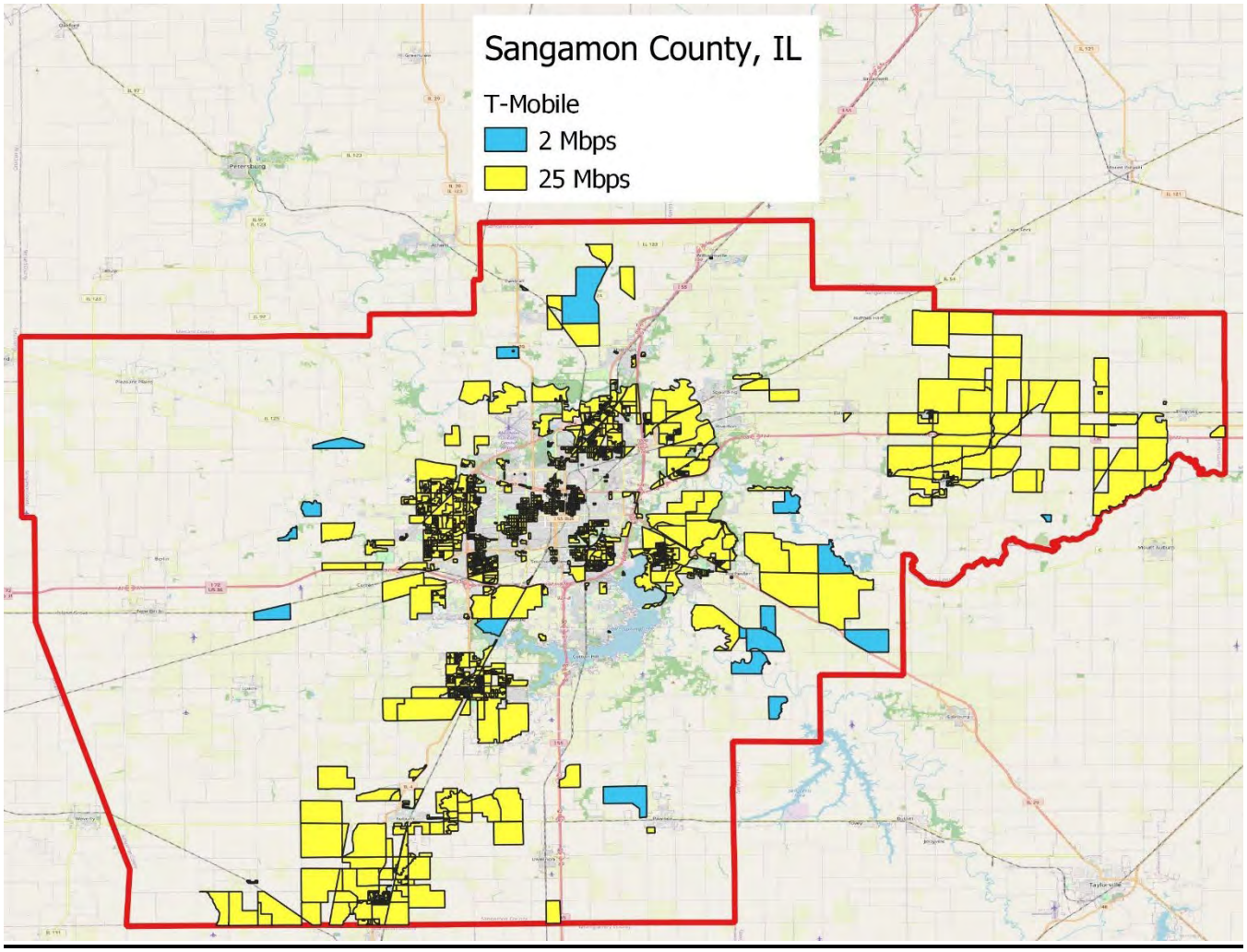
Map 16 – Royell Communications FCC 477 Data



T-Mobile

T-Mobile reports coverage across much of the county with broadband using its cellular spectrum. The speeds claimed on the map below likely represent areas where T-Mobile sells its traditional hotspots using 4G LTE spectrum. The company reports speeds of 2 Mbps (blue) and 25 Mbps (yellow) in the most recent FCC reporting. It's likely that the 25/3 Mbps broadband is not available everywhere shown on the map below. The company is starting to sell faster broadband using 5G spectrum, but those products were not in the county as of the date of this map. The new FWA product should be able to deliver speeds of 100 Mbps download to customers within a few miles of a tower.

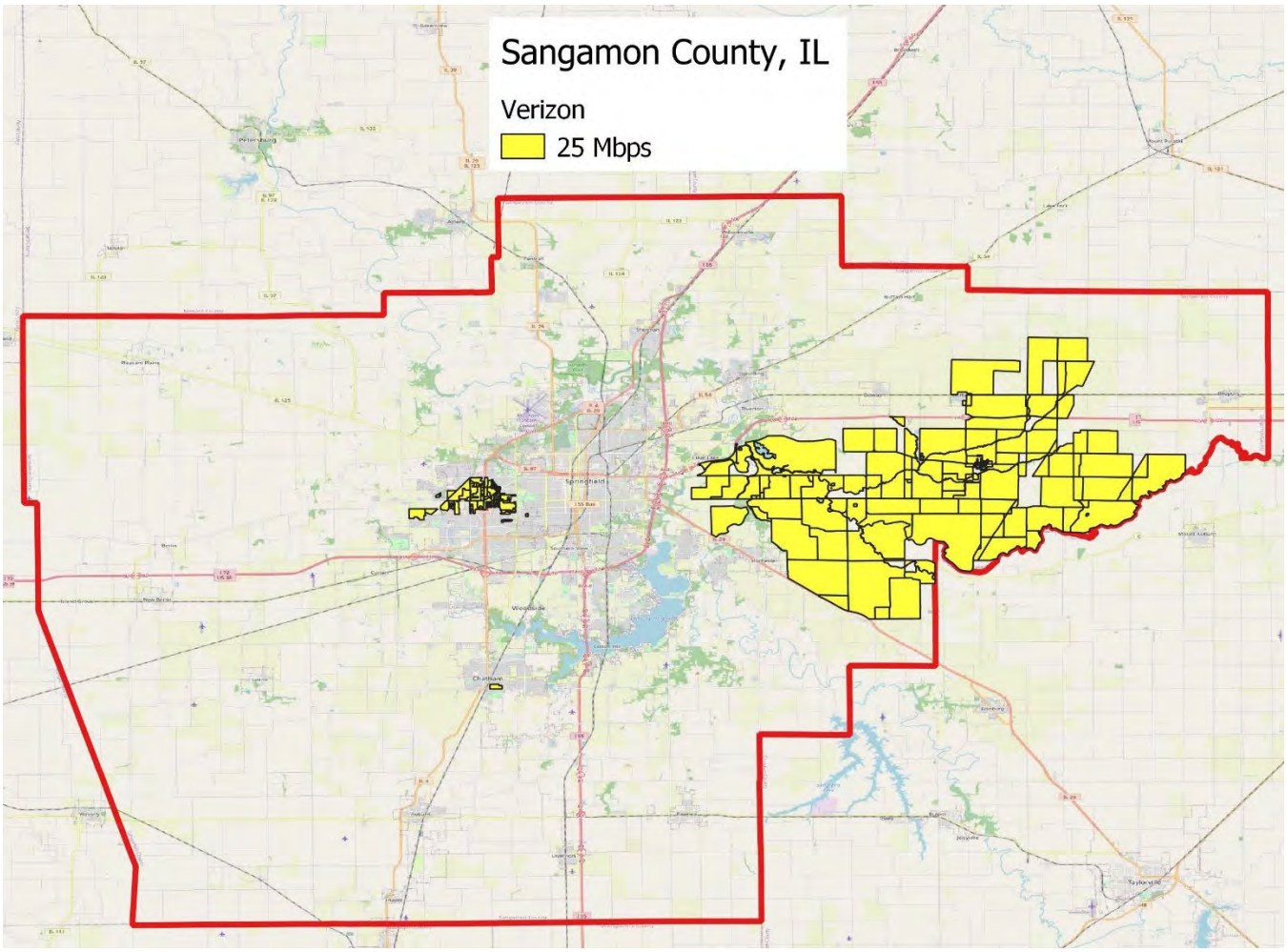
Map 17 – T-Mobile Net FCC 477 Data



Verizon

Verizon reports broadband coverage across the eastern part of the county using its cellular spectrum. The speeds claimed on the map below likely represent areas where Verizon sells its traditional hotspots using 4G LTE spectrum. The company is starting to sell faster broadband using 5G spectrum, but those speeds are likely to be reported at 100 Mbps download. It's likely that the 25/3 Mbps broadband is not available everywhere shown on the map below.

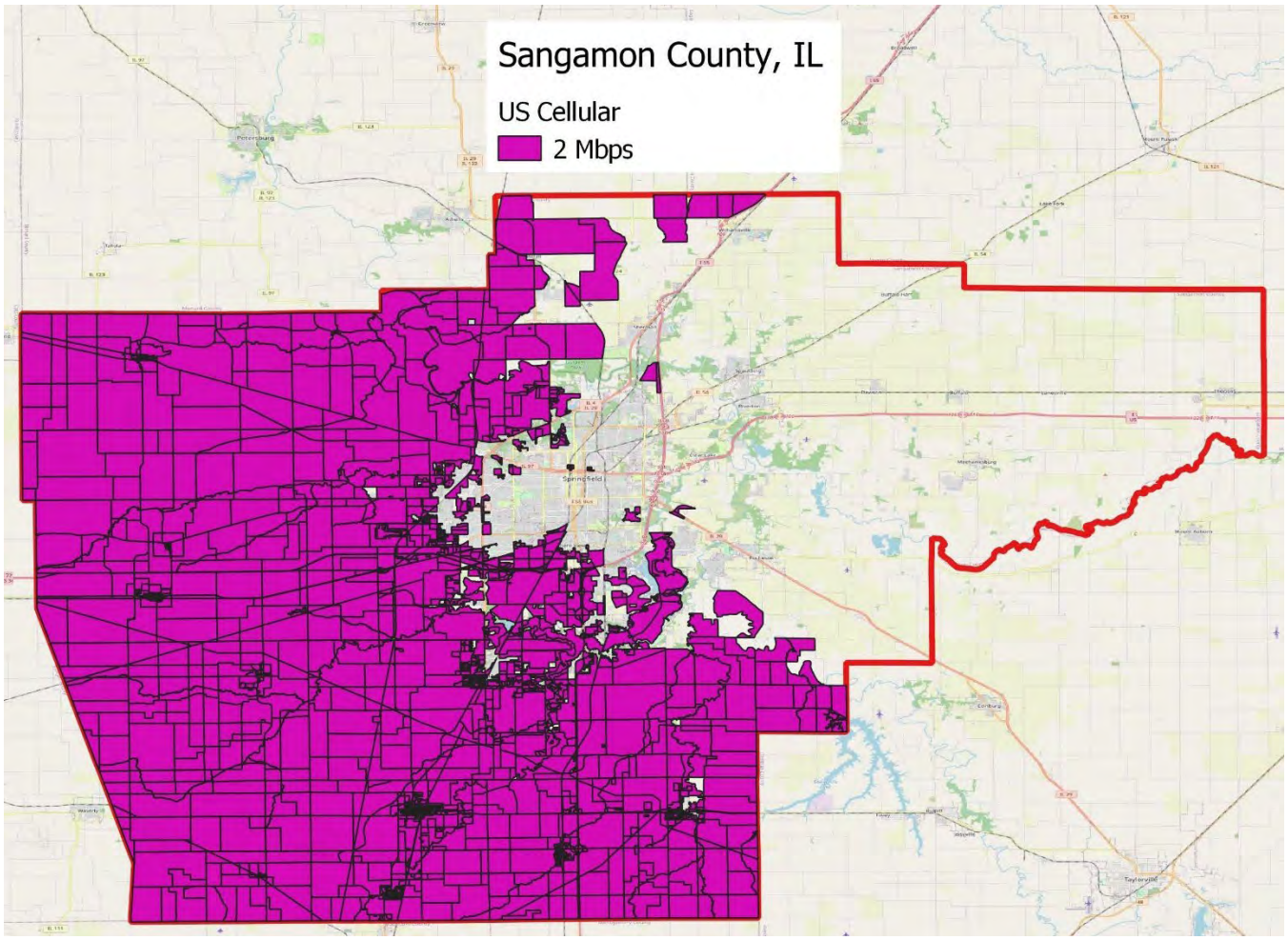
Map 18 – Verizon FCC 477 Data



UScellular

UScellular (recently rebranded from being called U.S. Cellular) reports coverage of the western part of the county with broadband using its 4G LTE or 3G EVDO cellular spectrum. The company sells a fixed home broadband connection. According to the FCC 477 data, UScellular reports speeds of 2 Mbps or less for its entire service area in the county. It's likely that these speeds are not available everywhere since there are many places in the county with poor or no cellular coverage.

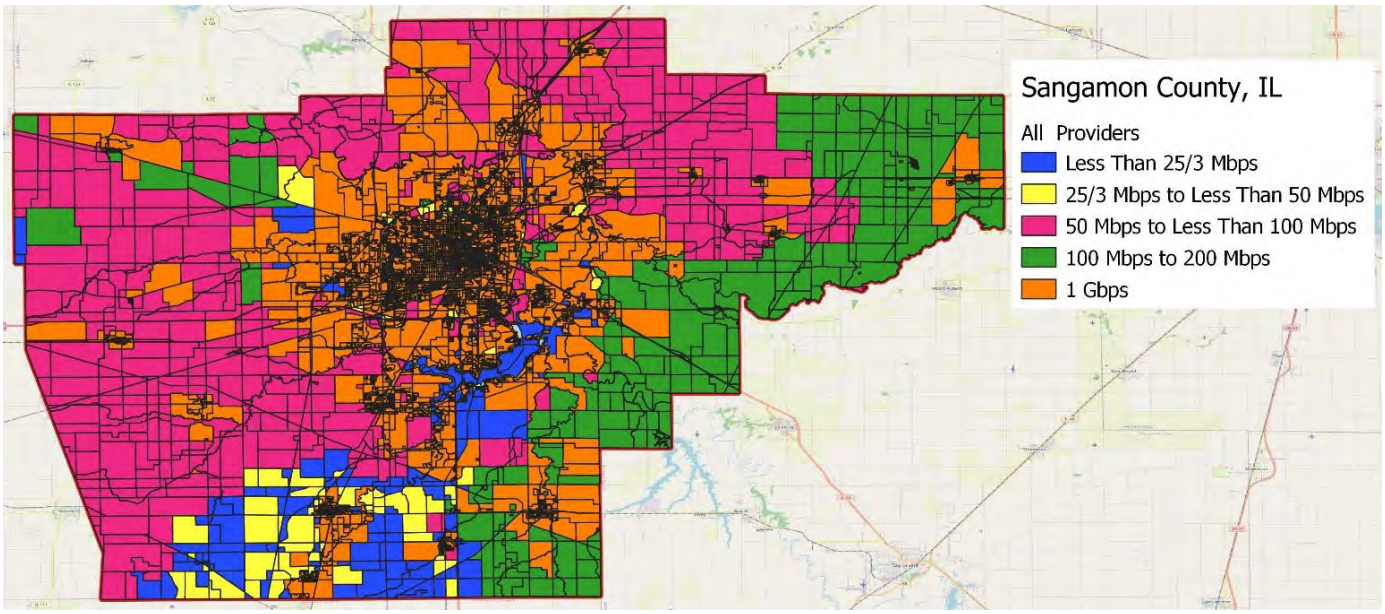
Map 19 – U.S. Cellular FCC 477 Data



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 – something which the County knew not to be true, and what prompted this feasibility study.

Map 20 - Composite of all FCC 477 Data



Updating the Broadband Map

There are a few changes that must be made to Map 20 to properly show the state of broadband.

Edge Distortions. The map includes distortions along the edges of the ISP service areas. This is true around the areas served by Sparklight, Comcast, CASSCOMM, and Mediacom, but also the areas served by AT&T, Frontier, and CASSCOMM. The reason for this is simple – the service areas of the various ISPs don't follow or match up with Census block boundaries. With the FCC rules, if an ISP has only one served customer in a Census block, everybody in that block is shown to also be served.

Possible Upgrades. There have been grants and other subsidies awarded to build faster broadband in the county that should be recognized.

Several ISPs like A.C.T.S. and Royell Communications are upgrading some fixed wireless networks to fiber.

Grants and Subsidies. AMG and Mercury Broadband have both been awarded the RDOF subsidy in the county.

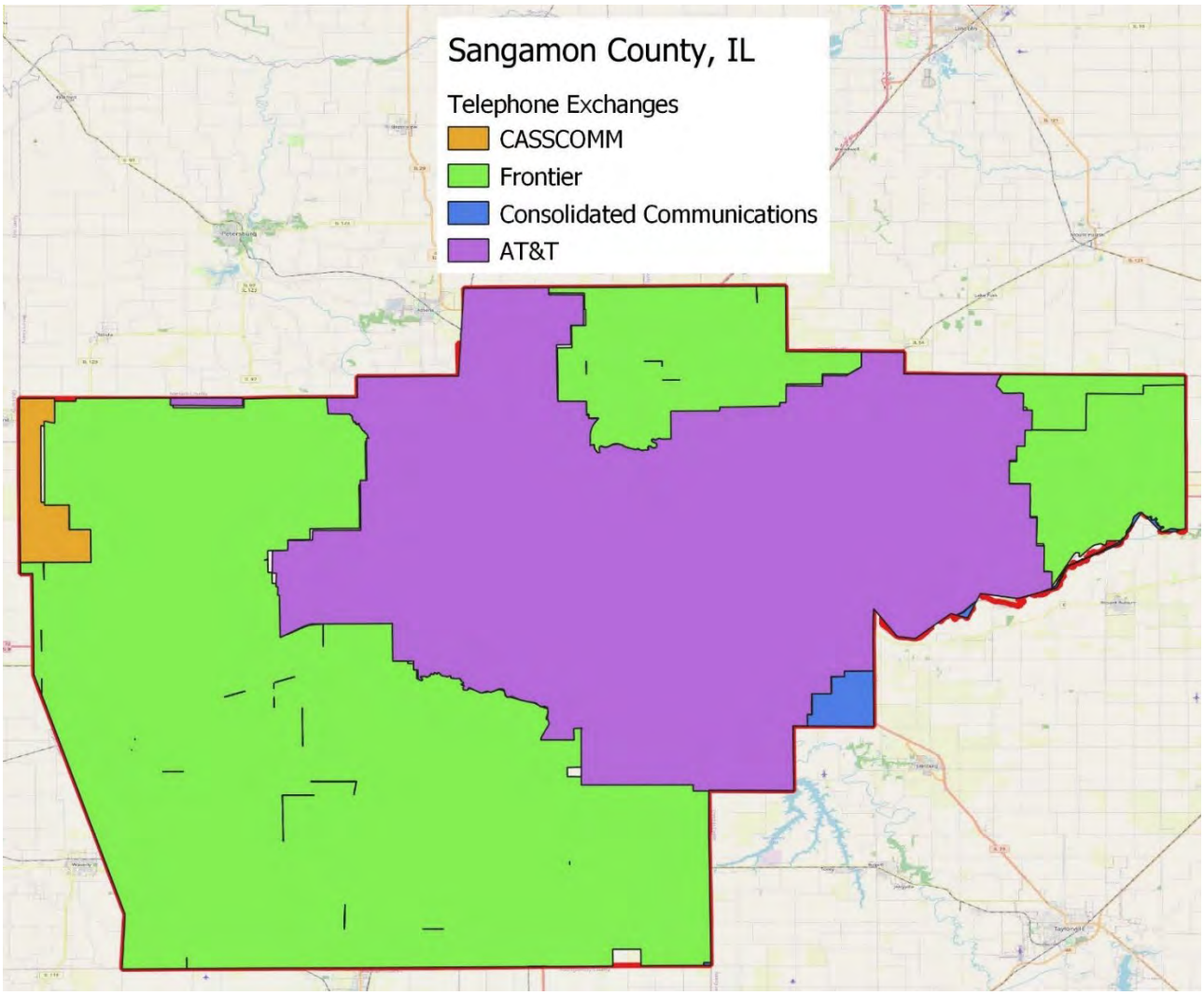
The Edge Issue

Telephone Company Exchange Boundaries.

The incumbent telephone companies in the county are AT&T, Frontier, Consolidated Communications, and CASSCOMM. The map below shows the historical monopoly boundaries for each telephone

company. These boundaries were formally awarded early in the last century by the Illinois Commerce Commission, and each telephone company was given monopoly status within the borders shown on the map. Even today, the big incumbents rarely build and serve outside of the historic monopoly areas.

Map 21 Telephone Exchange Boundaries



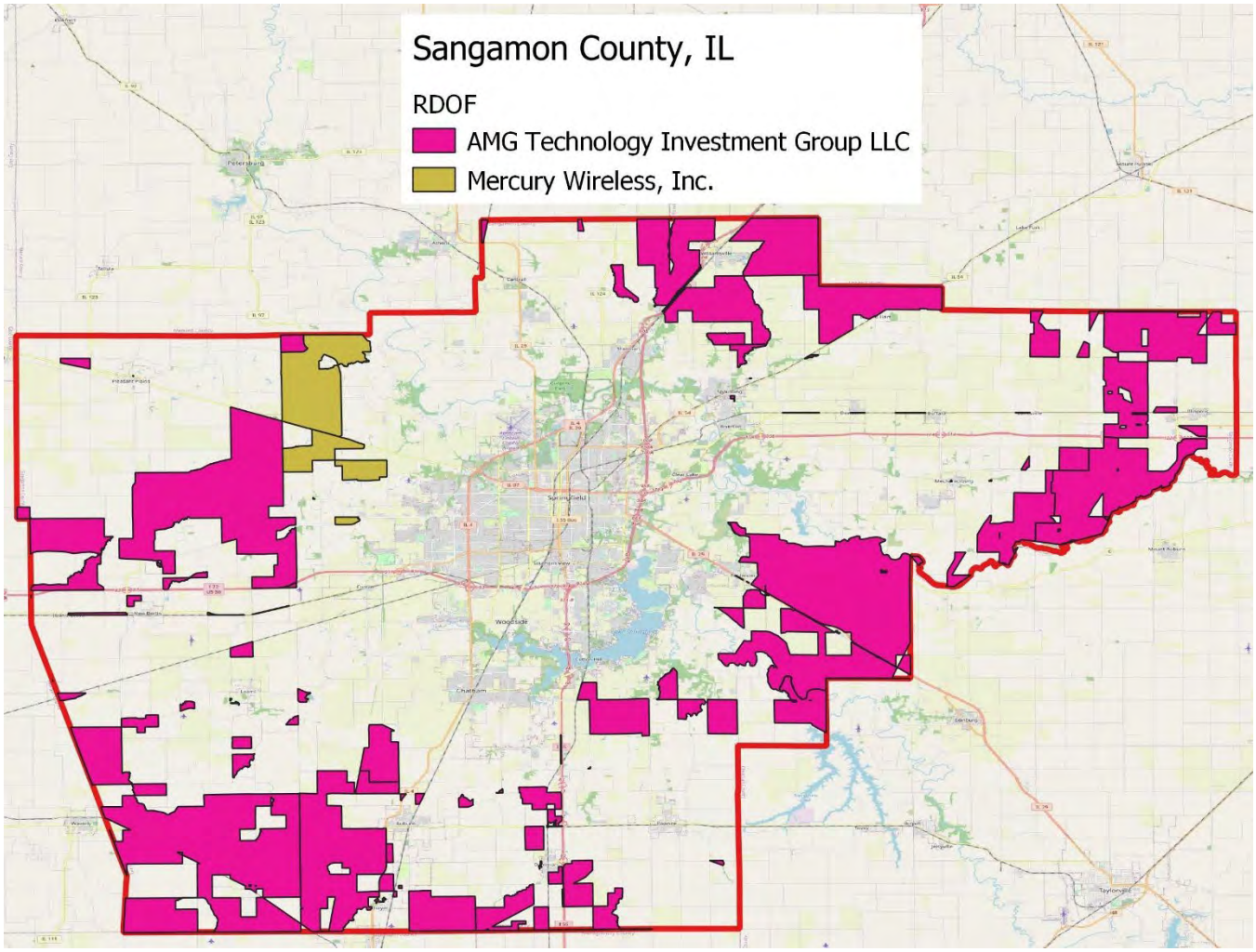
Grants and Other Subsidies

The only areas that are covered by a grans or a subsidy program are from the FCC's RDOF program.

FCC Rural Digital Opportunity Fund (RDOF)

This program is funded by the FCC from the Universal Service Fund. ISPs won the right to serve rural areas by competing for funding in an FCC reverse auction that concluded in December 2020. ISPs tentatively won over $9 billion to improve broadband in rural America. The following map shows the RDOF awards claimed in the county.

Map 22 - 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. The RDOF subsidy is paid out over ten years.

An RDOF recipient has six years to build the full broadband solution – starting with the year after the award. A recipient of a 2022 RDOF award must build 40% of the network by the end of 2025, 60% of the deployment by the end of 2026, 80% of the network by the end of 2027, and 100% of the network by the end of 2028. At the end of 2028, the FCC will publish a final list of locations in the RDOF area, and the ISPs have until the end of 2030 to reach any locations that were not already covered.

There were two RDOF auction winners in Sangamon County and the FCC made both of these awards in the summer of 2022.

- **AMG Technology Investment Group LLC** (Nextlink) was awarded $3,935,193 in Sangamon County. This is a controversial award since the company promised in the RDOF auction to deliver gigabit fixed wireless service. We don't know any engineers who think that this technology is currently available or even possible if it is eventually manufactured. While radios might be developed that could deliver this much speed, it is unlikely that the high speeds will carry very far

from a tower. And regardless of the speeds, all fixed wireless suffers from impediments in the line-of-sight, like trees or hills that can slow or block the wireless signal.

- **Mercury Broadband** won $265,344 to serve in Sangamon County. Mercury Broadband is a fixed wireless provider headquartered in Topeka, KS. Mercury Broadband provides service in Kansas, Missouri, and Indiana. Mercury Broadband is implementing a hybrid of fixed wireless and fiber-to-the-home technologies for its RDOF awards. There is no way to know which technology is planned for the county.

Mapping the Need for Better Broadband

This discussion requires the introduction of a new term – passings. The industry uses passings to mean any home or business that can become a broadband customer.

Finley Engineering gathered GIS data from the county that allowed us to identify and count the homes and businesses in every Census block. This allowed us to compare the number of customers that are covered by the various technologies claimed by the ISPs. This means, for example, that we can count the number of potential customers that can buy services from various ISPs shown in the maps included in the section above.

For purposes of qualifying for current broadband grants, areas are typically categorized into the following speed classifications:

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

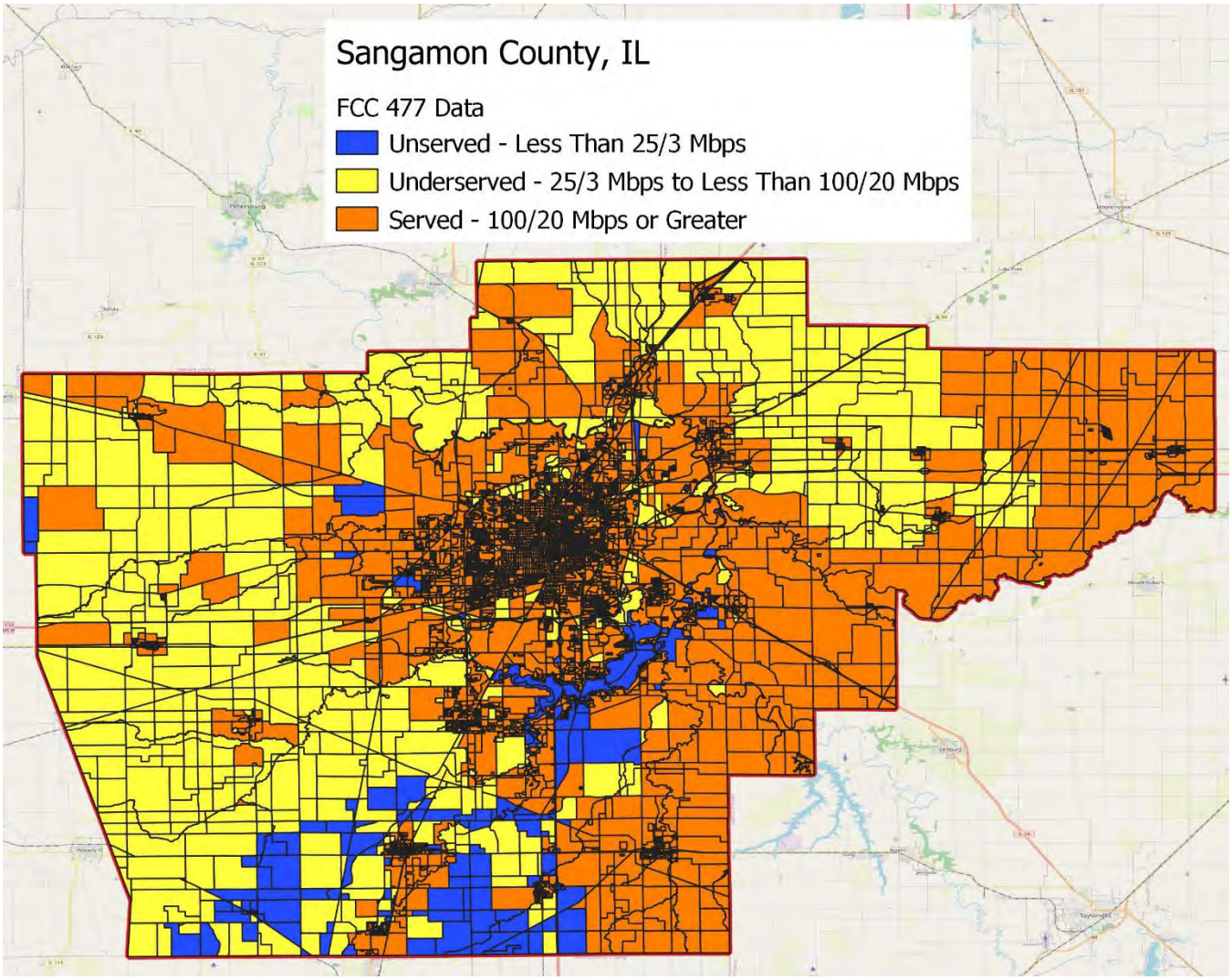
The following map shows broadband availability as defined by the FCC 477 process. On this and the following map, the blue areas (unserved) are where existing broadband speeds are slower than 25/3 Mbps. The yellow areas (underserved) are where existing speeds are between 25/3 Mbps and 100/20 Mbps. The orange areas (served) are where speeds are at 100/20 Mbps or faster. Following are the number of passings that match Map 23 below.

	Speeds	Passings
Unserved	Less than 25/3 Mbps	227
Underserved	From 25/3 Mbps to 100/20 Mbps	6,082
Served	100/20 Mbps or faster	85,910
Total		92,219

The map highlights two issues discussed earlier. First is that reporting speeds by Census blocks often show faster speeds than many households can receive. We also know that some of the ISPs are exaggerating the available speeds – delivering speeds slower than what is claimed in the FCC 477 reporting.

This is a significant problem for the county. Some of the big federal grants emphasize bringing broadband to unserved areas, and according to the FCC, almost nobody in the county is unserved. Below we will develop a map that we think is a more accurate depiction of the broadband situation in the county.

Map 23 – Grant Eligibility per the FCC 477 Data



Current Broadband Coverage Map

Map 23 above reflects the areas that are eligible for grants if the current FCC mapping was accurate and up-to-date. We know that the FCC maps are not accurate. In our analysis, we found changes that must be reflected to show the areas that are unserved and underserved.

There are a number of issues that contribute to the FCC maps being inaccurate:

- Mapping by Census Block. The FCC rules show an entire Census Block as having the fastest technology speed available, even if that fast technology is only available for one passing in the Census Block.
- Reporting of Marketing Speeds. The FCC allows ISPs to report marketing speeds instead of actual speeds. In many cases, an ISP are reporting marketing speeds to the FCC that are faster than the speeds being delivered to customers.
- ISP Errors. We often find an ISP reporting coverage in areas where it doesn't have customers.

- Technology Upgrades. There is a time lag in the FCC reporting which means the maps are regularly six months or more behind. This wasn't much of an issue in the past, but at a time when many ISPs are upgrading technology, the maps might reflect technologies in some areas that have been upgraded.
- Grant and Subsidy Awards. The FCC maps only reflect networks that have been built and are operating. As described above, it can take many years to build a network that has been funded by a grant or subsidy. A great example is the RDOF awards, where ISPs have until 2028 to fully complete any upgrades. We have to assume that once a grant award has been made that the ISP will make the upgrades (even though they sometimes don't).
- Change of Definition. One interesting change is a change in definition. Until recently, fixed wireless broadband was not considered in determining which areas are served or unserved. However, the NTIA has recently ruled that customers served by wireless ISPs using licensed spectrum can be counted as served or underserved. This change isn't used universally across the industry, but it will be the definition used for the $42.5 billion BEAD grant program.

Following is a list of the adjustments that we made to the map above to define the areas that we think are eligible for grants today:

Edge Issues. We reduced the network coverage area of the telephone companies and cable companies to correct the census block reporting to the FCC. For example, the FCC maps show some rural areas served by cable companies where there is no cable network.

Speed Corrections. We made corrections to restate the speeds of some ISPs based on the Finley field reviews, the speed tests, and other information. For example, we downgraded the reported speeds for several ISPs and for some DSL coverage.

BEAD Grant Definition of Grant-eligible.

There will be a huge amount of grant money coming to the state from the $42.5 billion Broadband Equity, Access, and Deployment grant program. That grant has a new definition of broadband compared to other federal grants. The NTIA has said that areas served by wireless ISPs that use licensed spectrum will not be grant-eligible if the speeds offered are fast enough – using the same definition that served is a broadband connection faster than 100/20 Mbps.

There are two types of wireless carriers that might meet this new definition:

- Fixed wireless WISPs that have purchased licenses for Citizens Band Radio Spectrum (CBRS).
- Cellular carriers that use cellular frequencies that offer FWA fixed wireless access.

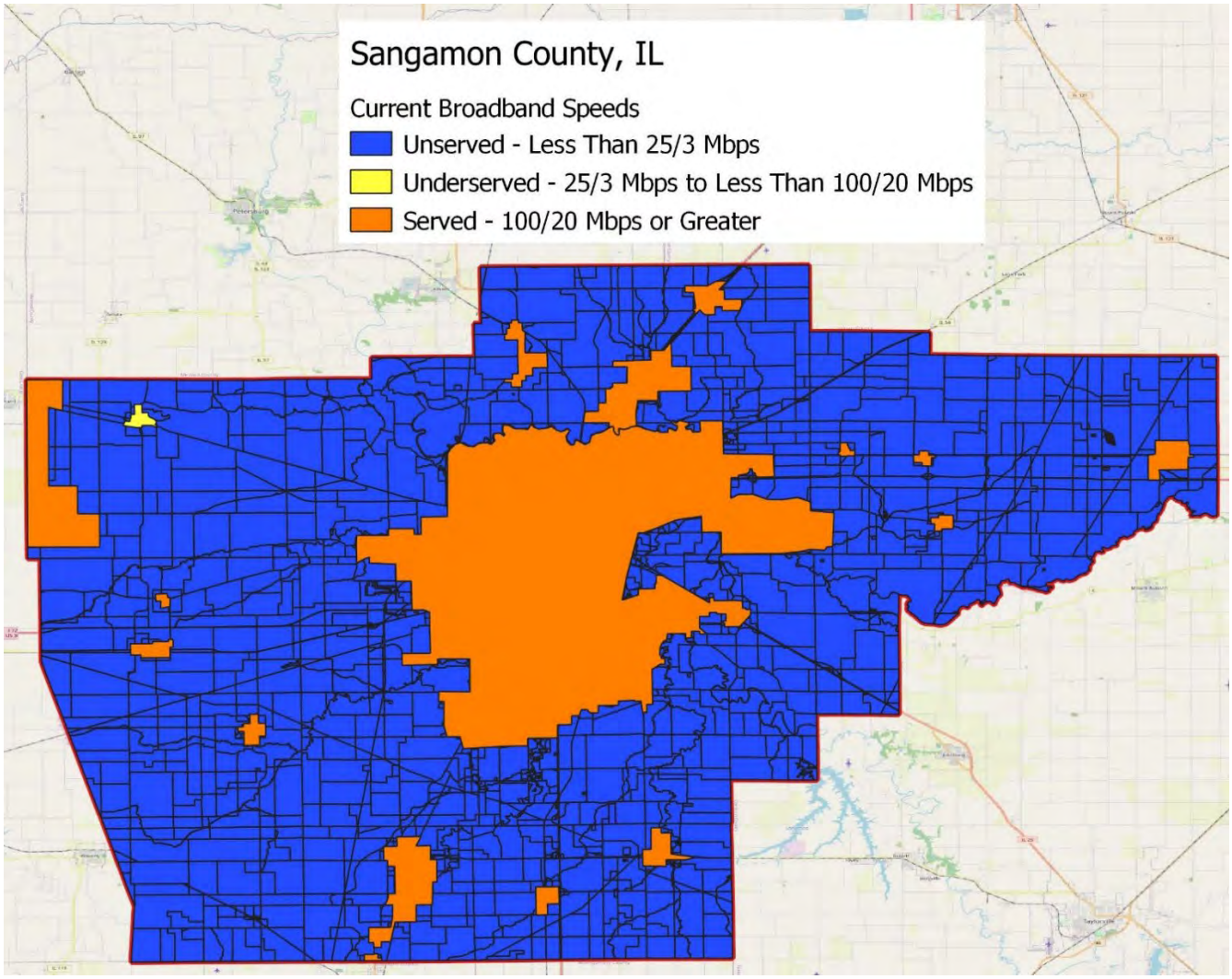
In both cases, the areas covered by wireless ISPs with speeds greater than 100/20 Mbps would not be grant-eligible. The majority of wireless ISPs in the county do not own licensed spectrum. Most wireless ISPs use the same spectrum used for home WiFi for fixed wireless coverage. There is also some portion of CBRS spectrum that is unlicensed. These bands of spectrum are free for anybody to use, meaning the wireless ISPs don't have to buy spectrum. The NTIA has clearly said that they believe that broadband using only unlicensed spectrum is not reliable. This is mostly due to the interference that comes when multiple wireless ISPs use the same spectrum.

There only wireless ISPs claiming broadband coverage using licensed spectrum today are T-Mobile, Verizon, and UScellular. But for now, these companies are still delivering relatively low speeds using hotspots, with speeds mostly below 25/3 Mbps, and we have elected to show these areas as unserved.

The following map reflects all of the above changes and defines the current state of broadband in the county today. The passings for the corrected map are as follows:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	6,457
Underserved	From 25/3 Mbps to 100/20 Mbps	352
Served	100/20 Mbps or faster	85,410
Total		92,219

Map 24- Current Broadband Speeds



Final Broadband Map

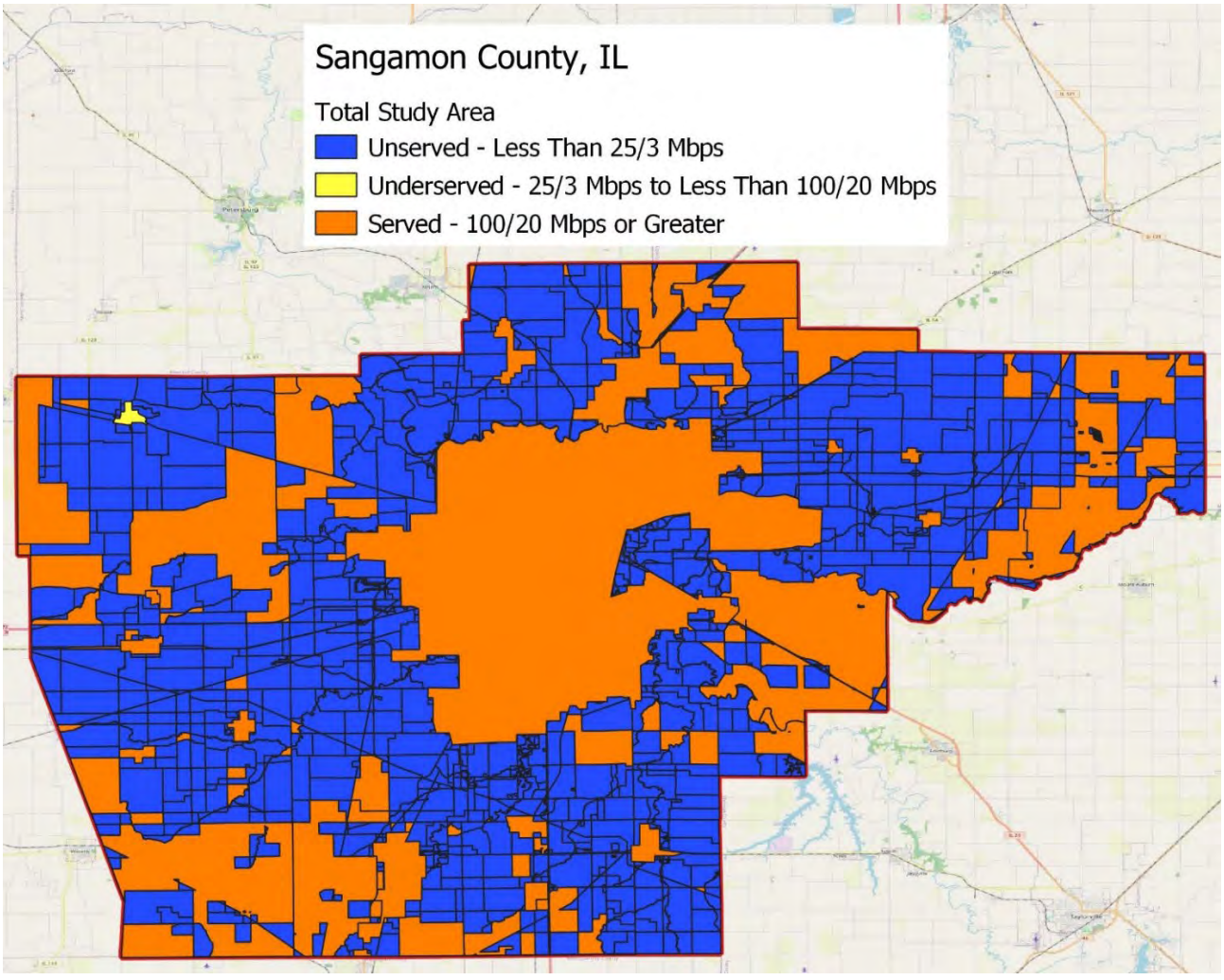
There is one more adjustment to be made to define the areas that are eligible today for BEAD and other grant programs that allow for funding broadband in areas with speeds under 100/20 Mbps.

The map must be updated to include the RDOF awards made by the FCC to Nextlink and Mercury Broadband. Now that the FCC has made these awards, the RDOF areas are off limits to other federal broadband grants and are considered to be served.

Changing the passing to reflect the RDOF awards shows the following passings:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	5,277
Underserved	From 25/3 Mbps to 100/20 Mbps	352
Served	100/20 Mbps or faster	86,590
Total		92,219

Map 25 – Grant Eligible Broadband Map



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 the county, as documented in the preceding section of the report.
- The Gap in Broadband Availability. There are homes with no landline broadband available.
- The Gap in Broadband Affordability. In every community, there are residents who don't subscribe to broadband because of the cost.
- The Gap in Computer Ownership. There are residents who don't subscribe to broadband because they can't afford a computer.
- The Gap in Broadband Skills. There are residents 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 claim are being delivered. This section of the report looks at other sources of information that can add to the narrative about broadband speeds 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 for customers since most web activities don't take very long. When customers visit a website, open a picture, or even take a speed test, the customer only needs bandwidth for a brief time. The burst technology gives customers the impression that they have a faster download speed than they actually have (or it could be conversely argued that they have a fast speed, but just for a minute or two).

Microsoft measured downloads starting in September 2018 and found:

- The 2019 FCC data claimed that 14.5 million people in the U.S. don't have access to download speeds of at least 25/3 Mbps. In October 2020, Microsoft claimed that 120.4 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2020 that 90.6% of households in Sangamon County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 52.8% 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 Mbps, 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 earlier in this report, the FCC doesn't challenge the speeds reported to them by ISPs. The Microsoft data highlights a big problem with the FCC data.

Comparing Sangamon County with the Rest of the Country

There are numerous ways to compare Sangamon County to the rest of the state and the country.

FCC Adoption Rate

How does Illinois compare to other states? In the 2021 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 Mississippi at 50.4%, and the highest is Delaware at 92.7%.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that are able to 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 2021 about Sangamon County:

Urban population:	166,111
% that can buy at least 25/3 broadband	98.7%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	98.7%
Rural population:	28,561
% that can buy at least 25/3 broadband	97%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	97%

The FCC data coverage above 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 statistics are badly misstated. According to the FCC, only 857 people in the county can't buy a broadband speed of at least 25/2 Mbps. According to our mapping analysis above, we believe there are 3,872 households and businesses that can't buy 25/3 Mbps.

Ookla Speed Test by State

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

	Download	Upload
Quarter 2 2021	114 Mbps	18 Mbps
Quarter 3 2021	117 Mbps	19 Mbps
Quarter 4 2021	128 Mbps	20 Mbps
Quarter 1 2022	133 Mbps	20 Mbps
Quarter 2 2022	128 Mbps	20 Mbps

As seen in the table above, download broadband speeds have been improving in Illinois. Just since early 2021, the median download speed has increased from 114 Mbps to 128 Mbps. The are several reasons for these speed increases. The big cable companies have been unilaterally increasing the speeds delivered to customers without raising rates. There are also some ISPs building fiber networks. Finally, there is a trend nationwide for customers upgrading to faster broadband products, which will be discussed in more detail below.

There is not as much increase in upload speeds. Part of the reason for this is that cable companies are not usually upgrading upload speeds when they increase download speeds. For example, a customer may continue to see the identical upload speed after upgrading from 100 Mbps download to 300 Mbps download.

According to Ookla, Comcast is the fastest ISP in Illinois, with a median download speed of 184 Mbps.

Comparing Sangamon 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 of 25/3 Mbps broadband. According to the FCC data, Sangamon County is in the middle of the pack in the state.

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 county.

The general speeds available on various technologies are as follows:

- DSL delivered on one copper pair can deliver speeds as fast as 25 Mbps for a mile or two from the DSL transmitter, assuming the copper is in good condition and other factors are ideal. There are older and slower types of DSL deployed that might have maximum speed capability of 3 Mbps, 6 Mbps, 12 Mbps, or 16 Mbps. DSL delivered on two copper pairs can deliver twice the speeds. This technology is usually only deployed using the latest types of DSL and has maximum speeds of around 50 Mbps – on perfect copper.
- High-orbit satellite broadband can deliver speeds as fast as 75 Mbps. The problem with this broadband is that the satellites are so far above the earth that there is a lot of delays (latency) in the signal, and it's hard to do real-time web activities like streaming video, connecting to a corporate WAN, a school server, making VoIP calls, or even shopping on some websites. Satellite speeds are greatly reduced for customers that don't have a full view of the open sky – like customers with trees around their homes or located near hills and mountains.
- Fixed point-to-multipoint wireless is capable of download speeds up to 100 Mbps. There are new vendors claiming future speeds will be even faster. 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.
- 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. Sparklight, Mediacom, and Comcast have upgraded to the most recent DOCSIS 3.1 standard and can deliver speeds of a little more than one gigabit. CASSCOM only advertises broadband speeds on its cable system of 50 Mbps, and we believe this is an older network still using the DOCSIS 2.0 standard.
- 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 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 long-standing 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 almost impossible for an ISP to understand DSL speeds for each customer since the speeds can vary widely during the day.

As discussed above, 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 or impediments between the tower and a 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 at the same time (20 customers X 100 Mbps), meaning this example PON has unused capacity. In this example, every customer is guaranteed to be able to use the full 100 Mbps connection. However, if an ISP instead sells a gigabit connection to 20 customers, then there are 20 gigabits of potential customer usage that have been pledged over the same 2.4-gigabit physical path. The ISP has sold more than eight times more capacity to customers than is physically available, and this particular PON has an oversubscription ratio of eight to one.

When people first hear about oversubscription, they are often aghast – they think an ISP has done something shady and is selling more bandwidth than can be delivered. But ISPs understand how customers use bandwidth, and they can take advantage of the real behavior of customers in deciding the oversubscription ratios. ISPs know that a home subscribing to a gigabit connection almost never uses the

full bandwidth capacity. A home doesn't use much bandwidth when people are asleep or away from home. 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 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 the experience of working with hundreds of ISPs that an ISP can give every customer gigabit speeds on a residential GPON network and still deliver full speeds to customers more than 99% of the time. An oversubscription of 8 on a fiber network is a high-quality broadband network.

Even if this example PON got too busy, it would likely be temporary. 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 neighbors of the doctors wouldn't notice a perceptible difference in performance.

Oversubscription is different for business customers. Businesses might use steady bandwidth, such as connecting VLANs to multiple branches, using software platforms in the cloud, using cloud-based VoIP, etc. An oversubscription ratio that works in a residential neighborhood might not work in 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 on cable networks 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 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, cable companies have lowered the number of households on a neighborhood node to reduce oversubscription problems.

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 impact of oversubscribed networks reared its head during the pandemic. The issue now is not so much 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 faster download speeds 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

No Broadband Available

There are residents in every rural area who say they have no broadband available. What do people mean when they tell us there is no broadband at their home?

We know that DSL is often not available. Rural customers all over the country have been reporting for years that CenturyLink won't provide new DSL service. Even where CenturyLink 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 and barely any upload speeds.

A lot of homes won't consider satellite broadband as an option. We've talked to many rural residents who tried satellite broadband and rejected it. The speeds are often far below what is advertised since trees and hills can block a satellite signal. The latency is dreadful - in places where the speeds are impaired, high latency means a household can't hold a connection to a website, making basic things like shopping on the web impossible. Satellite plans also come with tiny data caps, and people find it impossible to make it through the month with a 40 - 60 gigabyte data cap. The killer issue with satellite broadband is the cost. Viasat told investors in 2021 that its average revenue per customer was over $93 per month. 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 is a long list of reasons why fixed wireless might not work at a given home, many of which were discussed earlier.

Rural homes might also have tried 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 coverage is often spotty and poor in most rural areas.

We believe it when a rural household tells us they have no broadband available. They will typically already have tried DSL, 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 the broadband adoption for the country is around 87% - meaning that is the number of homes that are buying a broadband connection. 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 is almost always the price – people say they can't afford broadband.

Statistics on Affordability

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

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

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.[8] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[9] This report looks at a study conducted in three low-income neighborhoods of Detroit.

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

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

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 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[10]. 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 Sangamon County

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

- Population Growth. The 2020 Census reports that the county population decreased 0.6% from 2010 to 2020. The population for Illinois decreased by 0.1%.
- Population Ages. The county has the same percentage of children at 5.6% as the state and of persons under 18 at 22.1% as the state. Sangamon County has a higher percentage of those over 65 at 18.1% than the Illinois average of 16.6%.
- Homeownership. There is a higher percentage of home ownership in the county at 70.0% than the state average of 66.3%. The average home in the county costs $144,100 compared to the state average of $202,100.
- Education. The percentage of those with a high school diploma at 92.5% is higher than the state average of 89.7%. The percentage with a bachelor's degree or higher at 34.1% is slightly below the statewide average of 35.5%.
- Income. The median household income of $61,743 is somewhat below the state average of $68,428. Per capita income of $35,549 is also somewhat lower than the statewide average of $37,306. The percentage of homes in poverty at 12.8% is above the statewide average of 11.08%.

Our takeaway is that the demographics in the county don't indicate that broadband should be harder to afford in Sangamon County compared to the rest of the state. Other than housing prices being lower, the County is similar to the state in every demographic aspect.

But there are a few issues in the demographics to keep in mind. Almost 13% of homes are below the poverty threshold and will have issues affording broadband. Below we look more closely at the distribution of incomes in the county.

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

Income Statistics for Sangamon County

One of the best sources of demographic data comes from the Department of Housing and Urban Development (HUD). HUD collects nationwide data that is often used when awarding broadband grants. HUD data is used to identify lower-income parts of a community – areas that are often given preference in grants related to housing, economic development, and broadband deployment. Following is what HUD says about Cottonwood County.

HUD (Department of Housing and Urban Development)

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

HUD Community Development Block Grant (CDBG)

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

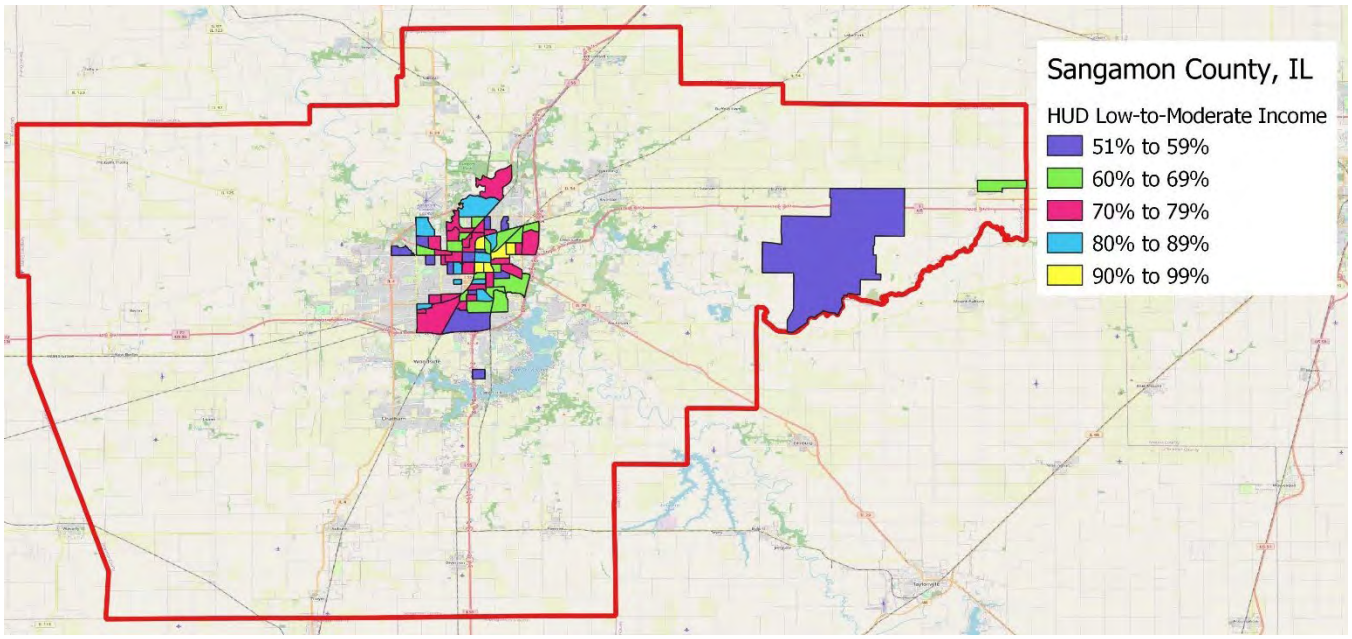
HUD uses two sources of statistical information to calculate income levels around the country. The two sources are:

- The American Community Survey (ACS), and
- The Income Limits for Metropolitan Areas and for Non-Metropolitan Counties.

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

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

The CDBG identifies areas where 51% of the population is considered low-to-moderate income. The map below identifies that parts of the City of Springfield and one eastern part of the county have over 51% of the population with low-to-moderate incomes.



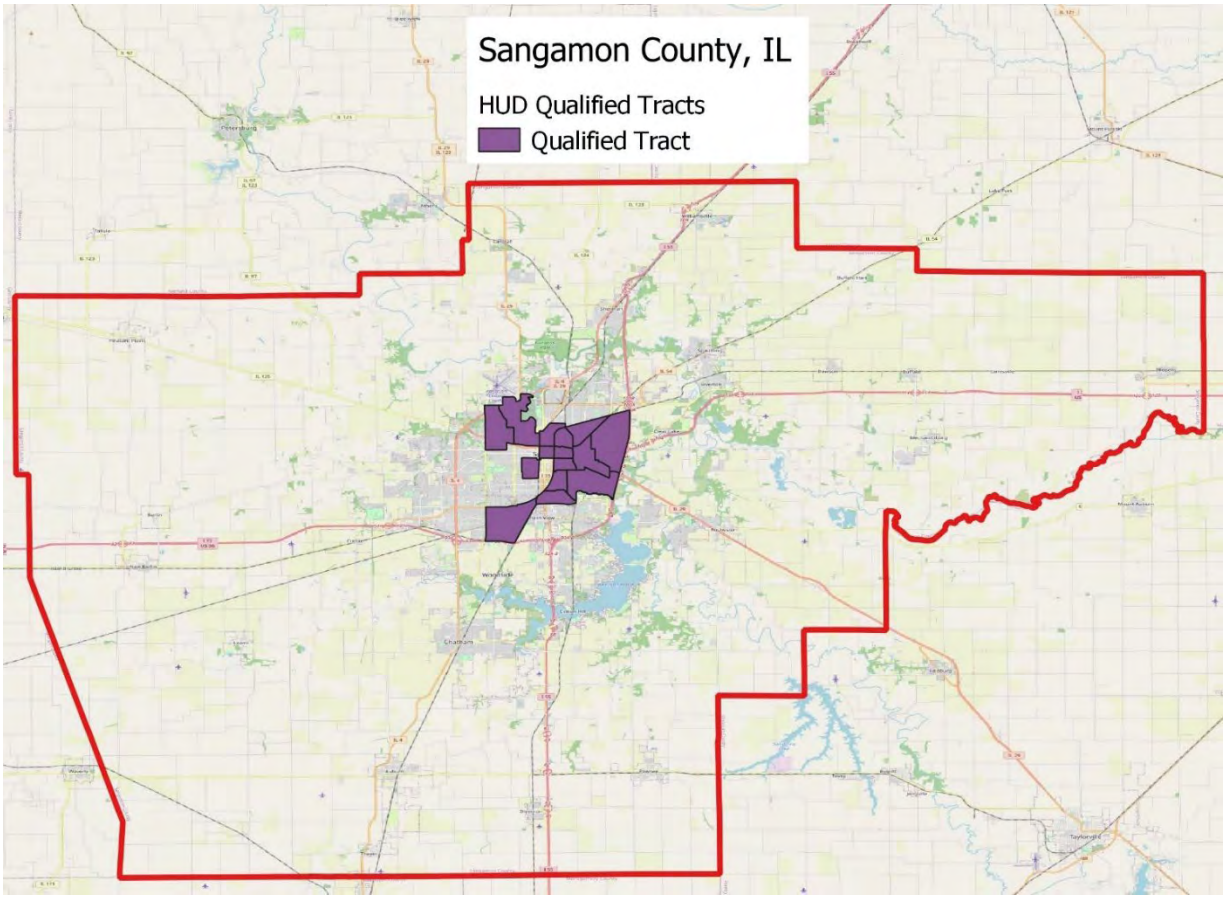
HUD Qualified Tracts

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

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

HUD uses its Very Low-income Limits to standardize the calculations. HUD then uses a mapping tool to specifically identify areas it labels as Qualified Census Tracts. These areas cannot exceed 20% of the area's total population. In Sangamon County, 15 Census Tract has been identified as a qualified HUD tract by meeting the requirement of having over 50% of the population having incomes below 60% of the area's median gross income.

HUD Qualified Tracts in Sangamon County



American Community Survey (ACS)

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

One of the many functions done using ACS data is to identify pockets of the country with high levels of poverty. The ACS poverty designation is then used in many federal grants and funding aimed at alleviating poverty. The current ACS survey does not identify any areas of the county with poverty levels above 20%.

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 cell phones are good tools for things like shopping online, but they are inadequate for students trying to do homework. Any plan to close the digital divide must find solutions for closing the computer gap.

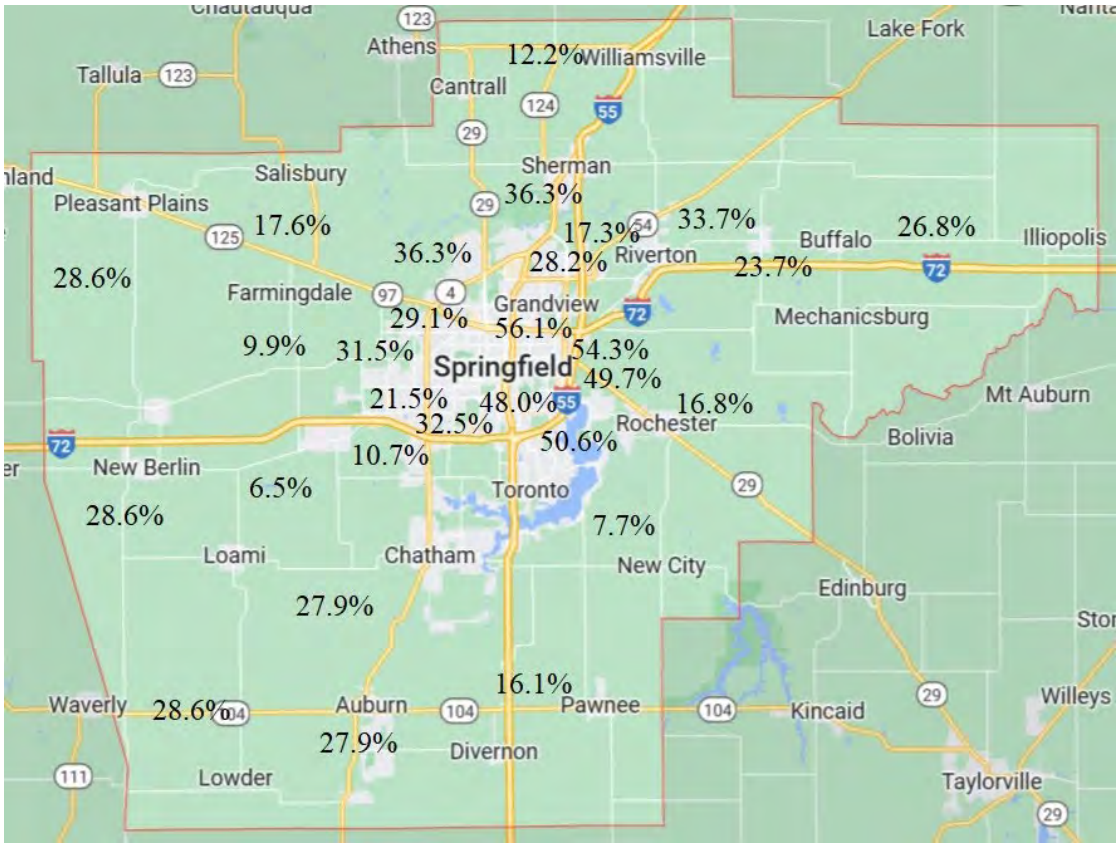
A survey by Pew Research Center in 2021 shows a huge disparity between income and technology adoption. Consider the following results of that poll:

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

Other studies have shown that the percentage of homes that have any of 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.

We created the following map that shows the different levels of computer ownership around the county. This map comes from the U.S. Census and shows the percentage of homes that don't have a home computer in different parts of the county. The percentage of homes without computers varies from 7.7% to 56.1% in different parts of the county.



The percentage of homes without a computer highlights the challenge of bringing a new broadband network to people - a solution is needed for many homes for both a broadband connection and a computer. As will be discussed below, many homes also need computer training.

The historical solution to a lack of computers was to put computers in libraries and public places. However, in 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.

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 computer scientists, engineers, and similar tech jobs is at an all-time high. 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 the same rate since the early 1980s. Home and business requirements for bandwidth have been doubling every three to four years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over 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, 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 demand for broadband speeds had been growing over the last decade by about 21% annually. Business demand 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 25/3 Mbps was an adequate definition of bandwidth in 2015, then growing the need for faster speeds by 21% annually would result in the following speed requirements.

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. This is the 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 say that households that cannot buy a product with 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 combine download and upload usage.

1st Quarter 2018	215 Gigabytes
1st Quarter 2019	274 Gigabytes
1st Quarter 2020	403 Gigabytes
1st Quarter 2022	514 Gigabytes
2nd Quarter 2022	491 Gigabytes

This data shows several things. First, it shows extraordinary growth in the average use of broadband across the country. 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 grew 23% from the end of the first quarter through the end of the year. Broadband usage grew by 13% between the second quarter of 2021 to the second quarter of 2022.

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 gigabytes at the end of 2021. In the first quarter of 2022, OpenVault reports an average of 481 gigabytes of download data and 33 gigabytes of upload data. In the second quarter of 2022, OpenVault reports an average of 460 gigabytes of download data and 31 gigabytes of upload data.

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

4th Quarter 2018	4.0%
4th Quarter 2019	7.2%
4th Quarter 2020	14.1%
4th Quarter 2021	16.1%
1st Quarter 2022	14.6%
2nd Quarter 2022	13.7%

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 2.2% in the first quarter of 2022.

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, 2021, and 2022.

	June 2020	June 2021	June 2022
Under 50 Mbps	18.4%	10.5%	5.7%
50 - 99 Mbps	20.4%	9.6%	8.5%
100 - 199 Mbps	37.8%	47.5%	10.1%
200 - 499 Mbps	13.5%	17.2%	55.4%
500 - 999 Mbps	5.0%	4.7%	6.0%
1 Gbps	4.9%	10.5%	14.2%

Between June 2020 and June 2022, the number of households subscribed to gigabit broadband has doubled, while the number subscribed to slower speeds is dropping precipitously. Many millions of homes have upgraded to faster broadband plans.

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

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

The percentage of homes using less than 100 gigabytes per month has dropped by 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 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. For the last decade, the peak period for broadband usage – the busy hour – was always in the evenings. During the pandemic, the volume of usage in the evenings has remained flat while students and home workers increased the broadband used during the daytime.

OpenVault says that nationwide broadband usage peaked in the third week of March 2020. It will be interesting going forward to see how home usage changes. OpenVault doesn't have any better crystal ball than the rest of us, but they are predicting that broadband usage will never return to 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. As this report was being written, Jessica Rosenworcel, the FCC Chairman, suggested to the rest of the FCC that the time has come to raise the definition of broadband to 100/20 Mbps.

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

It's also important to look toward the future when considering broadband needs. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband requirements a decade from now. Consider the following chart that predicts broadband needs moving forward. The chart applies the 21% historical annual growth rate for broadband speed, assuming that 100 Mbps is the right definition of broadband in 2022. Forward-looking predictions are often criticized for being too aggressive, but when considering that the demand for broadband speeds has been growing at the same rate since the early 1980s, it is not a big stretch to predict broadband needs into the future.

Download Speeds in Megabits / Second

2022	2023	2024	2025	2026	2027	2028	2029
100	121	146	177	214	259	314	380

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 2040 would be 2.9 Gbps. It's easy to say that such future speeds are not possible, but recall that just 20 years ago, a 1 Mbps DSL connection was considered to be a blazingly fast broadband connection. The only current technologies that can keep up with this growth in demand are fiber and cable coaxial networks. There is already fiber gear today that can deliver 10 Gbps download speeds, and coaxial networks are expected to have the same capabilities within five or six years.

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

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

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

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

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

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. Existing Provider Analysis

Our analysis started with an initial review of available broadband mapping data and field reviews in Sangamon County on July 14 and August 18, 2022, by Tim Arbeiter, and August 24-25, 2022, by Sam Tennant, both of Finley Engineering. The final competitive analysis incorporates all their fieldwork data to determine the extent of broadband deployment.

Finley attempted to understand the broadband available today from the incumbent providers by examining the existing infrastructure used to provide broadband. Our review also included looking at detailed speed reporting and technology codes contained in the FCC 477 data, a review of CAF Funding deployed locations, and the Ookla location and provider-specific speed test data from October 2021 thru September 2022.

All this information is compiled to create a GIS map used to conduct the Sangamon County field review; our analysis contained an onsite assessment of more than twenty-six specific locations documenting more than 210 locations with broadband assets. Our initial GIS map for review is a starting point of discovery. During our review of Sangamon County, we found other broadband assets in proximity to one of our initial review points or additional broadband assets as we evaluated the county.

We made an extensive drive through Sangamon County and identified existing infrastructure supporting broadband, like electronic sites supporting the AT&T, Frontier Communications, and CASSCOMM networks. We also identified fiber and cable nodes in the Comcast, Mediacom, Cable One, and CASSCOMM cable networks.

Finley's goal for this review was to make the best estimation of the broadband investments and speeds available in various places across Sangamon County. The Finley Team also looked at local factors impacting the cost of building a new fiber network in Sangamon County. Our primary focus is to understand the ground conditions for constructing buried fiber networks in areas that need investment and expansion.

The rest of our competitive review is an individual analysis of existing providers' networks, planned network expansions, and if they have the technological capability to provide greater than 100/20 Mbps wireline broadband in Sangamon County.

AT&T

AT&T (Illinois Bell) is the incumbent telephone provider to approximately 42% of the land mass and 81% of the living units in Sangamon County. AT&T indicates the company currently offers internet services over existing copper cables with a combination of legacy ADSL, ADSL2+, and VDSL equipment with

speeds of up to 100/20 Mbps. The rural areas of Sangamon County (outside the city limits of Springfield) are areas where ADSL and ADSL2+ technology is essentially the only solution offered by AT&T, with maximum reported speeds of 18/1 Mbps internet.

We found some limited rural areas where AT&T indicates VDSL service is used with maximum speeds of 100/20 Mbps. AT&T cannot provide 100/20 Mbps service to many locations in rural Sangamon County. The overstated speeds are due to the census block reporting to the FCC.

Within the city limits of Springfield, AT&T offers ADSL, ADSL2+, VDSL, and FTTH service, and the speeds indicated by AT&T for ADSL, ADSL2+, and VDSL in FCC 477 reporting similar to those in rural areas. In Springfield, ATT offers FTTH services, and from our provider interview, AT&T indicates the use of XGS-PON (10Gb PON) as the technology for FTTH service.

Our review of Ookla speed tests in the areas AT&T indicates the use of FTTH technology in FCC 477 reporting supports the deployment of fiber technology as we see multiple speed tests in these areas with download and upload speeds above 100 Mbps. The FTTH deployment areas are limited and likely in the same areas where AT&T has fiber-rich assets required for 5G wireless deployments.

AT&T commented in provider interviews that the company had made significant investments in Sangamon County since 2021, and even higher levels of investment are planned for 2022 and 2023. AT&T did not indicate the value of investments in wireline networks to support 100 Mbps symmetrical service; but did indicate the ongoing investment in fiber, XGS-PON technology, and 5G wireless networks. AT&T did note that due to the low customer density and significant investment, considerable contributions by Sangamon County, the State of Illinois, and other funding sources would be required to expand wireline broadband networks in rural areas of the county.

From our review, AT&T can provide broadband speeds greater than 100/20 Mbps at low latency, where the company has invested in an all-fiber network. Our technology analysis and Ookla speed review can provide speeds greater than 500 Mbps in the areas of fiber deployment. In areas of Sangamon County where AT&T is using copper-based technology, we find AT&T cannot provide 100/20 Mbps service, and in most rural areas, it cannot provide 25/3 Mbps broadband.

AT&T Central Office Location in Riverton

Frontier Communications

Frontier Communications is the incumbent telephone provider to approximately 56% of the land mass and 19% of the living units in Sangamon County. Frontier indicates the company currently offers internet services primarily over existing buried copper cables with a combination of legacy ADSL, ADSL2+, and VDSL equipment with speeds of up to 100/20 Mbps. Frontier primarily serves the rural areas of Sangamon County (outside the city limits of Springfield).

The small towns in the county are areas where ADSL and ADSL2+ technology is utilized; Frontier reports a maximum speed in FCC 477 data of 18/1 Mbps. FCC 477 data also indicates that VDSL service is primarily associated with the small towns in Sangamon County and is likely only a technology deployed in Central Office locations with maximum speeds of 115/7 Mbps associated with VDSL technology.

Frontier noted in the provider interview the deployment of limited FTTH technology in the rural area east of Pleasant Plains and the ability to offer 2 Gbps symmetrical speeds in these areas with the use of XGS-PON (10Gb PON) for FTTH service. Our review of Ookla speed tests in the areas did not find a conclusive speed test from anyone using a symmetrical broadband connection; in all fairness, this service may be accessible to less than 100 customer locations with few active customers.

Frontier commented in the provider interview that the company is considering a significant internally funded broadband build in Sangamon County and is very interested in discussing its plans with the County. Frontier would like to discuss grant funding strategies to leverage Frontier's internal investment and modest funding support from Sangamon County that could leverage a more significant future grant investment.

From our review, Frontier is limited in providing broadband speeds of 25/3 Mbps in rural areas and may be able to meet 25/3 Mbps broadband speeds in the small towns of Sangamon County but cannot support robust 100/20 Mbps service over the existing copper facilities. In the small area where symmetrical fiber service is available, Frontier is likely capable of providing low latency broadband of greater than 100/20 Mbps to a limited number of locations close to the FTTH deployment.

Frontier Remote and Copper Cross Connect (Cimic)

Frontier Central Office Location (Williamsville)

CASSCOMM

CASSCOMM is the incumbent telephone provider to a small area in northwest Sangamon County, serving 1% of the land mass and less than 1% of the living units in Sangamon County. CASSCOMM has deployed a FTTH network to 100% of the small part of Sangamon County, where the company provides regulated telephone services.

CASSCOMM is a competitive FTTH provider in the rural villages and adjacent rural areas of Williamsville, Sherman, and Riverton. CASSCOMM provides DOCSIS 3.0 cable broadband service in the village of Pleasant Plains.

From our review, CASSCOMM can provide broadband speeds greater than 100/20 Mbps at low latency where the company has invested in an all-fiber network. From our analysis of technology and Ookla speed review, CASSCOMM is providing symmetrical speeds in excess of 100 Mbps, where customers are subscribing to those service packages in the Williamsville, Riverton, and Sherman markets.

CASSCOMM PON Cabinet at Rail Golf Course (Sherman)

CASSCOMM PON Cabinet (Riverton)

CASSCOMM Fiber and Customer Drop Splice Point (Williamsville)

Our review of the DOCSIS 3.0 cable system in Pleasant Plains finds a quite different broadband speed experience than in the CASSCOMM FTTH areas. This is not a criticism of the system but characterizes the stark differences in capability between the two systems. With the current DOCSIS 3.0 system in place and the current Frontier service levels, Pleasant Plains is defined as an Underserved Area and we found speeds above 25/3 Mbps, but not many above 50/5 Mbps).

CASSCOMM indicated that the current investment plans for Pleasant Plains are for a full FTTH deployment to be completed before the end of 2023, with some of the FTTH deployment completed on the east side of Pleasant Plains occurring first. Cass also denoted within the interview that the company currently has the inventory to complete the FTTH build. Still, some items for customer connections are slow to arrive due to supply chain challenges.

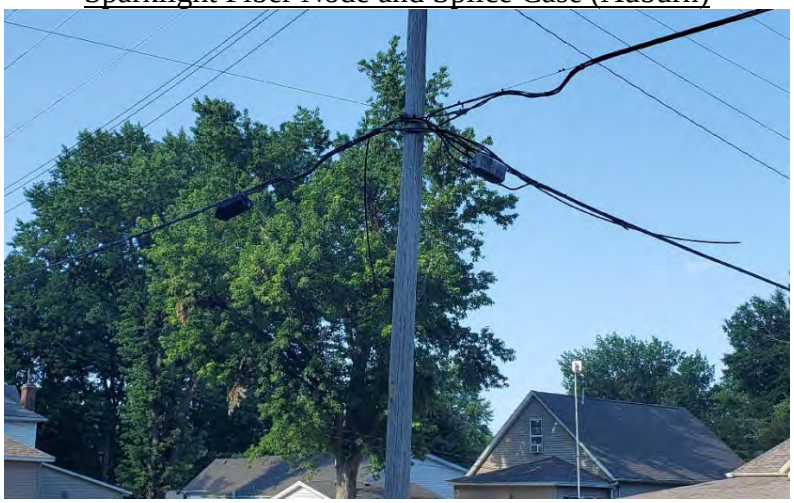
Sparklight (Cable One Inc.) ***(Declined Provider Interview)***

Sparklight (Cable One) operates a DOCSIS 3.0 hybrid fiber coaxial system in Thayer and Auburn and a small rural area between the two communities. DOCSIS 3.0 systems can support 1 Gbps/200 Mbps in a fiber-enabled CMTS or field-deployed optical node when properly configured and adequate fiber nodes are placed in the system.

In our field review of the Sparklight system, we found fiber in the Sparklight hybrid-fiber coaxial system but could not identify the number of passive or powered coax nodes fed from a fiber-connected node.

Ookla speed tests in the Thayer, Auburn areas show broadband speed tests above 100/20 Mbps with latency characteristics of a wireline broadband network. Our review of the Ookla speed test data, FCC 477 data, and field review of the Sparklight service area showed that the network could provide greater than 100/20 Mbps service. We note that we found speed tests under 100/20 Mbps, but we don't know if those speeds are from customers who have purchased a broadband package of speeds less than 100/20Mb, or Sparklight customers who may be having technical issues.

Sparklight Fiber Node and Splice Case (Auburn)



Sparklight power enclosure for power/amplification and capability for battery backup

Mediacom Illinois

Mediacom operates a buried DOCSIS 3.1 hybrid fiber coaxial system in New Berlin, Loami, Dawson, Buffalo, Mechanicsburg, Cantral, a suburban/rural area just to the east of Springfield and other scattered census blocks around Sangamon County per FCC 477 reporting. DOCSIS 3.1 systems can support an aggregate of 10 Gbps/1-2 Gbps in a fiber-enabled CMTS or field-deployed optical node with a DOCSIS 3.1 system when properly configured and maintained and adequate fiber nodes are placed in the system.

Mediacom noted in the provider interview that it uses a fiber node +2- or +6-line powered coax node system configuration dependent on the system and future projects.

In our field review of the Mediacom system, we found fiber in the hybrid-fiber coaxial system. Unfortunately, we could not identify the number of passive or powered coax nodes fed from a fiber-connected node. Ookla speed tests in the New Berlin, Loami, Dawson, Buffalo, and Mechanicsburg areas show broadband speed tests well above 100/20 Mbps with latency characteristics of a wireline broadband network. Our review of the Ookla speed test data, FCC 477 data, field review of the Mediacom service area, and our collective broadband provider interview indicate that Mediacom has deployed a network and technology capable of providing greater than 100/20Mb service.

We note that we find a few speed tests less than 100/20 Mbps but do not know if those speeds are from customers that have purchased a broadband package with speeds less than 100/20 Mbps or customers who may be having technical issues. Of note, the FCC 477 coverage for Mediacom is likely overstated in the rural areas around the small villages of New Berlin, Loami, Dawson, Buffalo, and Mechanicsburg related to the reporting requirements of FCC 477 submissions.

In the suburban/rural area east of Springfield, this phenomenon is also present as Mediacom may provide service to select subdivisions and streets, and the FCC 477 data overrepresents coverage to less dense parts of the census block(s).

Mediacom noted in the provider interview that all current network investments in Sangamon County have been internally funded, and the company anticipates participating in the Connect Illinois Grant Program and future opportunities from BEAD funding. Mediacom also notes that clear communications from the County regarding areas of most need, expedited permitting, anticipated areas of growth, and considering a mix of technologies for current internet needs and long-term broadband goals are critical to success.

Mediacom Cable Power amp (Dawson)

Mediacom Cable Power amp (Loami)

Mediacom Cable Power amp (New Berlin)

Comcast

Comcast operates a DOCSIS 3.1 hybrid fiber coaxial system in Springfield, Divernon, Pawnee, Rochester, Illiopolis, and surrounding rural areas. DOCSIS 3.1 systems can support an aggregate of 10 Gbps/1-2 Gbps in a fiber-enabled CMTS or field-deployed optical node with a DOCSIS 3.1 system when properly configured and maintained and adequate fiber nodes are placed in the system.

Our field review of the Comcast system found fiber in the hybrid-fiber coaxial system. We could not identify the number of passive or powered coax nodes fed from a fiber-connected network. Ookla speed tests in the Springfield, Divernon, Pawnee, Rochester, and Illiopolis areas show broadband speed tests well above 100/20 Mbps with latency characteristics of a cable broadband network. Our review of the Ookla speed test data, FCC 477 data, field review of the Comcast service area, and our collective broadband provider interview indicate that Comcast has deployed a network capable of providing greater than 100/20Mb service.

We note that we found a few speed tests less than 100/20 Mbps but do not know if those speeds are from customers that have purchased a broadband package with speeds less than 100/20 Mbps or customers who may be having technical issues. We note that the FCC 477 coverage for Comcast is likely overstated in the rural areas around Divernon, Pawnee, Rochester, and Illiopolis due to the FCC 477 reporting by census block. This also may be true within the suburban/rural areas around Springfield. Comcast may only provide service to select subdivisions and streets, so the FCC 477 data may be overrepresented in less dense parts of the census block.

Comcast noted in the provider interview that all current network investments in Sangamon County had been internally funded investments and have submitted four Connect Illinois Grant applications in Sangamon County. Company leaders are also evaluating the broadband grant funding landscape and anticipate participating in future rounds of Connect Illinois Grant Program and future opportunities from BEAD funding. Comcast notes that they are committed to helping expand broadband access in Sangamon County and are open to discussing innovative ways to drive broadband access, literacy, and adoption.

Comcast fiber splice point and cable node (Rochester)

Comcast cable node (Rural area SW of Springfield)

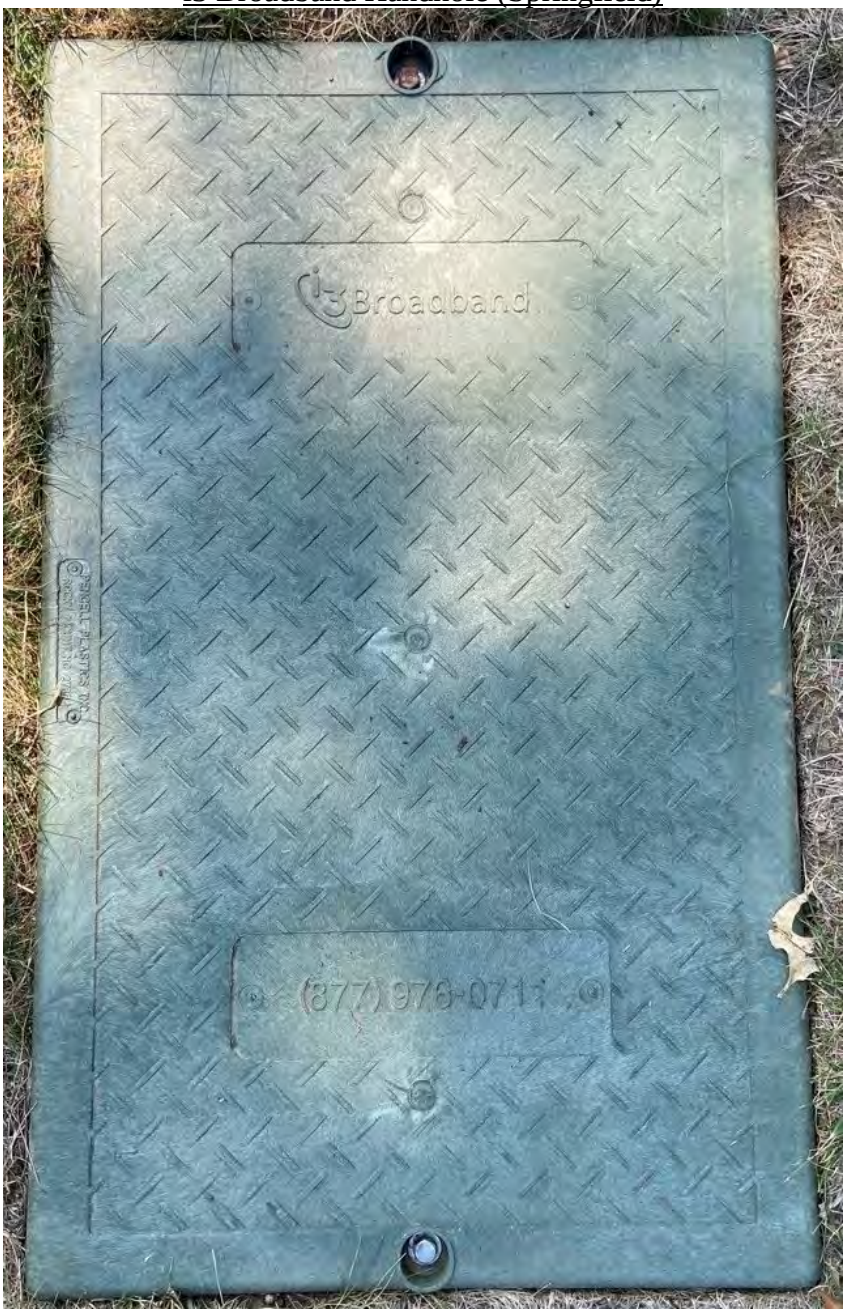
Comcast cable node (Rural area SW of Springfield)

Comcast cable node (Pawnee)

i3 Broadband

i3 Broadband offers FTTH services in a small area of western Springfield. We were unable to get a provider interview with i3 but could identify i3-branded fiber handhole's in the service area identified in FCC 477 reporting. Our team reviewed Ookla speed test data over multiple quarters and could locate broadband speeds greater than 100/50 Mbps and some symmetrical speeds with very low latency. In our view, these speed tests are most likely attributable to i3 Broadband subscribers since no other FTTH operator is in the service area.

i3 Broadband Handhole (Springfield)



i3 Broadband Handhole (Springfield)

Veloxinet

Veloxinet is a privately owned internet service provider offering Fixed Wireless Access (FWA) broadband service in a small part of northern Sangamon County with larger areas of service in Menard County. Veloxinet is currently in north Sangamon County, starting some FTTH work in far northern Sangamon County, and at this time, the deployment is limited in size.

Finley's provider review finds that Veloxinet does not own any spectrum that could provide fixed wireless broadband but uses the public GAA spectrum in the 3.65 band for services. Veloxinet uses a standard mix of industry-recognized vendors for 3.65 CBRS deployments and some limited 5.8 GHz unlicensed equipment. The information provided from the provider interview and the most recent FCC 477 reporting shows that Veloxinet is not providing 100/20 Mbps service as a fixed wireless solution.

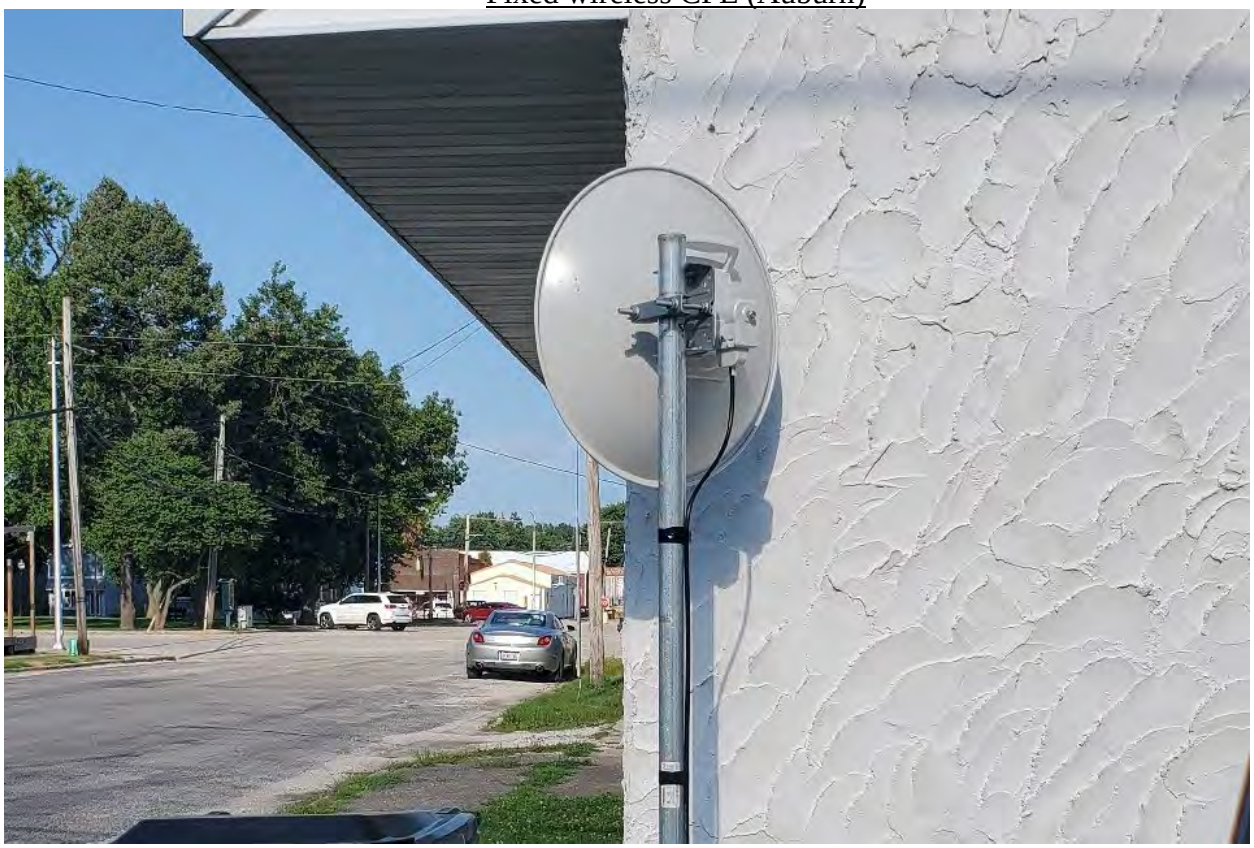
For Veloxinet, fiber is critical to future operations. It will continue to expand investments in FTTH networks that can provide more than 100/20 Mbps service today and are capable of future upgrades of greater than 1 Gbps service. Veloxinet, at this time, is making all broadband investments from the cash flow of existing operations and is interested in pursuing broadband grant funds with Sangamon County or other sources if the pursuit of the funding opportunity is possible for a smaller broadband provider like Veloxinet.

Royell Communications

Royell Communications is a privately owned internet service provider offering Fixed Wireless Access (FWA) broadband service in Sangamon and surrounding counties with a significant existing customer base. Royell Communications is currently working on completing an FTTH build within the City of Auburn and anticipates completing the project within 12 months.

Royell did not offer specific details regarding vendors, technology, or spectrum utilized for FWA access to customers, backhaul links in the extended FWA network, or any details on FTTH network topography or vendors.

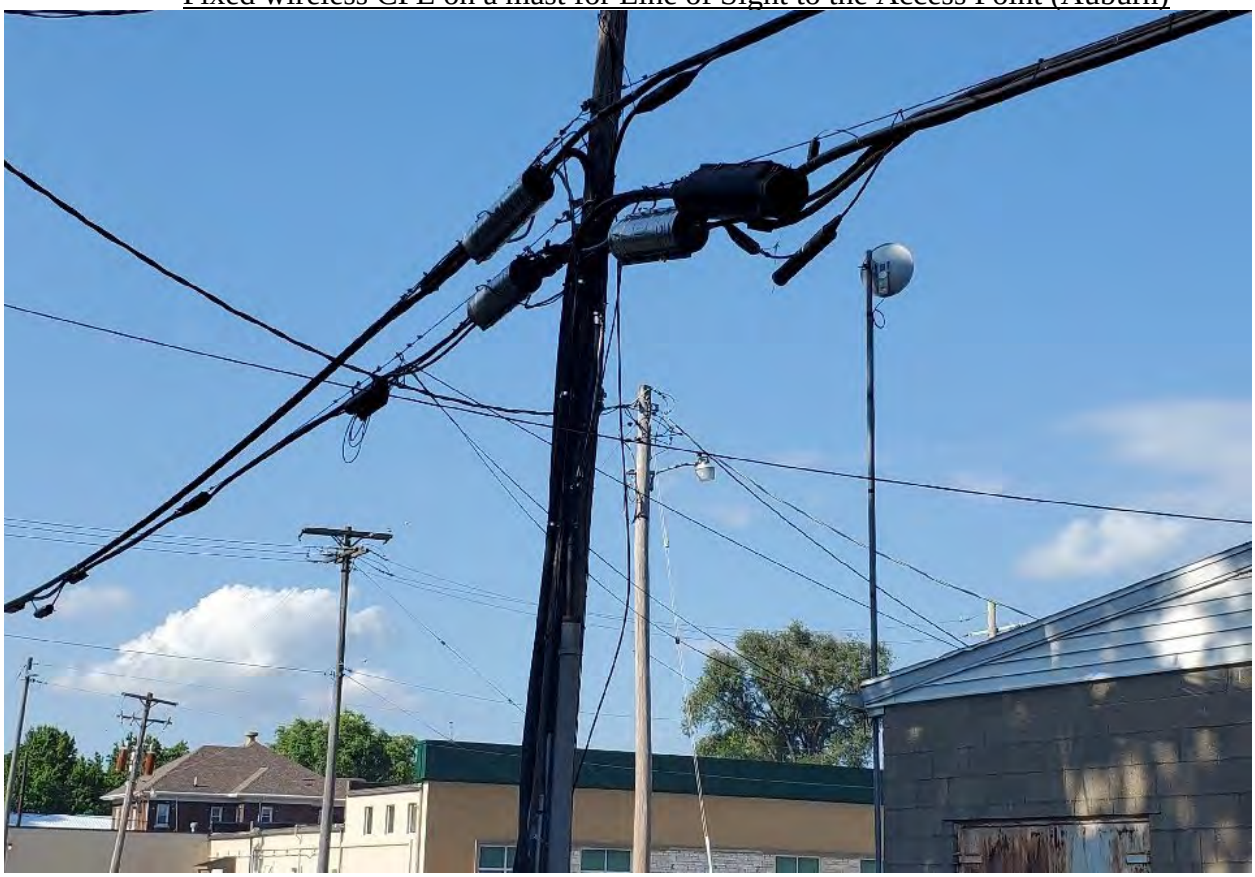
Fixed wireless CPE (Auburn)



Our provider review finds that Royell does not own any spectrum that could be used for providing fixed wireless broadband. The information gathered from the Royell provider interviews, review of available data, and speed offerings, Finley estimates that Royell is currently using unlicensed spectrum and may be utilizing up to 20 MHz of Generally Authorized Access (GAA) spectrum available in the CBRS 3.5 GHz band to provide service in Sangamon County and surrounding areas. From the information Finley could gather from the FCC 477 reporting, Royell subscriber package offerings, and the provider interviews, Royell cannot provide 100/20 Mbps service as an FWA access internet solution.

Royell acknowledges that investments in fiber are critical to future operations. Auburn is investing in a wireline FTTH network capable of providing greater than 100/20 Mbps service at this time and in future upgrades of delivering greater than 1 Gbps service. Royell is currently making all broadband investments from the cash flow of existing operations and is unsure of any participation in grant funding opportunities.

Fixed wireless CPE on a mast for Line of Sight to the Access Point (Auburn)



Royell Communications Tower with Backhaul Radios and Access Points (Auburn)

Rise Broadband (Skybeam)

Rise Broadband (Skybeam) is a privately owned internet service provider offering.
Our provider review finds that Rise does not own any spectrum that could provide fixed wireless broadband but uses the GAA spectrum in the 3.65 band for services. Rise uses a standard mix of industry-recognized vendors for 3.65 CBRS deployments and 5.8 GHz unlicensed equipment. From our broadband evaluation from the provider interviews and data in the most recent FCC 477 reporting, Rise is not providing 100/20 Mbps service as an FWA access internet solution.

Shelby Electric Cooperative

Shelby Electric offers Fixed Wireless Access (FWA) broadband service to a small part of the eastern edge of Sangamon County from (3) tower and access point sites in Christian County. Shelby provides service with unlicensed equipment and speeds less than 100/20 Mbps. Shelby is currently overbuilding their FWA service area in Macon County with FTTH. Shelby noted in the provider interview that Sangamon County should work with local partners with a long-term vested interest in the area and would be open to a partnership arrangement with Sangamon County to deploy FTTH assets like the arrangement Shelby is engaged in with Macon County.

A.C.T.S.

A.C.T.S. is a privately owned internet service provider offering Fixed Wireless Access (FWA) broadband service on the eastern edge of Sangamon County and surrounding counties. We could not complete a provider interview with A.C.T.S., so we do not know any specific provider information, nor were we able to access certain details regarding vendors, technology, spectrum utilized, or backhaul links in the extended FWA network.

Our provider review finds that A.C.T.S. does not own any spectrum that could be used for providing fixed wireless broadband. From the information gathered from the review of available data and speed offerings, we assume that A.C.T.S. is currently using unlicensed spectrum and may be utilizing up to 20 MHz of Generally Authorized Access (G.A.A.) spectrum available in the CBRS. 3.5 GHz band to provide service in Sangamon County. In our assessment, we do not believe A.C.T.S. can deliver the 200 Mbps symmetrical service found in FCC 477 reporting, and in our review of Ookla speed test data do not see any speed tests which approached 100/20 Mbps service.

GHP Enterprises

GHP Enterprises is a competitive service provider currently building an FTTH network in New Berlin with plans of expanding to Berlin and a longer-term plan to invest in an FTTH network in Loami. GHP noted in the provider interview that construction plans are ongoing in New Berlin but did not indicate a firm completion timeline. GHP is interested in working with the County to determine the best approaches for broadband solutions in western Sangamon County.

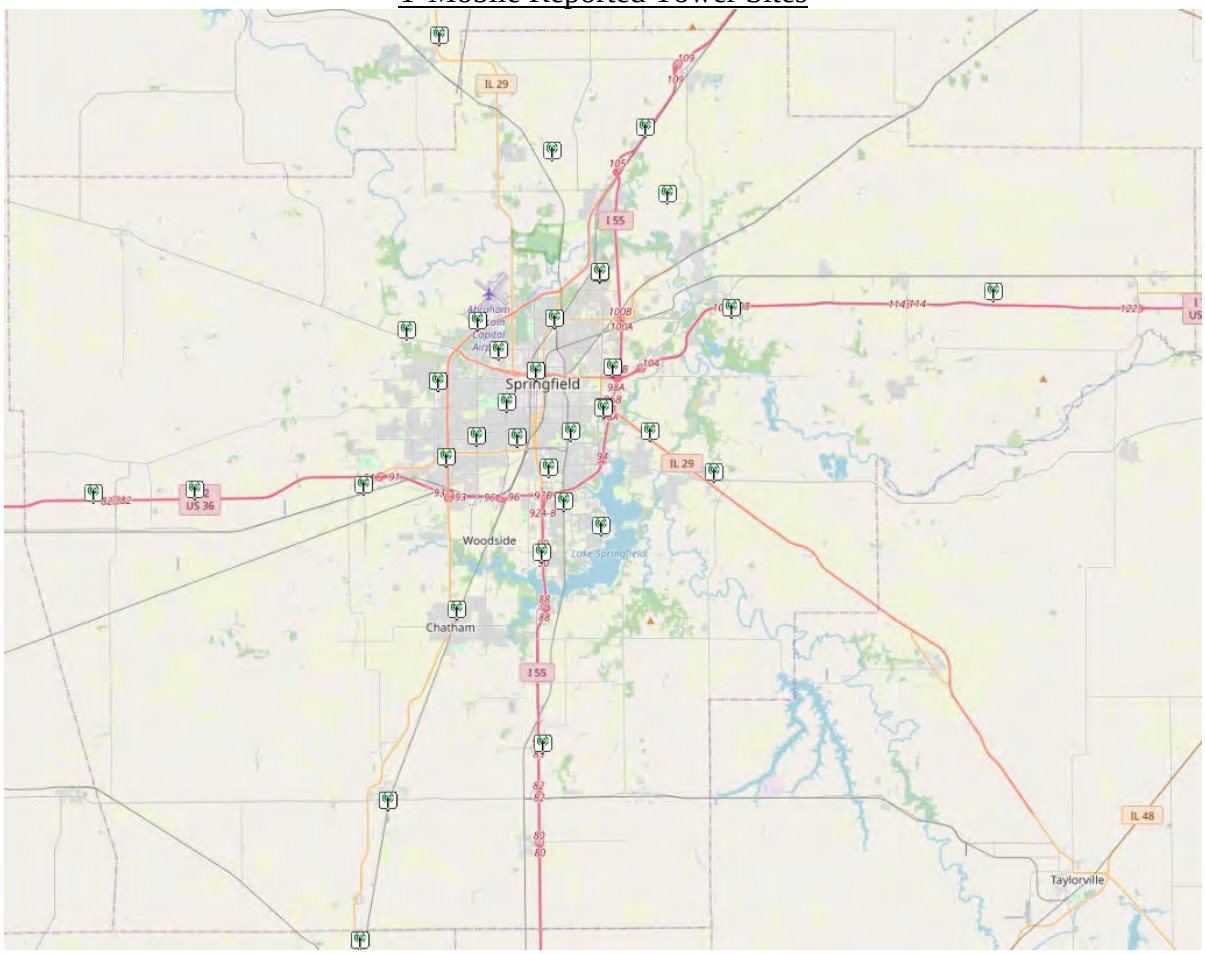
T-Mobile

T-Mobile is a national carrier offering mobile and fixed wireless broadband service over various 5G, 4G, and 3G/2G networks, depending on the specific equipment at each tower location. In Sangamon County, T-Mobile primarily offers service with 600 MHz, PCS, and some limited AWS spectrum. Backhaul facilities are a mixture of fixed wireless and fiber backhaul facilities.

T-Mobile indicates they can provide 25/3 Mbps fixed wireless coverage to some portions of Sangamon County; the FCC 477 data reported by T-Mobile generally aligns with the cell tower map coverage written through crowd-sourced coverage data. T-Mobile advertises speeds greater than 25/3 Mbps and utilizes the mobile network infrastructure for the fixed home broadband platform; any broadband traffic originating

or terminating to a fixed home broadband connection is deprioritized compared to the mobile network in times of heavy demand.

T-Mobile Reported Tower Sites



B. Fiber Network Design

Evaluating the Network Options

In our evaluation of Sangamon County, we considered the design and construction of an all-fiber broadband network. For the study we completed a FTTP network design for the part of the county which does not have wireline 100/20Mb broadband and also areas which don't have a funded obligation to construct a broadband network capable of providing greater than 100/20Mb broadband. This means our design only considered Underserved and Unserved Areas in the county for a new FTTP network.

Each of these areas received different consideration for construction of FTTP infrastructure, our evaluation considered the following criteria that are necessary elements of a broadband solution:

- A review of the existing broadband provider's current deployments and funded broadband deployment obligations.
- Type of construction required in each area like plowing, boring, and presence of rock.
- Bandwidth capacity.

- Cost of the network.
- Expected lifecycle of the technology.
- Resiliency and redundancy of the network.

Fiber Network Design *(Underserved and Unserved Sangamon County)*

Following is a short summary of the primary assumptions, fiber architecture and optical equipment decisions included in the Underserved and Unserved Sangamon County FTTP network design. These assumptions are discussed in more detail below.

FTTP Architecture:	Centralized Split Passive Optical Network (PON)
Fiber Type:	Armored fiber cable
Buried Fiber Placement:	Buried conduit with cable
Cable Fill Factor:	1.5 fibers for every existing service location
Network Core:	New Networks
Remote Equipment:	(4) Remote Hut Sites
Internet Backbone:	Existing connections from providers
Fiber Drop:	Buried fiber drops
Network FTTP Equipment:	XGS-PON (10 Gigabit symmetrical technology)
Premise FTTP Equipment:	XGS-PON (2.5 Gigabit symmetrical technology)
Percentage Buried Fiber:	100%

We reviewed the Underserved and Unserved Areas of Sangamon County as a distinct area for implementation of an all-fiber network. Many of these rural areas are adjacent to existing wireline broadband networks. We reviewed locations around Sangamon County to best consolidate customers into four distinct serving areas for ease of construction and discussion of possible future projects with providers.

The design of fiber networks and the associated electronics are straightforward, but every network differs in the details of how the network will be deployed, the method of construction, geography, topography, the number of customers, and the long-term goals of the fiber provider. Below is a description of the major component of a FTTP network and a discussion of the factors which influenced our design decisions for the network.

There are two primary types of fiber electronics used in an FTTP network – passive and active. Finley chose a passive network for several reasons that are included in the following discussions. There is also a comparison between active and passive fiber technology below.

All network architecture, design elements, and the electronic equipment used in this design are standards-based and used by multiple broadband operators across the United States.

The Sangamon County design is an all-Internet Protocol (IP) network, meaning that all traffic and connections are IP-based. The FTTP network is broken into two distinct types of connectivity:

- Fiber network *(Physical network of connectivity from the central office to customers)*
- IP network *(IP packets with internet information on optical signals)*

The easiest way to understand the distinction is that the fiber strands (the physical network) carry IP packets that communicate to and from the Internet.

Overall Design Criteria

The network construction method is a buried conduit with fiber cable blown or pulled inside the conduit. We know that based on information from the provider interviews that PON technology is being utilized by existing ISPs that have already built FTTP networks in Sangamon County.

Considering the above existing deployment scenarios, and to strike a balance of existing approaches and practical network design, we utilized a centralized PON architecture for high-level design purposes. In a centralized PON network, each customer has a fiber connection from the service location to the PON cabinet, where optical splitters are utilized to serve up to 64 customers. In this sign we were more conservative and utilized a splitter capable of serving 32 customers to reduce optical loss and retain a higher level of bandwidth available per customer. As customer demand for broadband speeds grows, a centralized PON can be upgraded to an active equipment site and would function as a homerun fiber network.

Since the density of customers on a per-mile of roads is low in some parts of Sangamon County, much of the design uses low-count fibers except where the fiber gets closer to the PON cabinet locations. Much of the Underserved/Unserved area in Sangamon County adjacent to town areas is somewhat dense and is characterized by residential housing areas with homes situated on small acreage homesites. The low density and distributed nature of the Underserved and Unserved areas in Sangamon County is best addressed by utilizing four hut site locations, and nine PON cabinet locations. All fiber connections are terminated at these two locations, with connectivity between these sites as well. The hut site and equipment locations could be reduced if existing ISPs expand services to the Underserved/Unserved from areas already served by PON.

The basis for cable size in any FTTP network design relies mostly on the network topology, fiber cable fill percentage, and the number of potential broadband customers – these factors largely determine the size of fiber required, the requirements to terminate the fiber in cabinets or frames, and the type of buildings or cabinets required for the FTTP optical equipment.

Finley's design started by using Sangamon County address data to complete our design. Our assumed buried cable routes are accurate enough to create costs estimates but would require more in-depth desktop review and design before building a network.

In the telecom industry, the number of potential customers is referred to as passings. We utilized Sangamon County address data to best capture the location information. Due to the rural nature of most of the design area we have treated all locations as residential in terms of design criteria. Our experience is that the network needed to bring broadband to small businesses is nearly identical to what is needed for households.

We counted passings in the rural area as follows. The first set of numbers counted were from earlier in 2022 before the FCC made the RDOF subsidy awards to Nextlink and Mercury Wireless. Those awards

are supposed to bring broadband to 1,180 rural customers, with construction deadlines stretched out as late as 2028.

	Before RDOF	After RDOF
Residential Passings	5,640	4,460
Business/Anchor Locations	309	309
Total	5,949	4,769

We also considered the capacity of the network needed for future growth. While we understand that many rural areas have recently been contracting in population, we know from years of building fiber networks that it is prudent to plan for increased fiber utilization over time. We always think of a fiber network as a hundred-year investment, and there is no way to know what might happen to the local economy many decades from now. The network was designed to be able to accommodate growth if it ever appears, even decades from now.

In the network design, we assumed a 1.5 fiber factor, meaning that we deigned enough fiber to reach 50% more passing than are in the study area today at any given tap. We carried this factor throughout the network from the core hub to the customer locations.

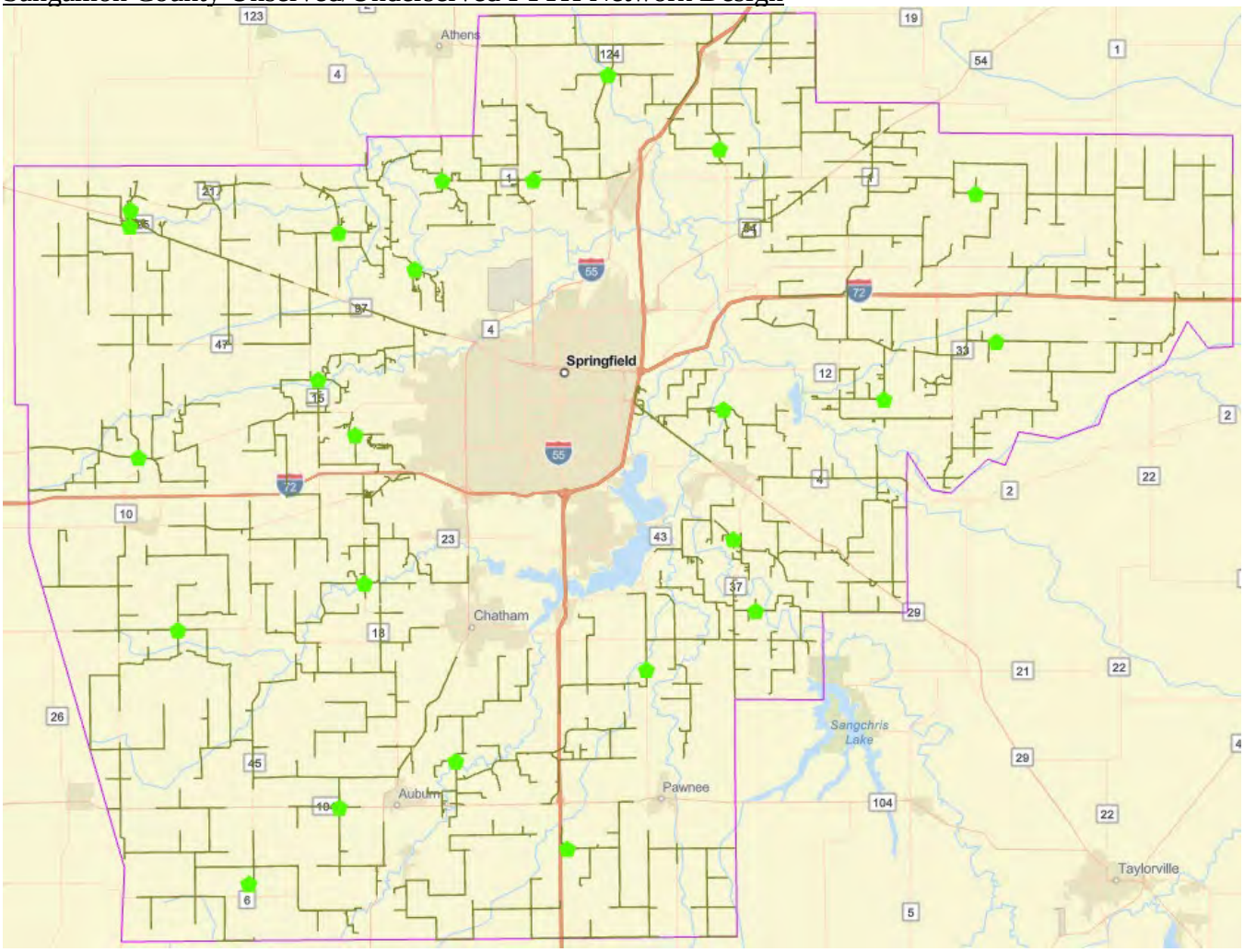
We note that completing and pricing a fiber network design is becoming increasingly complex when considering locations and areas which currently have a network capable of delivering at least 100/20Mb, areas which have been awarded funding and are not yet built, and areas which have been initially awarded funding but are not finally authorized. Our approach is to create a preliminary design for the largest area we think makes sense and then use only the areas which we determine to be Underserved/Unserved when considering existing services and the areas of known funding for 100/20Mb wireline networks.

There are two components of the fiber network design:

Backbone Fiber. Our preliminary network design includes two location that will house the backbone electronics and FTTH equipment, two additional hut sites for FTTH optical equipment, and twenty-four new passive optical cabinets to support the distribution fiber network.

The map below shows the entire Sangamon County FTTP network design layout we considered, and customer locations covered with the FTTP network. Our design and cost estimate is only for the Underserved and Unserved locations in the county.

Sangamon County Unserved/Underserved FTTH Network Design



Last-Mile Fiber Network. The last mile fiber network extends from each hut, remote, and PON cabinet locations to reach customer locations. Our initial design covers 823 miles of fiber, including backbone routes. After we accounted for the pockets of broadband that will be brought from the RDOF subsidies, the final miles of fiber was reduced to 660 miles.

Finley used pricing from similar projects which used 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 for additional network construction and repair. Also, standard-sized fiber is generally priced more competitively.

Our design tries to determine the right-sized fiber cable for each route. One of the most significant costs of deploying fiber is the cost of labor needed to splice fibers together, so our goal is not to include unneeded fiber pairs to limit the needed number of splices. 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.

The biggest cost component of deploying fiber is labor. Labor costs vary around the country due to differences in hourly wages. The difference in local wages can be a big factor in choosing between the different construction methods. In this study, we have used cost assumptions from similar projects in Illinois and near Sangamon County to estimate the labor and material rates.

Buried Fiber Basics

From a fiber cost perspective, the costs of materials are similar between aerial and buried construction. Buried fiber incurs on additional material cost for buying conduit – which are empty tubes placed into the ground that are the home for the fiber.

There are several different techniques used to bury fiber. The different construction methods are generally chosen to meet two criteria. The first is customer density, and different methods are used in streets with dense housing versus roads where there are far fewer customers per mile. The more important consideration is the condition of the soil and substrate under highways. Burying fiber can be extremely labor-intensive and expensive in soil that contains a lot of rock. The engineering analysis includes the following types of construction:

Trenching. This is buried construction where a ditch 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 are dug in city streets – the cost of digging and then replacing asphalt can be costly. Trenching is disruptive, and 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.

Boring. Boring is the most common method of burying fiber. In boring, a pothole is dug in the street, which means a hole approximately 2 feet by 2 feet. A boring machine is inserted into the empty pothole and laterally drills a hole through the substrate of the street. Empty conduit is then pulled through the freshly dug hole. Conduit is flexible and durable plastic tubing. Eventually, the fiber building will push or pull fiber through the empty conduit. Boring costs can vary widely depending on the composition of the substrate. If roads were originally excavated to a three feet depth when constructed, it's relatively easy to bore through an area. Boring is much harder and expensive and sometimes impossible in areas where there is native rock close to the surface of the street. There is often an intermediate condition called cobble, where the substrate under the street includes boulders that were put back into the hole when a street is paved.

Plowing / Direct Burying. In rural areas where there is an unpaved shoulder along roads, a common construction method is to direct bury the fiber into the ground. This involves using a heavy truck that plows a furrow in the ground, just as would be done by a tractor on a farm. The plow pushes fiber into the ground at the same time that it creates the furrow. There is most often not even any follow-up construction since the plowed furrow naturally closes after the plow passes. Direct burying is rarely used in cities, but there are probably a few roads on the outskirts of the city where this could be used.

Microtrenching. This involves digging a narrow trench a few inches wide and 8- to 12-inch-deep trench in the street, putting in the fiber, and then refilling and sealing the hole. We don't expect any need for this construction technique in this design.

Optical Electronics Design

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.

Finley Engineering is technology neutral, and we considered the pros and cons of the two technologies for deployment in Sangamon County.

Passive Optical Network (PON) Technology

PON technology is most easily described as having one laser in the network core that serves a neighborhood cluster of customers. That means one laser at the core communicating with a neighborhood of laser at the customer end – one laser to many.

For the last fifteen years, the industry standard for passive optical networks has been GPON (Gigabit PON). The GPON technology delivers a 2.4 gigabit data stream for download and 1 gigabit for upload to a neighborhood of up to 32 customers. The newest PON technology that is starting to see widespread use is XGS-PON technology. This new technology can deliver 10-gigabits of both download and upload bandwidth to a cluster of customers. A neighborhood cluster is called a PON in the industry, and with GPON the typical size of a PON has been 32 customers with XGS-PON the PON can contain up to 128 customers. If an ISP deploys XGS-PON to the same cluster of 32 customers that means four times more download bandwidth and ten times more upload bandwidth.

As recently as 2020, there was at least a 15% or greater price penalty for buying XGS-PON technology. However, we've seen recent quotes for XGS-PON that are nearly identical in price to buying the GPON that's been the industry standard. In the broadband industry, that pricing point represents a tipping point where XGS-PON is quickly becoming the new standard. The price has dropped because some large ISPs like AT&T and Vodaphone are installing millions of new customers per year on the new technology. XGS-PON is not a new technology and has been around for about five years. But until recently, the price differential stopped most network owners from considering the technology.

The current vendors for PON equipment include Alcatel-Lucent, Adtran, DZS, Nokia, Juniper, and Calix. Following are the primary pros and cons of using PON technology.

PON Advantages

- No electronics in the field. PON uses passive splitters to distribute the bandwidth over the fiber to the customers. There are only two active components in the PON distribution network – the Optical Line Terminal (OLT) and the Optical Network Terminal (ONT). The OLT sits in an environmentally controlled hut or building, and the ONT sits on the side of the home or inside of the home.

- Less field maintenance and more reliability. Because PON uses passive splitters in the field, there are fewer powered network elements in the distribution network. This equates to less maintenance, fewer field personnel required, more reliability, and fewer managed network elements in the distribution network. A PON network also means less land and rights-of-way required due to less need for large powered huts.
- Less fiber needed. PON uses significantly fewer fibers than an active system. A PON network can carry up to 128 customers on the fiber leading to the neighborhood. In GPON technology, most ISPs configured the network to have 32 customers in a PON. There is not yet an industry-wide consensus for the ideal size for an XGS-PON PON cluster. The one fiber carrying the traffic from many customers differs drastically from an active network that requires one fiber between the core and each customer. Less fiber means lower construction costs, less loading on poles, quicker fiber installations with less splicing, and smaller fiber management systems.
- Higher density electronics. Because PON electronics have only one optical port for many customers, the PON chassis in the OLT can serve a large number of customers in a small space. This means less space for electronics, less power usage, less air conditioning, and reduced backup power requirements.
- Ability to still use active Ethernet. Most PON manufacturers offer the option to serve some customers on active Ethernet in the same chassis by the use of a separate core card.
- Location Flexibility There are a lot more options for locating passive devices and placing them close to customers. Network owners can deploy both large, centralized splitter sites and widely distributed tiny splitter cabinets.
- Takes the best advantage of oversubscription. All of the customers in a neighborhood node share the bandwidth delivered to the node. This is a more efficient use of bandwidth than sending a dedicated amount of bandwidth to each customer.
- Network Expansion. Perhaps the most important benefit of PON is that it's far easier to accommodate future growth. Fiber networks are expected to last for far more than fifty years, and with a PON network, it's easy to add new homes in a neighborhood or a whole new subdivision or neighborhood that appears in an unexpected place. A PON network can be expanded for small expansion by adding new splitters. For major expansion, a new hut can be added to the network allowing for a huge expansion outward. This is drastically different from an active network where a fiber is needed from the core to reach new houses added to existing neighborhoods.

PON Weaknesses

- Distance Limitation. Customers have to be within 12 miles of the OLT core electronics. This can present a challenge in large rural networks and is a consideration in Sangamon County.
- More Complex Engineering. Because of distance limitations and splitter requirements, a PON network requires an engineering plan for the placement of electronics and splitters. This is not a major issue since industry engineers are well-versed in designing PON networks.
- More customers are affected by a single fiber cut. Cutting one neighborhood fiber can knock more customers out of service.

Active Ethernet (Active E**)**

In an Active E network, one fiber goes from the core electronics directly to each customer. Following are the pros and cons of Active Ethernet.

The primary vendors in the Active E equipment market are Cisco, Calix, Adtran, and Nokia-Alcatel-Lucent. Since PON equipment has won a much greater market share than Active E equipment, this part of the industry has been in a bit of a decline for a few years.

Active Ethernet Strengths

- Greater distance. Where a PON has a 12-mile limit between the core electronics and the customer, an active connection can reach over 50 miles.
- Less engineering and planning. Since every fiber run is a home run between the electronics chassis and the customer, there is less engineering and planning needed to design and deploy an AON network. Engineering means just planning one fiber per passing.
- Pure IP Network. The active Ethernet network delivers pure native IP, meaning it could be plugged directly into customer modems or switches.
- Can deliver greater bandwidth. Lasers are available that can deliver speeds greater than 10 Gbps. Such lasers can be expensive, but they are easy to integrate into an active network.

Active Ethernet Weaknesses

- Higher Cost. Active Ethernet typically costs around 15% more to build than a passive network. This comes from needing more fibers and also more lasers.
- Uses more fiber than PON. With one fiber home run per customer, Active networks require significantly more fiber. This means larger fiber bundles to the same number of electronic chassis. This has an effect on capital costs, pole loading, conduit, and hand-hole sizing, etc. Larger fiber bundles require larger field huts to handle the larger fiber entrance. In a densely populated area, the size of the fibers can be unwieldy.
- Less dense electronics. Since there is a core laser for every customer connection, the electronic chassis support fewer customers in the same rack space. This means a larger chassis and more rack space, which equates to more air-conditioned space and more and larger power and backup power at the electronics locations.
- More powered network elements. There are more field locations that require power. This means more failure points in the network, more field huts, more power, more battery backup, and generators.
- Expensive growth after construction. This may be the biggest drawback. It can be expensive to add new customers in the middle of an active network because that means somehow bringing more fibers to an area where all of the fibers are used.

After weighing the process and cons, Finley Engineering chose PON technology, specifically XGS-PON for the Sangamon County designs.

Electronics Parameters

After choosing PON technology, there are additional design parameters to consider. The electronics design is key because it can affect how the fiber network is constructed.

- An 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.

Distributed Design. The size of the city makes it impractical to serve all of the customers out of one electronics site. We elected to use a distributed fiber network design. As discussed earlier, the preliminary network design includes one location that will house electronics and two passive optical splitter cabinets to support the distribution fiber network. The core location is a new POP site with an undetermined location.

This design was chosen for several reasons:

- This makes sure that no customer is more than 12 miles away from a neighborhood hut. This distance limitation means 12 miles of fiber along a road, not a 12-mile circle.
- This design makes it easier to activate neighborhoods as the fiber is built. Once one of the three electronics sites is activated, the city 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.

Centralized Splitter Design. We elected to use a centralized splitter design. A splitter is a passive device that splits one fiber to connect to multiple customers. This is called passive because no power is needed at locations where the fibers are split. The primary advantage of using centralized splitters is that the number of fibers needed to reach neighborhood is smaller. If the splitters were located only in the three primary hut locations, the number of fibers between customers and those huts would be too large and unmanageable. The design puts a few splitters inside the core hut to serve customers located near the hut.

Redundancy. When possible, a good network fiber design should include fiber route redundancy. This can most easily be accomplished by the use of fiber rings that include self-healing electronics. A fiber ring is just what it sounds like – fiber is built to complete a full circle (but doesn't have to be shaped like a circle). Fiber rings are most normally part of the feeder fiber network so that cutting a fiber feeding one neighborhood doesn't knock out service for other neighborhoods. But redundant rings can also be built into distribution fiber serving homes. This is usually only done when there are specific neighborhoods or large business customers willing to pay extra for redundancy. The terrain, topography and low density in the county make it hard to design natural rings and we have not included fiber rings at this design. But this could be analyzed during final design and field review.

Oversubscription. Before talking about any broadband technology, it's important to understand the concept of oversubscription and how this affects broadband performance on various technologies. Oversubscription comes into play for any technology where customers share bandwidth somewhere in the network. Oversubscription is a way to quantify the number of customers that share a given portion of the network.

The easiest way to understand the concept is with an example. Consider an XGS-PON network that delivers 10 gigabits of download bandwidth to a neighborhood. If an ISP connects 32 customers in a PON and sells a gigabit of download bandwidth to each customer, then in aggregate, those customers could use 32 gigabits of download broadband at the same time. In this example, the ISP has sold more than three times more capacity to customers than is physically available, and this particular PON has an oversubscription ratio of 3.2 to one.

When people first hear about oversubscription, they are often aghast – they think an ISP has done something shady and is selling people 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 customer 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 streaming videos and barely use any bandwidth. The ISP is banking on the normal behavior of its customers in determining a safe oversubscription ratio.

ISPs have different philosophies on what constitutes a safe oversubscription ratio. The ratio used in this example of 3.2 to 1 is extremely conservative. Once an ISP understands its customer base, it might decide that it can safely put more than 32 customers in an XGS-PON neighborhood. They might decide that the network would still be safe with 64 or 128 customers.

ISPs understand that customers are using more bandwidth every year and engaging in more data-intensive tasks. Certainly, a PON neighborhood with half a dozen people now working from home is a lot busier than it was before the pandemic. It might be years before a lot of neighborhood PONs get oversubscribed, but eventually, the growth in bandwidth demand will catch up to PON capacity.

It is possible to badly oversubscribe a neighborhood using some technologies. 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, cable companies have largely eliminated the problem by decreasing the number of households in a neighborhood node, which lowers the oversubscription ratio.

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 one. The upload links in neighborhoods got overloaded when multiple people were trying 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 for 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 were rightfully upset if they pay for a 100 Mbps or larger download product and still can't work from home.

As an aside, the oversubscription ratios in business neighborhoods are completely different. Businesses might engage in steady large bandwidth uses like 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 is likely to be too high in some 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. A retail district might look a lot like a residential neighborhood, while ISPs might only put a few businesses on a PON in neighborhoods where the businesses use a lot of broadband.

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 the Sangamon network, there is a potential chokepoint at each PON, as described above. There could be a chokepoint on the fiber ring connecting the five huts. There could be several chokepoints inside the core hub in any device that processes all of the Internet traffic. For example, any router that decides how to route Internet traffic could get overloaded. Finally, the path to the Internet can be a chokepoint. This is outside of the control of the local ISP and is often the biggest source of network slowdowns.

One of the design decisions to make with a PON network is the number of customers to place on a single PON. The XGS-PON technology allows up to 128 customers to share a single feeder fiber. We elected to limit each neighborhood PON to 32 customers. The primary reason for this is to ensure that each customer can be provided with a gigabit broadband product if desired. Even with GPON technology, there is enough bandwidth on a single PON (2.4 gigabits download) that there is almost always a gigabit of bandwidth available to any customer at a given second. This network design concept is referred to as oversubscription, and there is a more detailed discussion on the topic at the end of this section.

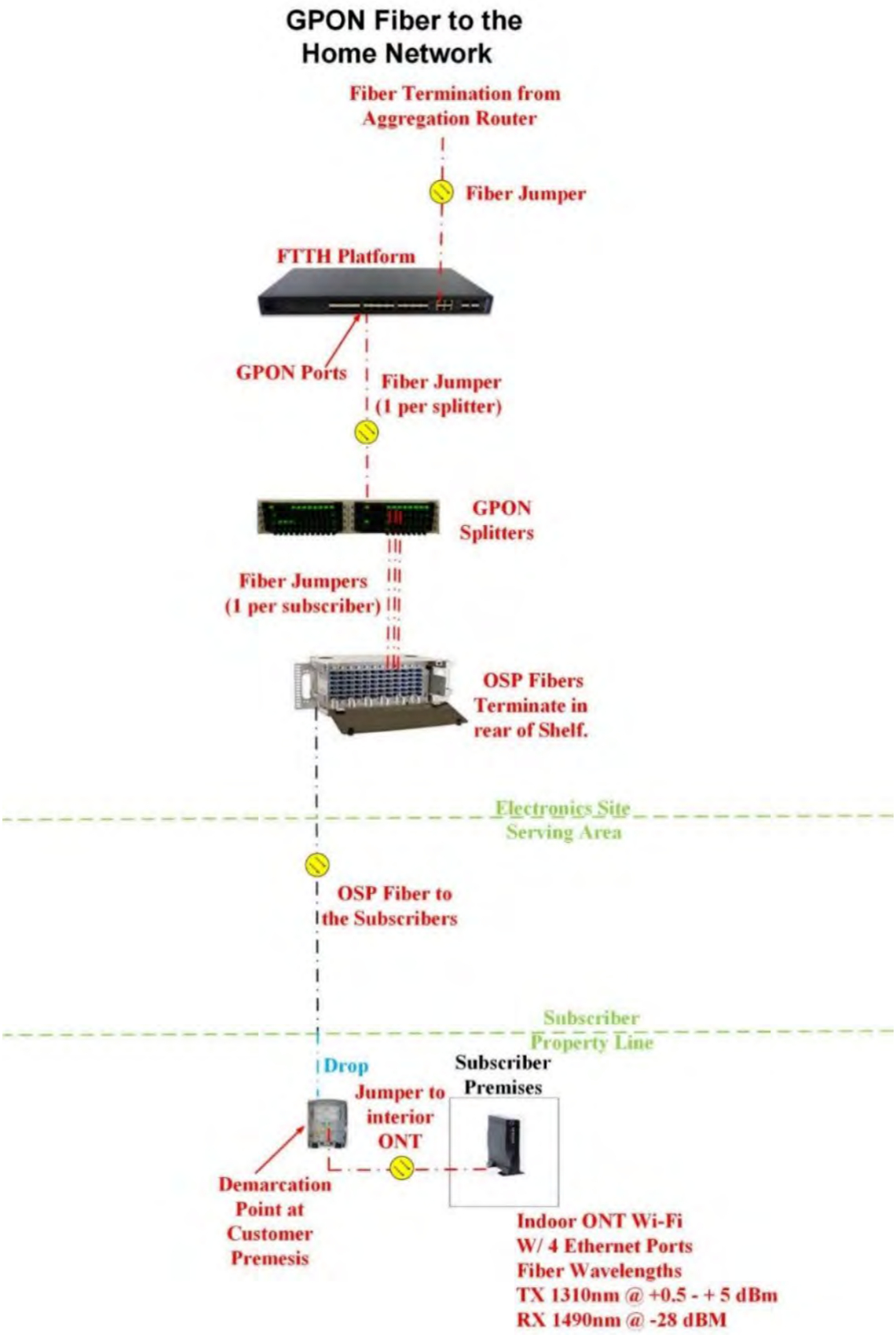
The Components of a PON Network

A PON network can be designed in numerous configurations, but all designs include the same key elements. All networks start at a network core where the connection is made to the Internet. At this core, the ISP generally inserts the signals for the various products being delivered to customers.

From the core, there are direct fibers to Optical Line Terminal (OLT), which are the devices that provide the light source for customers. These OLTs can be located in the same location as the fiber core or can be spread around the city in neighborhood nodes, generally in huts or large cabinets.

There is one fiber leaving an OLT for each “PON”, which is the local network consisting of up to 32 customers. These fibers go to splitter cabinets, where each fiber is then split into the 32 separate fibers that go to customers. The splitter cabinets can be located at the same location as the OLT electronics, or they can be moved deeper into the network to be closer to customers. The name passive for the technology comes from the fact that the splitter site doesn’t require electronics or power – the splitting is just what it sounds like – one fiber is spliced and split into many individual paths. The paths between the splitter and each customer are home runs, meaning that there is a single dedicated fiber between a splitter site and each customer.

The following diagram shows the configuration of the network starting with one of the hub sites and ending at a customer premise.


GPON Fiber to the Home Network
Fiber Termination from Aggregation Router
Fiber Jumper
FTTH Platform
GPON Ports
Fiber Jumper (1 per splitter)
GPON Splitters
Fiber Jumpers (1 per subscriber)
OSP Fibers Terminate in rear of Shelf.
Electronics Site Serving Area
OSP Fiber to the Subscribers
Subscriber Property Line
Drop
Jumper to interior ONT
Subscriber Premises
Demarcation Point at Customer Premesis
Indoor ONT Wi-Fi
W/ 4 Ethernet Ports
Fiber Wavelengths
TX 1310nm @ +0.5 - + 5 dBm
RX 1490nm @ -28 dBM

Connection to the Internet

Network like the one designed in Sangamon County need access to more than one feed to the open Internet. In Sangamon County, some options exist today, but the long-haul networks for the major backbone providers primarily follow Hwy 55 and Hwy 72 and are likely owned by the incumbent providers in Sangamon County. While Tier 1 backbone connections may exist, they are somewhat limited in nature in the rural areas. The existing ISPs also have backbone connections and are largely in existence for operation of their own networks as they exist today and may have capacity for expansion to other areas. Several ISPs have made applications to Connect Illinois for funding to deploy new last-mile networks in Sangamon County and it's reasonable to think that any grant awards would also provide more middle-mile fiber routes.

We also know that as part of statewide middle-mile initiatives. Multiple providers or groups of providers are considering new middle-mile networks which traverse the county. We encourage Sangamon County and any interested providers to collaboratively work to discuss current plans for backbone connections (also known as middle mile or "metro fiber"), and to proactively engage with each other to increase middle mile options which provide redundancy and resiliency to last mile providers in areas of Sangamon County without adequate options today.

Central Office & IP Core Network

As discussed above, there are already existing fiber backbone connections, current and planned FTTP builds, and some portions of an existing fiber ring. Completing backbone connectivity in rural areas need not be complicated, but would benefit by coordination among ISPs, especially for any of the fiber builds which might occur over the next year as a result of NTIA Middle Mile, ARPA, Capital Projects, or BEADS funded broadband projects. Since many of the funding programs provide incentives for local support of the proposed projects, it would be to the County's advantage to discuss the ability and willingness for ISPs to interconnect fiber networks.

Optical Line Terminal (OLT)

The electronics used to light the fiber to customers is called an optical line terminal (OLT). Our design places one OLT in the new POP building. 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 functions using circuit cards which can each service between 128 to 256 subscribers. Multiple cards can be installed in each OLT chassis, and multiple chassis can be installed in each remote hub site, meaning that it's easy to scale the network to accommodate future growth.

There are multiple vendors that provide an all-inclusive PON solution combining the cabinet and FTTP equipment solution. All vendors meet industry standards, and all of them are priced similarly.

PON Splitters

The next component on the network diagram is a PON splitter. This is a device that can split one fiber in order to connect up to 32 customers. On the diagram, you can see that there is only one fiber between the OLT and the GPON splitter. This is the place in the network where significant fiber can be saved since one fiber coming into the splitter can serve up to 32 customers. The splitters do not require power, which is why they are referred to as passive. The splitters can be located anywhere in the network where fiber splits are needed to reach customers. Generally, some of the splitters are located in the central office core or at the various network nodes, but many are located in small neighborhood cabinets located closer to customers.

PON Cabinet

Associated with a splitter cabinet is a PON cabinet. The purpose of this device is to neatly arrange and manage the fibers coming into or out of the splitters to make it easy to identify which fiber serves which customer. The primary purpose of the PON cabinet is to accumulate customer connections at strategic points with the design goal that no fiber in the network needs to be larger than 288 fibers. The PON cabinets designed for the Sangamon County network are of varying sizes that depend on the customers served from a given hut location.

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

Fiber Drops

The local distribution fibers are built to reach from PON cabinet sites to every customer location. The fiber design assumes a fiber built to reach each location in the Sangamon County service areas, even if they don’t initially buy service.

To connect a customer to the fiber network, a fiber drop is built from the street to connect to the outside of a customer premise building. The customer drop is a two-fiber cable that is fusion-spliced to a single fiber of the main-line cable. These splices are housed in a splice case that is sized for each location depending upon the number of homes or businesses that can be served. 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.

At the Customer Location

The piece of customer electronics used to serve customers is referred to in the industry as an ONT (Optical Network Terminal). This is an electronic device that contains a laser, and which connects back to the OLT in the huts or the central office. The ONT receives optical light signals from the fiber network and converts the signal to traditional Ethernet on the customer side of the device.

Originally the ONTs were only placed on the outside of buildings in a small enclosure and powered by tapping into the electricity after the power meter. But today there is also an ONT that can be placed indoors and that is powered by plugging it into an outlet, much like the cable modems used by cable companies. The cost of the two kinds of units are nearly identical, so the study doesn't choose between the two types of units.

Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other providers are electing internal units since they are protected from the weather. The industry is split on this choice, but it appears that internal units are becoming the most predominant choice for new construction. One of the major contributing factors that favor indoor ONTs is that ISPs are tying the ONTs to indoor WiFi routers to provide good wireless connectivity within the home.

ONTs are available in multiple sizes that can be categorized into units designed to serve homes and small businesses and units designed to serve large businesses. The study assumes that the smaller unit will be used for most customers, including most small businesses. These units provide one to four Ethernet streams, which is sufficient for most customers.

Historically, many FTTP networks were designed with battery back-up for the ONT. The batteries were 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, there is no power in the fiber, and thus a customer-located battery backup is required to maintain phone service. In 2015 an FCC ruling declared that every voice provider must offer a battery backup solution for customers that buy telephone service that is not delivered on copper. That ruling said that fiber ISPs only have to make these units available and that customers could be charged the full cost of the unit.

Regardless of the type of ONT (indoor or outdoor), it will be necessary to drill through the side of the home to bring wiring. ISPs have widely differing ideas on the best way to do this – but most ISPs look for the installation method that requires the least amount of work inside of the customer premise.

Multi-Dwelling Units (MDUs). In Sangamon County, a small percentage of residential living units are in apartment buildings with eight or more living units. The study assumes that the overall cost of serving an MDU customer is roughly the same as serving an equal number of single-family homes. We know

from experience that this is a good assumption. Generally, the drop and electronics costs are lower for an MDU since these components can be shared among multiple tenants. But the wiring costs to reach individual living units adds cost.

There are also smaller MDUs with two, three, or four units. Generally, smaller MDUs are treated the same as a single-family home from a network perspective. For example, an ISP might decide for a quadplex to run four fiber drops and install four ONTs inside units if every unit subscribes to fiber.

Because of modern wiring techniques, the cost of serving apartments is rarely an issue. There will invariably be some older apartment buildings that cost extra to serve for some reason, such as having solid concrete slabs between floors that make it hard to run fiber. But ISPs have gotten adept at finding ways to bring fiber inside most apartment buildings.

But there are still roadblocks in serving MDUs, and any ISP that builds fiber will find out that there will be some apartments they are unable to serve. Following is a short 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 city that would not allow a new fiber network owner into the building.

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.

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

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

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

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

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

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

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

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

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

Buried Utilities. Property owners might not allow any outdoor wires above ground. This would mean that drops and connections between buildings must be buried. In many cases, that would mean boring connections under driveways and parking lots—which is not always a safe process since the locations of other utilities are not always well known or marked on private property. The expected industry requirements for utilities using public rights-of-way may not be followed on private property. For example, buried conduit and fiber in public rights-of-way generally require some use of a technology that allows the infrastructure to be detected by anybody trying to locate

existing technology. However, infrastructure without such marking technology would be invisible to a locator.

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

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

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

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

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

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

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

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

Restrictions on Sales and Marketing. It's fairly routine that ISPs are not allowed to sell or market inside MDUs in the same manner that is done for single-family homes. For example, there might be no-solicitation rules in MDUs that won'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 a small issue might make it impossible to serve a given building. For example, it can be impossible to serve a building if the overbuilder doesn't have a secure location to place core electronics or doesn't have access to building entrance facilities.

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

C. Broadband 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, Frontier, Consolidated Communications, and CASSCOMM serve Sangamon County with copper telephone wires using DSL technology. Some of these companies are converting to fiber.
- Sparklight, Comcast, Mediacom, and CASSCOMM 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, including the new low orbit satellites offered by Starlink.
- The cellular companies offer hotspot home broadband using 4G spectrum. We've recently started to see a new broadband product offered by cellular companies – home broadband using 5G spectrum.
- Some residents get all of their broadband from their cell phone data plan.
- Metro Ethernet is used to bring fiber directly to large businesses, schools, cell towers, etc.

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 ago. Consider fiber. We recently have been recommending that new fiber builders consider XGS-PON. While this technology has been around for almost five years, the technology was originally too expensive and cutting-edge to consider by most ISPs. But AT&T and Vodaphone have built enough of the technology that the cost for the hardware has dropped to be comparable to the commonly used GPON technology. This means that discussion of last-mile fiber should now center of delivering 10-gigabit speeds – a huge increase in capacity that blows away every other technology. Some vendors of the technology have recently announced an update that provides 25-gigabit speeds for customers, and 40-gigabit PON technology is being explored in vendor labs.

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 approved the use of 6 GHz WiFi spectrum in 2021, which 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. Cellular speeds in a lot of the country are now double or 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 2,300 satellites in orbit and is still in beta test mode. Customers are reporting download speeds from 50 Mbps to 150 Mbps. We also see 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 freely 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 commercial 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 speeds but won't be fully available for five year.

Even 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 in the market yet, but the cellular carriers are now using new spectrum bands that are labeled as 5G to offer home broadband. The carriers are also using the new frequencies to speed up cell phone data speeds.

DSL over Copper Wires

CenturyLink, Frontier, and Nuvera Communications provide broadband using DSL (Digital Subscriber Line). DSL is used to provide a broadband path over telephone copper wire. The copper 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 by the big telcos that started to cut back on the maintenance of copper in the 1980s as the companies were deregulated from some of their historical obligations.

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

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

Hybrid Fiber Coaxial Network

Cable companies use a technology called Hybrid Fiber Coaxial (HFC). Hybrid refers to the fact that an HFC network uses a fiber backbone network to bring bandwidth to neighborhoods and a copper network of coaxial cables to deliver service to customers. HFC networks are considered lean fiber networks

(meaning relatively few fiber strands) since the fiber is only used to deliver bandwidth between the headend core and neighborhood nodes. At each node is a broadband optical receiver that accepts the fiber signal from the headend and converts it into a signal that is sent over coaxial cable to reach homes and businesses.

The coaxial copper wires in 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 fewer since adding amplifiers reduces broadband speeds.

In an HFC network, all of the customers in a given node share the broadband in that node. This means that the number of customers sharing a node is a significant factor—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 400 Mbps download. By now, most big cable companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically 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 allowable bandwidth 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 for 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 on whatever they found during the trial. It typically takes most of a year to create a new chip, and it wouldn't 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.

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 the 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 undertake another costly upgrade on an aging copper network?

That's the point when cable companies will face to tough choice of pursuing the new standard or instead building fiber. 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. However, there is a lot of demand for faster upload speeds, and cable companies like Cox, Midco, and Altice have announced plans to convert properties to fiber.

Fixed Wireless

This technology is used by the large number of wireless ISPs (WISPs) in the county. 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 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 after the first few miles. Many wireless carriers advertise 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 gets 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 to allow for a point-to-point application. However, in rural markets, the public spectrum might go unused, in which case it would be available to boost the speeds for fixed wireless broadband.

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

- White Space Spectrum: The FCC has approved deployments of point-to-multipoint radios in what is called white space spectrum. This is spectrum in 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 non-line-of-sight frequencies can fill in the gaps (valleys, back side of ridges, dense tree cover, etc.) that defeat other GHz frequencies. The range is also significantly longer; however, the throughput per channel is much lower than WiFi or CBRS. The extended range comes with a burden since using the spectrum can interfere with television stations hundreds 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 ISP 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 for 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.

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

- There are already many WISPs operating in the county, and that means there is going to be interference with the radio signals. Interference translates into slower broadband speeds. The biggest drawback to using unlicensed spectrum is the fact that it is unlicensed, meaning there is no entity around that can settle disputes between WISPs. The WISP environment is often described as the Wild West, where WISPs grab channels and spectrum to make their own signals better to the detriment of other WISPs. This results in a never-ending battle for frequency and means that customer speeds go up and down.
- Compared to fiber technology, a wireless system has a relatively short, expected life. Most of our clients have found that customer radios have to be replaced every seven years or less.

Wireless equipment is rarely eligible for federal or state grants. For example, the BEAD grants require speeds of 100/100 Mbps. While fixed wireless technology can achieve that, the practical limitations in the field make those speeds unlikely except for customers living close to a tower.

Geostationary Satellite Broadband

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

The most limiting aspect of GEO satellite broadband is latency, which means a delay in the signal. 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). 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, which places satellites in 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 have a latency of around 35 milliseconds—about the same as experienced in a cable TV broadband network. This is much better than the current latency for high-orbit satellites. The low-orbit satellites can easily support real-time applications like VoIP, video streaming, live Internet connections like 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 2,200 satellites in orbit. The company has nearly half a million customers worldwide, with something over 200,000 in the U.S. The monthly rate is $110, and the receiver costs $599. Starlink claims it will eventually launch 30,000 satellites, with over 11,000 in the first constellation.

Starlink download speeds have been between 50 Mbps and 150 Mbps – a great upgrade for customers using rural DSL or fixed wireless broadband. Elon Musk says that speeds will approach 300 Mbps, but this 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. There is some movement at the FCC to open up the 17 GHz spectrum band for satellite backhaul.

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 says it will be able to serve the whole globe by the end of 2022. The latest news from the company suggests it might not sell broadband to residential customers but will concentrate on cell sites, governments, and large businesses.

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 recently contracted a large number of launches to start later in 2022. It's been speculated that these launches will carry around 500 satellites into orbit – including the company's first test satellites.

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 reach 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.

5G Home FWA Broadband

We are starting to see cellular carriers deploying a new generation of home cellular products. The cellular carriers are calling this FWA (fixed wireless access), and these products are competing with home broadband. Most reports from customers are that speeds are in the range of 100 Mbps download, and the plans offer unlimited usage.

These plans use the new frequencies that have been deployed in recent years to offer both faster broadband speeds and larger data caps. 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 its 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.

The adoption of these new home broadband products is growing quickly. In the first quarter of 2022, there were about 1 million net new broadband customers in the U.S. – half of them came from the FWA products of Verizon and T-Mobile. T-Mobile says it was surprising that a lot of new customers are in urban and suburban markets.

4G Cellphone 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 only launched in late 2018.

There is a gigantic difference between cellular broadband speeds in major cities and the rural parts of the county. Cellular data speeds are faster in cities for several reasons. First, there are more cell sites in cities. More importantly, the data speed a customer receives on a cell phone 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. Finally, the cellular carriers have introduced additional bands of spectrum in urban areas that are not available outside cities.

The real problem with using cell phones for broadband is the tiny monthly data caps. Anybody using a cell phone for home broadband is, by definition, a light broadband user.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in the 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 on 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 Gbps and string that fiber to multiple customers, each buying 1 Gbps service.

Future Technologies

These broadband products are not available in the county today, but they could be coming in the future.

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 utility poles and beaming broadband to a small receiver attached to homes or attached to the inside of a window. This technology requires fiber to the small cell sites to achieve the fastest speeds. 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 in 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.

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 the county.

Wireless Mesh Wireless - Starry

This is the technology used by Starry, a company 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.[11] 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 recently introduced 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 download 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 soon get back to its standard $50 rate. Starry has big plans to eventually pass up to 40 million households with the technology.

[11] 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 Sangamon 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 the parent company is pledged to secure debt.

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 (in this country, that would be equivalent to getting Comcast, AT&T, Verizon, and CenturyLink to agree 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. 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, which 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.

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 have historically been 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 municipalities that have built fiber rings that are promoted as "open-access" to carriers. For the most part, these networks only serve carriers or 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 serve end-user customers and 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 has to cover the full cost of debt on the network. The network owner still has to 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 operate 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 not to 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 according to 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 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 a city meet some social goal, such as building in poorer parts of a 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 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 a 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 built fiber into business and residential neighborhoods and 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 conduits along every street and will also extend the conduit to each home and business. 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 common practice for 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 land 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 a 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 have a business plan that contemplates eventually selling 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, which 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. The municipal 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 to 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 Fastenal 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 Fastenal 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. Penetration Rates

One of the biggest challenges facing any ISP entering a new market is to get a feel for the potential customer penetration rate – meaning how many households and businesses are likely to buy broadband. As will be shown in the financial results shown below, the customer penetration rate is usually the most significant variable in defining an ISP's success – every business plan relies on the business achieving some expected number of customers.

Surveys

The most common tools used by ISPs to understand a new market are a survey or a canvass. A survey is done by looking at a sample of the folks in the market while a canvass tries to get a response from everybody.

The surveys conducted for this study were online and not statistically valid. In simple terms, that means that these surveys cannot be relied upon to provide an accurate estimate of anything that is expressed as a numerical value, such the customer penetration rate. The online survey provides an idea of how customers will react to a new broadband network, but since the survey isn't statistically valid, we can't rely on the

numerical prediction of penetration rate as being accurate. These online surveys are still valuable in providing insight into how the community feels about existing broadband and what they would like in the future.

A statistically valid survey is one that defines the preciseness of the response. For example, most business surveys are conducted to achieve an accuracy of 95% plus or minus 5%. A survey that achieves that level of accuracy means that if everybody in the target universe (in your case the county) was interviewed, the responses would have an expected likelihood of between 90% and 100% of being the same as what was produced by the survey. Most businesses that conduct surveys are happy to have a 90% or better chance that the survey results are reliable.

Statisticians have defined specific processes that must be followed when conducting a survey. A valid survey must include the following:

- Random. A valid survey must be random in that it tries to reach out to a complete cross-section of the target market. In doing a broadband survey, it is just as important to hear from folks who don't have broadband as it is to hear from those who do.
- Non-biased. A valid survey must have unbiased questions that don't lead respondents to pick a certain answer.
- Sufficient responses. Statisticians have worked out a formula to define the number of completed surveys that are needed to achieve a given desired level of accuracy. For most communities, getting between 365 and 380 completed surveys will produce the 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 stop in the middle. Only fully completed surveys count in achieving a valid survey.

There are several common methods used to conduct a statistically valid survey of a whole community – knocking on doors, by telephone, or by mail. 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. It's important 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. 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, which is sometimes impossible.

It can be tricky to get a statistically valid survey by mail. For example, you can't mail a survey to everybody, or else it is the same as the online survey. Likely, the only responses will be from folks who have some interest in the broadband topic. Techniques for getting a valid mail survey involve mailing surveys to randomly selected homes and then following up non-responses with calls or visits. This is difficult to do properly, but it can work if the survey team is scrupulous about sticking to processes that ensure the responses are still random.

A canvass is done by working to hear from everybody in a community. It would be a challenge to canvass a whole county, although we know a few counties that have tried. A canvass is often tackled in smaller towns where it's reasonable to knock on every door and hear from everybody.

In broadband, a common kind of canvass is called a pledge card drive. This tries to get everybody to say they either will or will not subscribe if a new network is built. 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 more than a 40% response, the results start to take on the characteristics of a statistically valid survey.

Surveys for this Study

Even though the surveys done for this study were online, the survey produced some valuable insight. For example, the survey showed that folks are hoping for more competition and lower prices.

One of the most relevant questions asked in the survey is if respondents would buy broadband from somebody that builds a new fiber network. The response was:

Yes, definitely	39%
Probably	29%
Maybe	26%
Probably Not	5%
Definitely Not	1%

If this was a statistically valid survey, we would interpret these results something like the following:

- Almost everybody who says they definitely would buy will do so.
- In our experience, between half and two-thirds of respondents who responded with probably will buy broadband.
- Perhaps one-third of those who responded with maybe will do so.

In this case, if this was a statistically valid survey, we'd have a prediction that between 62% and 67% of folks in the county would be likely to buy broadband from a new fiber network. However, since this is not a statistically valid survey there must be caution in interpreting the responses. In the financial analysis, to be conservative, we decided to investigate a range of potential customer penetration rates between 50% and 70%. We created a 'base study' in the middle of that range with a 60% market penetration. Without a statistically valid survey, it is not possible to be more accurate than the wide range. But we can definitely say that there is a lot of interest in having a new fiber alternative for broadband.

Challenges of Selling Broadband

While a survey can tell you how the public feels about broadband, that is only half of the equation in achieving a target market penetration rate. It's still essential for the ISP to build a functional network that operates well without major outages. Then, the ISP has to sell broadband to folks and install customers. Over the years, we've seen some ISPs in new markets fail to meet target penetration rates. This could be for a wide variety of reasons, such as an unreliable network, prices that are too high for the community,

an installation process that doesn't install customers on the dates promised, or simple failure to market and get the word out to customers.

One of the most common mistakes we've seen with ISPs is a belief that broadband sells itself and that it will be easy to achieve the needed market penetration. The ISP might believe that the public will understand that fiber is a better technology and sign up on their own. As long as the public knows fiber is newly available, most fiber overbuilders say that they rather quickly get 20% to 30% of customer-initiated subscriptions. After that, the ISP has to do the hard work of selling to everybody else.

The sales process doesn't happen in a vacuum. Incumbents will flood a market with low-priced special offers to get customers to stay. Many people who will eventually become customers will first wait to see if their neighbors like the new ISP. Depending on the size of the market, it would not be unusual to see ISPs requiring four to five years of selling effort to reach the target penetration.

We've seen ISPs try a wide array of different approaches to selling broadband. The following are the most commonly used and successful techniques.

Presales. Pre-sales usually involves establishing a website and getting customers to commit to buying broadband before the new network is constructed. There is a big advantage to an ISP from knowing there are some committed customers before construction begins.

ISPs often offer some kind of incentive for those who commit early. This might be a month or two of free service or perhaps a guarantee that the early enrollees will be the first to get fiber broadband.

Presales work best in markets with lousy broadband since those without are often eager to get better broadband. Interestingly, the vast majority of folks who say they will buy actually do so.

Market Awareness. This is more passive marketing that is just trying to build awareness. For example, a new ISP might put up several billboards in a new community. They might take out radio, newspaper, or TV ads. They might send mail to everybody in the market. Many ISPs who don't succeed don't progress past these passive sales steps.

Coordinate with Construction. ISPs have learned that they get a lot of awareness during the construction process. While the crews are still in a neighborhood and ISP might provide door hangers telling folks what they are doing and offering to connect them immediately. We know one ISP building in small rural towns that got a 60% market penetration just from the coordination during construction – that is extraordinarily high. If anything, the lesson we learned in this community is that you never know which sales technique will succeed in a given market – and you have to be prepared to pivot when your sales techniques are striking out.

Door-knocking. The technique that we've repeatedly heard has the highest level of success. This involves sending salespeople to knock on residential doors to sell broadband. If the results of the survey are close to right, this technique should find the many people who should be willing to change ISPs.

Consultive Sales. This is the only way we know to sell to businesses. This involves a salesperson visiting businesses to sell broadband. In consultive sales, the salesperson reviews the needs of the business and suggests the best solution – which is different than just offering a better price for what the business already has today. It generally takes 2 – 4 meetings to close a typical business sale.

C. Financial Assumptions

Incremental Analysis

It's important to note that all of the projections were made on an incremental basis. This means that the studies only consider new revenues, new expenses, and new expected capital costs. This is the most common way that businesses of all sorts look at potential new ventures since the incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover its costs.

It's important to understand what an incremental analysis shows and does not show. An incremental analysis is basically a cash flow analysis. It looks at the money spent to launch and operate a new venture and compares those costs to the revenues that might be generated from the venture.

An incremental analysis is not the same as a prediction of what the accounting books of a new venture will 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 shown.

Following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that 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 would be added to the network in the tenth month after funding. 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 predict 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 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 set prices 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 for the community to have low-priced broadband 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 like 5 Mbps probably 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 the existing provider's special rates.

Following are the basic residential rates for broadband in the market today:

- Comcast charges $80 for its 100/5 Mbps service and $120 for 1200/35 Mbps on its cable network. Comcast charges $14 monthly for its modem and has a 1.2 TB data cap on its products. Comcast charges $10 for each additional GB of data, with a maximum of $50 extra per month.
- Mediacom charges $79.99 for its basic 200/10 Mbps product that comes with a 1 terabyte data cap. Mediacom charges $129.99 for its 1000/50 Mbps product with a 6-terabyte data cap. Mediacom charges $10 for 50 GB of additional data after reaching the cap. Mediacom charges $13 per month for a modem.
- Sparklight sells 200 Mbps for $65 per month with a data cap of 700 GB. Sparklight charges $80 for its 300 Mbps product with a 1.2 TB data cap. Sparklight's gigabyte product costs $110 per month and does not have a data cap. The company charges $10.50 per month for a router.
- AT&T sells DSL for $60 per month for 5 Mbps and $65 per month for speeds up to 25 Mbps. AT&T charges $10 for a DSL modem. AT&T Fiber starts at $60 for 100/100 Mbps up to $80 for gigabit service.
- Frontier charges $54.99 for DSL. Frontier charges $54.99 for 500/500 Mbps and $154.99 for 1/1 Gbps for its fiber products.
- i3 Broadband charges $54.99 for 250/250 Mbps, $64.99 for 500 Mbps, and $89.99 for 1 Gbps service. i3 Broadband charges $7 per month for a modem.
- CASSCOMM charges $74.95 for 4/1 Mbps on its DSL network. CASSCOMM charges $59.99 for 10/2 Mbps and $99.95 for 50/5 Mbps on its cable network. The company charges $59.95 for 75/75 Mbps and $149.95 for 1/1 Gbps on its fiber network.
- Consolidated Communications charges $31.95 for up to 10 Mbps and $50.95 for up to 50 Mbps on its DSL network. The company charges $10 per month for a modem rental.
- Veloxinet charges $49 for 50/25 Mbps and $45 for 25/10 Mbps on its fixed wireless network.
- PWR-net (Shelby Electric) charges $39.95 for 1 Mbps, $69.95 for 10/2 Mbps, and $99.95 for 15/2 Mbps on its fixed wireless network.
- Royell Communications sells 3/1 Mbps service for $37.95, $54.95 for 10/1 Mbps, and $79.95 for 25/5 Mbps on its fixed wireless network.
- Rise Broadband provides up to 5, 10, and 15 Mbps for $42, 20 and 25 Mbps for $47, and up to 50 Mbps for $57. Each product comes with a 250 GB data cap; each additional 10 GB is $5.
- A.C.T.S. charges $20 for 10 Mbps, $50 for 50 Mbps, $80 for 100 Mbps, and $125 for 200 Mbps on its fixed wireless network.
- T-Mobile's new fixed cellular plan costs $60 per month for customers that use autopay. Speeds are up to 100 Mbps.
- Verizon's new fixed cellular plan costs $55 for existing Verizon customers and $75 for non-Verizon customers. Speeds are not guaranteed.

Fiber would bring significantly faster upload speeds than every technology deployed in rural areas. 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 broadband that is twenty times faster.

In the forecasts, we used $60 as the starting price for broadband. That's higher than Frontier and the slowest products offered by fixed wireless ISPs. That starting price is less than the cable companies and faster fixed wireless products..

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

- Price Steps or Tiers. Most ISPs set prices in tiers (like the above examples for incumbents). Probably the key attribute of 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	85%	$60.00	60%	$60.00	45%
250 Mbps	$ 90.00	14%	$75.00	30%	$70.00	40%
Gigabit	$120.00	1%	$90.00	10%	$80.00	15%
For 1,000 Customers:						
Revenue	$64,800		$67,500		$67,000	
Increase			4%		3%	

  The difference in the steps or tiers is that "Rate 1" prices are set at $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, 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 businesses 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. 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. Only a few of the many smaller 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 rate 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 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 keep 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 don't use 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. 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 rate for a business customers with unlimited calling is $35.

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.

Cable TV Products

We did not include cable TV in the feasibility assessment. Millions of households nationwide have been dropping traditional cable every year and are instead using streaming video services. Even should an ISP decide to bring a TV option, there is little margin on the product, so adding cable TV would make little difference to the financial analysis.

Broadband Products

The three speeds below are arbitrary, and an ISP might use these prices but a different set of speeds. We have used a 3-tier pricing structure with a $15 price step between tiers. The broadband products are all assumed to have symmetrical download and upload speeds.

	Price	Percentage
Residential Fiber Broadband		
100 Mbps	$ 60.00	60%
250 Mbps	$ 75.00	30%
Gigabit	$ 90.00	10%
Business Fiber Broadband		
100 Mbps	$ 80.00	50%
250 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. The cable companies in the county all enforce data caps and charge customers extra any month for using more data than the data cap limits. h.

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 $5.00 for residences and $10.00 for businesses. It's further assumed that 70% of residents would buy this product and 60% of businesses.

Large Broadband Products

There are entities in Sangamon County that buy larger bandwidth products. The studies are conservative and predict only small amounts of this revenue. 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 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 predicted in 2021 that the industry has plans to pass 61 million homes with fiber between 2021 and 2025 – that's far more fiber than has ever been built.

Supply chain issues are also suffering from the lack of 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 bring broadband to the rural areas. These investments are at the end of the fifth year of operations – the time when an expanded ISP would be expected to reach full market penetration. The first estimates below includes an assumption that a new fiber ISP would eventually gain a 60% penetration in the rural areas. We think that assumption is likely to be conservative, so we're also showing the assets needed for a 70% market penetration.

	60% Penetration	70% Penetration
Fiber	$37,189,682	$37,195,137
Drops	$ 2,787,708	$ 3,238,990
Electronics	$ 2,739,701	$ 3,018,377
Huts	$ 910,000	$ 910,000
Operational Assets	$ 219,057	$ 221,449
Total	$43,846,158	$44,583,953
Passings	5,629	5,629
Cost per Passing	$7,789	$7,920

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the average electronics for an ONT cost $551, which includes the cost of the labor for installation. 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.

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 can easily be more than what company personnel can 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. Finley Engineering estimated the average cost of drops for the whole study area to be $924.

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 Sangamon 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 in the rural areas. While the survey was not statistically valid, it still indicates the general overall desire for better broadband. The survey suggested that as many as 67% of folks would buy broadband from a new fiber network.

The only way to get a better estimate of the penetration rates would be through a statistically valid survey. However, it's difficult to conduct a reliable survey for a 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, so 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. This is the staff that takes new orders, answers customer questions about billing, services, etc. We've assumed an ISP would add two additional customer service reps over the first few years of network expansion.

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 that an ISP would add two new outside technicians and one additional inside technician.

We assumed that construction contractors would build the fiber network. We've also assumed that customer installations will be outsourced during the construction process and for the first few years thereafter. However, once the bulk of customers has been added, the forecasts assume that future installations could 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.

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 Sangamon 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, the 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, 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 in 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. The cost of a new vehicle is then depreciated monthly to write off the asset over the five years, or sixty months. All hard assets are depreciated except land. Depreciation rates are set according to the expected life of the assets—something that is usually determined to comply with IRS rules and accounting

standard practices. Soft assets like software are instead amortized, using the same process as depreciation.

D. Financial Results

The primary purpose of creating the financial forecasts is to determine if it might be profitable for an ISP to operate profitably in the rural parts of the county under different scenarios. An ISP must understand the cost of bringing a network solution before considering tackling bringing a broadband solution. ISPs also need to understand the amount of grant funding needed to make a scenario work to understand if a solution is financially possible.

We undertook the financial analysis with those two goals in mind. The cost of bringing a broadband solution to an area is not only the cost of the new fiber and electronics. An ISP has to understand all costs of expanding its network into a new area:

- When considering network costs, it's important to also consider what we call ancillary assets – vehicles, buildings, tools, backup power, test equipment, spares, inventory, furniture, computers, and software. Our analysis includes these extra asset costs. Over time, assets wear out and must be replaced, and our analysis includes the cost of replacing assets.
- In a time of increasing interest rates, it's vital to understand the cost of any debt needed to fund a project. Only a very tiny number of broadband projects find 100% grant financing, and most ISPs use debt for matching funds instead of equity. An ISP needs to be certain it can cover early interest and principal payments that must be covered until revenues grow large enough.
- All new broadband projects also have what we call startup costs. Staff must work to build the new network. There must be a marketing campaign to let customers know that broadband is available.

As will be shown below, there are also key variables outside the control of the ISP that can have a significant impact on financial performance. An ISP might achieve a higher or lower customer penetration rate than expected. Interest rates might be higher than anticipated when it's time to fund a network. We'll look at the impact of these variables.

Finally, there are other important variables that an ISP can control. Chief among these is broadband prices. Almost any business plan can succeed with high enough prices, but ISPs know that higher prices likely mean lower market penetration. Unfortunately, there is no guidebook describing the trade-off of prices and customer penetration – a term that economic books call the demand curve.

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. There are steps that an ISP can take to improve upon our 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 is completed – at a faster pace than is shown in these projections.
- More Concentrated Build Schedule. It's often possible to build a network faster than the timelines used in our forecasts. For example, the amount of network that can be constructed can be increased by adding more construction crews.

- New Staffing. We typically overestimate the new staff required to be conservative, and an existing ISP can often add a new rural market without hiring the staff we've predicted.

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 that we think summarize the results. Note that a table of all the financial results is included in Exhibit II, which makes it easier to compare the different scenarios.

Fiber to the Full Rural Area

As a reminder, the full study area is all of the rural places that we determined to be unserved or underserved. This first scenario is at a 60% customer penetration rate that we used for our base scenario.

Base Study

	Commercial Financing		Bond Financing	
	No Grant	Grant	No Grant	Grant
Asset Costs	$ 43.8 M	$ 43.8 M	$ 43.8 M	$ 43.8 M
Grant	$ 0.0 M	$ 24.7 M	$ 0.0 M	$ 30.0 M
Equity	$ 8.1 M	$ 3.4 M	$ 0.0 M	$ 0.0 M
Bank Debt	$ 47.7 M	$ 19.1 M	$ 57.9 M	$ 18.4 M
Total Financing	$ 53.8 M	$ 47.1 M	$ 57.9 M	$ 48.4 M
Penetration Rate	60%	60%	60%	60%
Cash after 5 Years	$ 0.14 M	$ 0.16 M	($ 6.32 M)	$ 0.10 M
Cash after 10 Years	($11.86 M)	$ 0.12 M	($24.58 M)	$ 0.13 M
Cash after 15 Years	($23.34 M)	$ 0.61 M	($42.63 M)	$ 0.39 M
Cash after 20 Years	($33.89 M)	$ 1.83 M	($60.22 M)	$ 1.14 M

There is a lot to unwrap in these results. Some of the most important things shown by these results are:

- Significant grant funding is required to bring broadband to the rural parts of the county. We expected that before we started the analysis, and we knew for sure when we saw that the cost per passing was almost $8,000. Every ISP is a little different, but we normally see that some grant funding is needed when the cost per passing exceeds $3,000 to $4,000. There is no hard metric for the need for grants because the amount of grant needed varies significantly by changes in the custom penetration rate, as will be demonstrated in greater detail below.
- The second and fourth columns above represent what we are calling the breakeven grant scenario. This shows the smallest amount of grant that is required for this project to always be able to remain cash positive – meaning the project always covers debt payment, operating expenses, and future capital costs. The amount of total amount of cash contribution needed for the commercial financing scenario (adding grant plus equity) is around 60%. No ISP is going to be happy with those projected results, because even after twenty years the ISP has earned back only about half of the equity contributed to the project. Commercial ISPs expect to make a profit over time, and these breakeven scenarios show no profits.

- Interestingly, if this was a municipal project, the local government would likely find the fourth column to be acceptable because it never runs out of cash. That is one of the biggest differences between commercial and municipal ISPs.
- But it's important to note that the amount of grant funding needed to break even is significantly higher in the municipal scenario. This is due to the differences between bond and bank financing. A municipal ISP would likely borrow all of the money upfront for the project, while a commercial ISP would borrow banks funds as needed during the construction process. Bank financing means a lot less interest expense during the early years of the project. The municipal borrowing is also significantly larger than a bank loan because the municipality contributes no equity and because the municipality would borrow the interest payments for the first several years of the project. These factors drive the municipal borrowing in the third column come in over $10 million higher than bank debt in the first column.
- Both of these scenarios assumed a 6% interest rate borrowed over a twenty-year term. The debt markets are in a lot of turmoil right now, and we see both bank and bond interest rates at about the same level. But historically, interest rates for bond financing tend to be a little lower than bank interest rates. A lower municipal interest rate would lower the amount of grant needed to break even. It's also often easier for municipal bond issues to stretch over longer borrowing terms, and if the borrowing term would be increased to twenty or twenty-five years, the amount of grant needed for the municipal scenario would also be lower.
- A final observation is that banks would likely expect a substantial equity infusion from a commercial ISP. Banks want borrowers to have 'skin in the game' which is a banking term referring to having a borrower putting some of its own money at risk – which makes it harder for a borrower to default and walk away from a loan. Many ISPs would not have the amount of free cash equity shown in the above scenarios. The requirement for equity as part of borrowing 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.

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 services. The base scenario studies above assumed a 60% penetration rate. The numbers below show two additional scenarios – lowering the penetration rate to 50% and raising it to 70%.

	50%		60%		70%	
	Base	Breakeven	Base	Breakeven	Base	Breakeven
Asset Costs	$ 43.1 M	$ 43.1 M	$ 43.8 M	$ 43.8 M	$ 44.6 M	$ 44.6 M
Grant	$ 0.0 M	$ 29.2 M	$ 0.0 M	$ 24.7 M	$ 0.0 M	$ 20.9 M
Equity	$ 8.1 M	$ 2.5 M	$ 8.1 M	$ 3.4 M	$ 8.1 M	$ 4.1 M
Bank Debt	$ 45.8 M	$ 14.2 M	$ 45.7 M	$ 19.1 M	$ 45.8 M	$ 23.2 M
Total Financing	$ 53.9 M	$ 45.9 M	$ 53.8 M	$ 47.1 M	$ 53.8 M	$ 48.2 M
Penetration Rate	50%	50%	60%	60%	70%	70%

Cash after 5 Years	$ 0.15 M	$ 0.16 M	$ 0.14 M	$ 0.16 M	$ 0.14 M	$ 0.14 M
Cash after 10 Years	($13.88 M)	$ 0.29 M	($11.86 M)	$ 0.12 M	($ 9.86 M)	$ 0.24 M
Cash after 15 Years	($27.43 M)	$ 0.91 M	($23.34 M)	$ 0.61 M	($19.30 M)	$ 0.92 M
Cash after 20 Years	($40.19 M)	$ 2.10 M	($33.89 M)	$ 1.83 M	($27.65 M)	$ 2.52 M

The above results show the following:

- The asset line shows how the needed capital increases as the penetration rate rises.
- The analysis shows that the amount of needed grants gets smaller as the business gets more paying customers. In this case, that change is drastic, with $29.2 million in grants needed at a 50% penetration and only $20.9 million in grants at a 70% penetration. The difference is due to the customer revenues helping to support the business better as the penetration rate rises.

Other Scenarios

We also looked at a few alternate business structures. These scenarios were examined at the base 60% penetration rate. The results would also vary with a higher or lower penetration rate.

ISP Leases the Network

In this scenario, the County would fund and 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.

This scenario turns out to be difficult in rural areas. The local government borrows the money, and even if lease payments are set to be equal to debt payments, there is not enough revenue and cash flow to offset capital upgrades and replacement. And that is assuming that a local government could find an ISP willing to guarantee debt payments.

The following scenario considers the 60% base penetration scenario and assumes breakeven grant funding assumed in that scenario above.

	County	ISP
Asset Costs	$ 43.7 M	$ 0.2 M
Grant	$ 24.7 M	$ 0.0 M
Equity	$ 0.0 M	$ 0.7 M
Bank Debt	$ 21.0 M	$ 4.9 M
Total Financing	$ 45.7 M	$ 5.7 M
Penetration Rate	60%	60%
Cash after 5 Years	$ 1.73 M	($ 1.15 M)
Cash after 10 Years	$ 0.51 M	($ 4.24 M)
Cash after 15 Years	($ 0.90 M)	($ 3.31 M)
Cash after 20 Years	($ 2.14 M)	($ 2.10 M)

This is an interesting scenario that looks to be difficult in a rural area. We've seen this scenario work better for both parties in cities. There are several reasons for this:

- The amount of overall debt needed per customer is a lot higher in a rural scenario unless the project is able to attract significant grant financing greater than the breakeven grants we've calculated.
- To go along with that, the amount of customer revenues is generally much higher in an urban study due to there being a lot more customers in the study footprint – a $45 million project in a city likely passes a lot more potential customers.
- With enough grant funding, this scenario could be made to work, but even then, it's a challenge to find an ISP willing to guarantee the debt payments of the local government that builds the network.

Open-Access

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

	County	ISPs
Asset Costs	$ 43.8 M	$ 0.2 M
Grant	$ 24.7 M	$ 0.0 M
Equity	$ 0.0 M	$ 0.2 M
Bank Debt	$ 21.1 M	$ 1.2 M
Total Financing	$ 45.8 M	$ 1.4 M
Penetration Rate	60%	60%
Cash after 5 Years	($ 4.25 M)	$ 0.22 M
Cash after 10 Years	($ 8.97 M)	$ 1.86 M
Cash after 15 Years	($13.79 M)	$ 4.04 M
Cash after 20 Years	($18.35 M)	$ 6.23 M

As the numbers above show, this scenario is massively out of balance, with all of the gains going to the ISPs and the losses to the County, The losses are fairly easy to understand. The County would be making nearly the identical capital investment as in a retail scenario, but the revenue from customers would be roughly half of what would be collected if the County was the ISP. The lower open-access revenues are not high enough to cover debt costs.

We know of cases where open-access is successful, including in rural areas, and in all of these cases, the scenario only works where there are something like 30,000 or more customers on the open-access network. Open-access clearly requires economy-of-scale to work. The government that owns the network has to cover the costs of a few employees along with the cost of maintaining the network, and it takes a lot of customers for that to work.

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 around $3.4 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $675,000. This is a significant sensitivity. Decreasing rates by $5 had a similar impact and lowered cash over 20 years by around $3.2 million. This provides evidence that an ISP should be careful about lowering rates. For example, if an ISP wants to consider rates to gain customers, the long-term impact of lower rates could be devastating 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 100 basis points, or 1% (such as changing the interest rate from 6% to 5%.). This increased cash flow by around $2.7 million over twenty years. The impact of increasing the interest rate was similar, where increasing the rate by 100 basis points lowered cash flow by around $2.5 million.

This provides a warning that anybody planning a new fiber network during a time of financial uncertainty to keep a close eye on interest rates and not proceed with financing if interest rates move too high. If you have a forecast that works at a 4% interest rate, it might no longer work at a 6% or 7% interest rate.

We've been lucky for the last decade that interest rates have held steady, but historically it's been more normal for interest rates to fluctuate. In times of rate fluctuation, it was somewhat normal for ISPs to 'shop' interest rates, meaning they would close a deal until rates were favorable. This might have meant delaying the start of a project by three months or a year – but ISPs were cautious about taking on interest rates that couldn't work. Unfortunately, ISPS probably don't have the option to wait when building a project that has accepted grant funding. The grant agency will expect the ISPs to fulfill its part of the funding, regardless of market issues like the interest rate.

Homeowners often take on high-rate mortgages because they believe that over the next five years they will have an opportunity to refinance. While businesses can also refinance loans, it's not nearly as easy to refinance as with a home, and businesses fear getting stuck with ugly interest rates for too long. Higher interest rates can create a real catch-22 for ISPs – the higher interest rates make them underperform, and underperforming makes them ineligible for refinancing.

The other caution that comes from this result for ISPs is to be cautious about taking on variable-rate loans. A lot of ISPs grow organically, meaning they roll profits from existing customers back into the network. In doing so, an ISP often has a revolving line of credit that makes it easier to know there will be enough cash to build when needed. These lines of credit are almost at variable interest rates. We already see that ISPs with this borrowing arrangement are slowing or even stopping construction due to the higher interest costs.

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 $3.4 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 there is not enough money in the business to cover the higher payments.

In both cases, the change in long-term cash flow is due to the changes in annual debt payments 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 early or refinanced, but the longer the loan term, the smaller the annual required debt payments, and the lower the pressure on cash in the early years of the new business.

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 a longer loan term – two changes that improve cash flow – the benefit is largely the same as adding the changes described above together.

An ISP must carefully monitor the key variables that are external and out of the ISP's control. That means possibly not taking on a loan if the interest rates are too high. The variable that drives the biggest change is the customer penetration rate, and an ISP has to feel certain it can achieve the targeted number of customers.

This also means that an ISP should understand that there are variables under its control. The biggest such variable is broadband prices. While it's never comfortable to raise rates, an ISP that is not meeting its business plan objectives often has little other choice, other than perhaps to trim expenses.

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 Sangamon 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 grants 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 amount of cash infusion needed to make each scenario reach breakeven (a combination of grant and equity).

	Penetration Rate	Assets Needed	Grant Plus Equity Needed	Percent of Assets
Rural Study Area	50%	$43.1 M	$31.7 M	74%
	55%	$43.5 M	$29.9 M	69%
	60%	$43.8 M	$28.1 M	64%
	65%	$44.2 M	$26.6 M	60%
	70%	$44.6 M	$25.0 M	56%

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

- The table shows that the amount of needed cash investment (grant plus equity) drops with an increase in the expected customer penetration rate.
- The overall level of needed cash infusion looks achievable when considering that there is a lot of grant funding available to fund rural projects between 50% and 75% of the costs of the assets.
- Note that all of the cash infusion 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 want to win a higher amount of grant than shown to reach its desired level of profitability.
- This heavy correlation with the customer penetration rate means that ISPs ought to take the extra steps needed to have faith in the projected customer penetration rate. That might mean conducting a statistically valid survey or a canvass of the grant area.

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, the interest rate on debt, and the term of borrowing. Any ISP thinking of tackling any of these projects must be aware of how changes in these variables can change the expected results of the business plan.

Open Access Doesn't Look Viable

The analysis above showed that an open-access environment scenario is likely to be a big loser for the local government but profitable for the ISPs.

Leasing the Network to an ISP Looks Challenging

The above analysis showed that it is a challenge for a local government to build a network and lease it to an ISP. It's possible this scenario could work if enough grant funding is found. But the biggest challenge for this scenario is finding an ISP willing to accept the risk of guaranteeing the government's loan

payments. Without such a guarantee, a local government could be taking on a lot of risk of having to permanently subsidize the network.

The Importance of the Breakeven Calculations - and the Important of Expected Returns

Several tables above discuss the amount of grant funding needed to achieve breakeven. Breakeven, in this case, refers to the business always maintaining 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 measure success by meeting some return goal, although some smaller ISPs only care more 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 based on operating margin, while another ISP may expect a return on equity based on free cash flow. Those are two quite 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 on the internal rate of return (IRR), which is the net present value in 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 expected by one ISP might turn out to be lower than an expected IRR of 6% for another ISP.

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 future failures of the business. 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 break even 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 make 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.

E. Funding for Broadband Networks

For a large percentage of broadband projects, the biggest challenge is finding funding. This section of the report looks at the various ways that other communities have been able to fund broadband networks. If a community wants fiber badly enough, there probably is a way to pay for it.

The County is not likely to consider being an ISP but since some of the options we considered include a public-private partnership, the following discussion covers both commercial bank financing and bond financing.

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 will most normally rely on traditional private financing, meaning loans. Some of the largest, publicly traded ISPs often raise money through corporate bonds. Following are some key challenges that ISPs must navigate to get bank financing:

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

Equity can take a number of different forms:

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

Bank Loan Basics: The banking industry generally does not like to finance long-term infrastructure projects. This is one of the primary reasons why the country has had such an infrastructure deficit. Until about the 1960s, banks would fund things like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. But various changes in

banking laws require banks to maintain larger cash reserves, which makes them less willing to make long-term loans. Banks have also increased their expectations over time to 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 the bank's equity.

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

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

Collateral. The biggest issue that borrowers have in getting a bank loan is the requirement for collateral, which is the assets a borrower pledges to a bank if the project fails. Banks like hard collateral like buildings, vehicles, shares of stock, and things they know they can readily sell for a reasonable price. Banks don't like broadband networks as collateral because even a little bit of web searching shows them that failed fiber networks are sometimes sold for pennies on the dollar. Fiber networks have little intrinsic value – all of the value of an ISP comes from the paying customers on a network.

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

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

Federal Loans

Rural Utility Service (RUS): This is a part of the Department of Agriculture and is the only federal agency that makes direct loans for broadband projects. The Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program) furnishes loans and loan guarantees to provide funds for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide broadband in eligible rural areas. These loans can't be used for any town with a population of over 20,000. The RUS acts much like a bank and follows similar lending practices. I like to describe the RUS as a bank from the 1950s because its lending rules were set by Congress to loan money for rural electrification and have never been modernized.

RUS makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband, including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.
- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan, excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may be reimbursed only if they are incurred after the date when a round of funding has been announced.

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 prepare externally.
- Agree to complete the build-out of the broadband system described in the loan application within three years from the date the borrower is notified that loan funds are available.
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas.
- Demonstrate an equity position equal to at least 10% of the amount of the loan requested in the application; and
- Provide additional security if it is necessary to ensure financial feasibility as determined by the administrator. (For anyone other than large borrowers, this generally means pledging the whole existing business as collateral).

In practical terms, RUS loans are administered as follows:

- The rules say that a project needs at least 10% equity, but this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS acts as a bank, and it will require enough equity so that the projected revenues can adequately cover debt payments.
- The loan terms are generally in the range of 12 years, but the RUS can choose to extend to 20 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under a RUS loan than with a bond.
- It is exceedingly hard to get funding 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 the RUS loan requirements.

- Their collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if the project is going to share fiber with some existing network, such as one built by a school system, they would want that asset as collateral. Many borrowers find the RUS collateral demands to be impossible to meet.

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 RUS has a major bias for lending to ISPs that are already RUS borrowers.

The other big drawback of these loans is that they take a long time to process. It's normal for a loan application to be at least six months, and we've seen a backlog at the agency push that out to 18 months. Very few borrowers are willing to wait that long unless they are certain they will be funded. Because of the timing and the collateral rules, it's extremely challenging to coordinate RUS loans with other forms of financing.

However, the RUS loan fund is often large, and there have been many times over the last decade when the available balance was more than $1 billion. Congress generally adds additional funds to the RUS pot each year. The RUS also has some discretion, and it has the power to include some portion of a loan as a grant that doesn't have to be repaid. This is something that can't be counted on, but we know of projects where the borrower only had to pay back 80% of what they borrowed. The RUS interest rate tends to be lower than bank rates during periods where bank interest rate move higher.

Servicing an RUS loan requires significant paperwork for drawing down funds, along with significant annual reporting requirements.

Other Bank Loans

There are two specialty banks that specialize in making broadband loans that should be mentioned. The first is CoBank. This is a boutique bank that is owned collectively by a bunch of telephone cooperatives. CoBank historically made loans to cooperatives, but over time has branched out to loan to the other parts of the industry.

CoBank is cautious and only takes on loans for projects that look to have a high chance of success. This means it rarely loans to start-ups but prefers existing ISPs with a long history and a strong balance sheet. CoBank loans are generally at market interest rates, similar to bank rates. CoBank also wants significant collateral. Finally, CoBank loans are rarely for more than 15 years and often for shorter terms.

The other industry bank is RTFC, which is a bank owned by electric cooperatives. RTFC rarely lends to anyone other than a cooperative but could be the source of funding if a local government is partnering with a cooperative. Borrowers must typically join the cooperative as a condition of borrowing.

Loan Guarantees

Another way to help finance broadband projects is through federal loan guarantees. A loan guarantee is just what it sounds like. Some state or federal agency will provide a loan guarantee, which is very much like getting a co-signer on a personal loan. These programs guarantee to make the payments in the case of a default and thus greatly lower the risk for a lending bank. In return for the lower risk, the banks are required to offer a significantly lower interest rate.

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, meaning lots of paperwork. 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.
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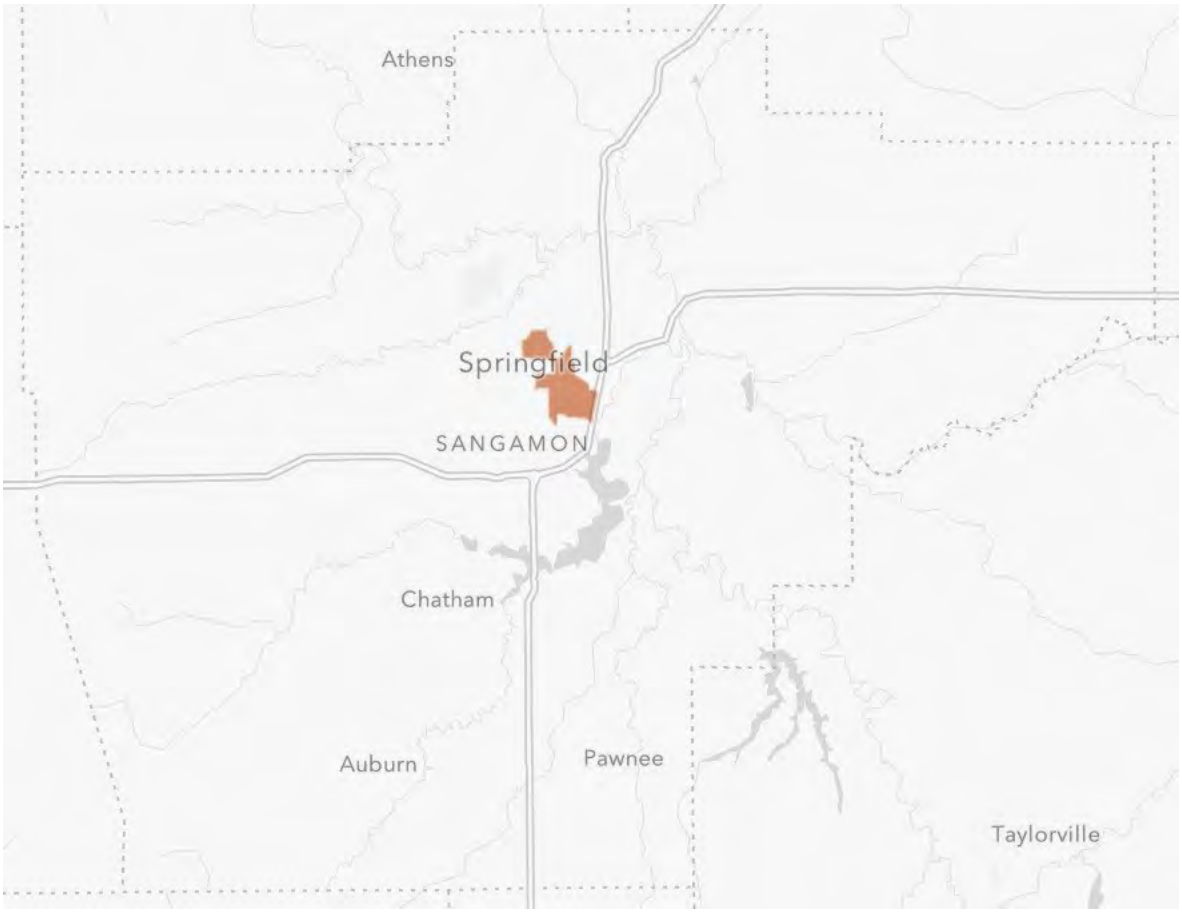
> **Small Business Administration 504 Loan Program**: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.
>
> **USDA Business and Industry Guaranteed Loans (B&I)**: The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

Opportunity Zones. Congress created a new investment opportunity as part of the 2017 Tax Cuts and Jobs Act. The Act created Opportunity Zones in which investors can get special capital gains treatment and other tax breaks for investing in qualified infrastructure within an opportunity zone. Each state governor designated specific opportunity zones. However, the only Opportunity Zone in the County is in Springfield and would provide no funding benefits for building rural broadband.



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 was to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Most of rural America qualifies for new market tax credit financing. New market tax credits are normally used to fund only a small portion of a project.

The NMTC Program works by giving big tax credits to investors 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 next four years, for a total of 39%.

The Community Development Financial Institutions (CDFI) Fund and the Department of the Treasury administer the program. Treasury allots credits each year in a complicated way, with the simplest explanation being that there are entities around the country each year that are awarded tax credits, and these entities work as brokers to allot the credits to specific projects. The credits are often purchased by large banks or other firms that invest in infrastructure.

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 then have a balloon payment for the principal. However, often some or even all of the principal can be excused, making this look almost like a grant.

Public Financing Options

If the County was going to invest in any infrastructure as part of a partnership, it's likely that funds would come from municipal bonds. 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 to 25 or 30 years. It's also possible to finance a project completely with bonds, meaning that no cash or equity is needed.

Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the creditworthiness (bond rating) of the borrower as well as the perceived risk of the project. In recent years when commercial interest rates were low, the rates for municipal bonds were similar to bank loans. But there have been times when bond rates are higher than bank rates.

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 selling the bonds.

The traditional source of public money used to finance telecom projects is through the issuance of tax-exempt municipal bonds, meaning the buyers of the bonds don't have to pay federal and/or state income taxes on the revenue from the bonds.

Revenue Bonds: Most of the municipal fiber networks that have been built have been financed through revenue bonds. Revenue bonds are typically backed primarily by the revenues of the fiber 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 impact of the interest rate on the bottom line. 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 governments 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 each year. In the case of the new telecommunications system, this type of financing would provide 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 interest rates. 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 historically been lower than interest rates on fixed-rate bonds. There is typically a maximum rate that the VRDOs cannot exceed. But in a market where there is a significant increase in overall interest rates, this kind of financing could end up being significantly more expensive.

Capital Appreciation (Zero Coupon) Bonds (CABs): CABs are bonds that are issued at a deep discount, and which do not bear any stated interest rate. Like a Series E savings bond, CABs are marketed at a price that implies a stated return calculated on the 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 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

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 default. 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 upfront and begin accruing interest expense on the full amount borrowed at the beginning. Construction loans

also mean 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 with 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 to imagine the construction of fiber networks in rural areas without some grant support. We've only included grant opportunities below that we think might be used in 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 went directly to states, counties, cities, towns, and townships. 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 exceeds 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 WiFi 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[12] directly 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 the 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.

[12] The full rules are at: https://home.treasury.gov/system/files/136/Capital-Projects-Fund-Guidance-States-Territories-and-Freely-Associated-States.pdf

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 improvements 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 3, 2021, can be funded under some circumstances. This might cover costs like a feasibility or engineering study.

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[13]. 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 was an earlier round in 2022 for $1.2 billion that has recently started to announce awards. The USDA just announced another round that starts in early September 2022, and the expectation is another round in 2023. The rumors are that these rounds could be for as much as an additional $2 billion. Following is a highlight of the rules for the latest ReConnect grants.

- Speeds. This is the first federal grant program that will consider 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 the FCC mapping data, but an applicant needs to be prepared to demonstrate why an area is eligible. Challenging the FCC maps 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)."

[13] https://www.usda.gov/reconnect

- Must be Rural. Grant-serving areas must be rural and remote. There is a ReConnect mapping tool[14] 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.
- 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. The funding can be used by an RDOF winner to supplement that award.

HUD Community Development Block Grants (CDBG)

Grants under this program can be used to build fiber or wireless networks in areas lacking broadband access. Any grant application must meet all three of the following objectives:

- The project must benefit low- or moderate-income neighborhoods
- The project must eliminate "slums / blight."
- The project must demonstrate urgent need.

The last criterion is fairly easy to demonstrate in any community without adequate broadband. The big hurdle for many grant applicants is the second objective of eliminating blight. We've seen an argument made that improving broadband improves incomes, which ultimately improves impoverished communities. For example, luring tenants to closed storefronts with good broadband meets this test.

The CDBG grants have wide latitude in considering grant applications and can be used in the following ways that benefit broadband:

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes the placing underground of new or existing distribution facilities and lines.
- Digital literacy classes as a public service.

[14] https://ruraldevelopment.maps.arcgis.com/apps/webappviewer/index.html?id=1e82a64056fc46e4a28361c5e9447246

- 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 administer state grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

It's hard to use this money to support a widespread network that serves different neighborhoods, but it can be useful to supplement other grants by using this money for low-income areas.

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. Detailed rules were defined by a Notice of Funding Opportunity.

- Every State Has a Separate Timeline. The money will go from NTIA to the states, and the states will administer the grants. However, the grants must meet all of the NTIA rules. There is a detailed process for states to get access to the funding. For example, States must reach out to stakeholders in all portions of the state. States must allow for a challenge process to give ISPs and local governments a chance to dispute the FCC broadband maps used to define grant eligibility. After the NTIA approves a state's plan, the state will have to develop and announce the specific grant program and timing.
- The Grant Application is Complicated. This is probably the most intensive set of grant application rules ever for broadband grants.
- Large Amount of Funding. States will get at least $100 million each, with the rest distributed based on 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.
- Deployed Speeds Must be 100/100 Mbps or Faster. 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 Grant Program. States have five years to disperse the funds. We don't know what that means. It could mean a series of grant 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 and local governments 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. The NTIA rules suggest that grant applicants willing to take less than 75% will have an advantage.
- Requires Two 9's Reliability. Deployed technology must 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.

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 to use the funding. States will have to name the entity that will operate the program, and interestingly, it doesn't have to be a branch of government. States could assign the role to non-profits or others.

The amount of funding that will go to each state is formulaic. 50% will be awarded based on the population of each state, according to the 2020 Census. 25% will be awarded based 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 from 2022 until 2026.

These grants can be awarded to a wide range of entities, including government entities, Indian Tribes, non-profit foundations and corporations, community anchor institutions, education agencies, entities that engage in workforce development, or a partnership between any of the above entities.

This will be a competitive grant program, with the rules to be developed by the NTIA. While the broadband infrastructure grant in the Act includes a long list of proscribed rules, Congress is largely letting the NTIA determine how to structure this grant program.

The two grant programs create an interesting choice for entities involved in digital inclusion. They can 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.

Smart Grid Grants

There is a lot of grant funding that will be awarded through the federal Department of Energy (DOE) related to smart grid infrastructure. This funding comes from the same Infrastructure, Investment, and Jobs Act that created the BEAD grants.

These grants will be awarded from the DOE to states, and the states will then award grants. The grants will stress electric grid resiliency. One of the best ways to gain resiliency and smart grid technologies is by deploying fiber to provide 2-way communication with network electronics and devices. Any fiber that is built for smart grid purposes could also double to bring last-mile broadband.

The specific details of these grants have not been released.

State Grant Programs[15]

Illinois Office of Broadband

The Illinois Broadband Office is part of the Illinois Department of Commerce & Economic Opportunity. In 2019 Governor Pritzker launched the statewide broadband grant program Connect Illinois. Rebuild Illinois, the Illinois infrastructure program includes $400 million to the Department of Commerce & Economic Opportunity for a statewide broadband deployment grant program. Additionally, $20 million in funding for the capital program for the Illinois Century Network, a high-speed broadband network serving K-12 and higher education institutions, among others.

Connect Illinois

The Connect Illinois Broadband Grant Program seeks to achieve what no state or federal approach has accomplished: ubiquitous broadband access for homes, businesses, and community anchor institutions. The Connect Illinois Broadband Grant Program has completed two rounds, with the third round starting in January 2022 with a rolling deadline. Round 3 has $50 million in funding, with the maximum funding for a project being $10 million. Priority will be given to projects that provide 50% or more of eligible total project costs in nonstate matching. The projects must be completed within three years of being awarded the grant. It is expected the Connect Illinois program will serve as the foundational program for the forthcoming IIJA BEAD funding.

Project Requirements

- Broadband Access for Illinois homes, businesses, and community anchor institutions in unserved and underserved areas.
- Broadband equity for projects with demonstratable needs based upon project economics or residential socioeconomic factors, such as poverty, unemployment, or broadband adoption rates.
- Broadband innovation for economic development and related applications; or
- Urban broadband for access, equity, and innovation in qualified Illinois cities or metropolitan areas of 75,000 residents or more.

Eligibility Details

Eligible applicants for this program include an incorporated business or partnership, a political subdivision; a nonprofit organization; a cooperative association; or a limited liability corporation organized to expand broadband access.

Award Details

$400 million has been appropriated and authorized as available funding for the Connect Illinois Broadband Grant Program. Up to $50 million will be available in Round 3. Priority consideration will be given to projects that leverage certain nonstate funding – from private, federal, and local

[15] https://www2.illinois.gov/dceo/ConnectIllinois/Pages/default.aspx

sources – totaling 50 percent or more of eligible total project costs. The maximum individual grant amount is $5 million, but applicants are encouraged to submit multiple proposals. Grant project work must be completed by June 30, 2024.

Additional Information

Applicants must submit a project narrative describing how the award will be executed in detail. The project narrative should include enough information for DCEO to understand the project's scope and the budget, including a detailed breakdown of the costs associated with each budget line and any additional detail to enable DCEO to manage the grant agreement activity against the planned project performance.

Current Grant Status

The Illinois Broadband Office paused Connect Illinois Round 3 application cycle to initiate a rulemaking process in July 2022. The rulemaking process is underway, and it is unknown when the round will reopen to accept applications.

Customer Financing

If a public-private partnership is unable to fully fund a project, we've seen citizens step up and agree to fund some portion of a broadband project. When you consider the high cost of building rural fiber, getting some assistance directly from potential customers is sometimes the only solution for raising all 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 by about $25 per month per household. The township provides inexpensive access to the network to the cooperative, which offers attractive customer rates. This area had no broadband before the project.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Many of the member towns have pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of its fiber network using a federal grant awarded from the Stimulus funding program in 2008. The County held a referendum and used a sales tax increase to finance bonds to pay for the remaining matching funds needed to build the project.

Direct Customer Contributions: It is also possible to fund some project costs through direct contributions from potential customers. This has never been done on a large scale because it would

be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware 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

If the County gets involved in helping to fund broadband, it will likely be through some kind of public-private partnership (PPP). There is no one model for a PPP, and such an arrangement can be structured in many ways, which was addressed earlier in this report. 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—lower interest rates, long repayment terms, and small or no payments for the first few years. But the downside is that there are more overall financing costs, and eventually, a bond makes a project cost more in terms of cash. The safety of a bond in the first few years can be attractive.

It's worth noting that in this period of higher interest rates that the difference between bond and bank loan interest rates often gets erratic. In periods with moderate or low interest rates the rates for bond financing are generally lower. But it's possible for bond interest rates to climb higher than bank loan rates.

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 from the commercial ISP.
- In terms of the amount borrowed, the two methods work well together if commercial 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 payments 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 borrowing power of a local government.

Following are a few examples of this type of PPP:

- 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.

ARPA Funding Partnership. We are seeing a lot of partnerships where counties, cities, and townships are contributing some ARPA funding to ISP partners to help bring broadband. Some folks don't think of this as a partnership and consider this the equivalent of making a local grant to an ISP. But generally, any county or city government willing to give funding to an ISP should expect to gain some benefits from the funding.

IV. OTHER ISSUES

A. Potential Partnerships

One of the operating options explored in this report involved exploring broadband partnerships - how might the County best explore finding a partner.

The Best Characteristics of an ISP Partner

Experience. Finding partner ISPs with a history of being successful is one of the most important characteristics to look for. We know of several investor-driven ISPs that want to invest and operate broadband networks but 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.

Similarly, an ideal partner will already have partnered with another government entity. Government entities don't like to hear this, but they are not great partners from the ISP's perspective, for various reasons described above. Finding an ISP partner that is comfortable working with local government is a big plus.

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 an 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 borrowed 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 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 ISPs that have 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 arises in public-private partnerships over time due to a fundamental difference in goals. The issue commonly arises when the two parties don't thoroughly discuss their long-term goals before a partnership begins. 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, or 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 the dissolution of the partnership.

The difference between the government and a commercial ISP often surfaces when there is a discussion of rates. Local governments often push back against rate increases – particularly in election years. Governments generally push ISP partners to provide 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 large, 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:

- Most ISPs have 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 its 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 may have 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, which requires a government to think like a bank.
- Anchor Tenant. Government entities often make good anchor tenants – which means 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 work sites 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, or right-of-way fees that a government might be willing to waive to help a new network get established.

The bottom line 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. An RFI typically describes the situation in the community, typically describes whatever work has already been accomplished (such as this feasibility study) and describes 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 in determining 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, we define larger to mean that the cost of the project is large – perhaps more than $25 million. We'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 its history, talking about the products it normally sells, 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.

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. A typical goal 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 using different jargon 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?"

We advise prospective partners (government or otherwise) to place their questions into three categories, 1) make-or-break questions, 2) questions that might disqualify a potential partner, and 3) all other questions.

Every community will have its own list of make-or-break questions based on 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 on 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 of 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 different views.

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. A good thought experiment is for the local government to change hats and look at these same issues from the perspective of the ISP that wants to operate a profitable business. This exercise often highlights that there are some tasks where the ISP must have control.

One of the stories we 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 six 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 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 surefire 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 in the municipality will probably push the limits.

Sangamon County, IL
Online Residential Broadband Survey
From Summer and Fall 2022

1. Do you have Internet access to your home today?

	Number	Percent
Yes	1,259	93%
No	90	7%

2. What's the primary reason you don't have home Internet service today?

	Number	Percent
It's not available at my home	64	65%
It's too expensive	26	26%
I don't have a computer	6	6%
I don't know how to use the internet	2	2%
I have no need for internet at my home	1	1%

3. Who provides internet service to your home today?

	Number	Percent
AT&T	184	15%
Frontier	43	4%
Consolidated Communications	2	<1%
CASSCOMM	36	3%
Comcast	569	47%
Mediacom	60	5%
Sparklight (Cable One)	24	2%
i3 Broadband	61	5%
Royell Communications	35	3%
PWR-net	2	<1%
Rise Broadband	77	6%
King Street Wireless	1	<1%
ConnectivityU	1	<1%
Starlink	19	1%
Other Satellite	53	4%
Cellular hotspot	31	3%
Fixed cellular	12	1%
Only use my cellphone data	13	1%

4. Are you receiving the speed you are paying for?

	Number	Percent
Yes	367	36%
No	288	29%
I'm not sure	355	35%

5. What Internet speed are you supposed to be getting?

	Number	Percent
1 – 10 Mbps	22	6%
11 – 25 Mbps	47	13%
26 – 50 Mbps	41	12%
51 – 100 Mbps	44	13%
101- 200 Mbps	23	7%
200 + Mbps	172	49%

6. What is the actual download speed you are getting in your home?

	Number	Percent
1 – 10 Mbps	47	13%
11 – 25 Mbps	49	14%
26 – 50 Mbps	35	10%
51 – 100 Mbps	54	15%
101 – 200 Mbps	37	11%
200 + Mbps	128	37%

7. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Provider on the following?

DOWNLOAD SPEED

	Number	Percent
1 Very Dissatisfied	131	13%
2 Dissatisfied	137	14%
3 Neutral	295	30%
4 Satisfied	245	25%
5 Very Satisfied	184	18%

CUSTOMER SERVICE:

	Number	Percent
1 Very Dissatisfied	192	19%
2 Dissatisfied	171	17%
3 Neutral	295	30%
4 Satisfied	180	18%
5 Very Satisfied	154	16%

VALUE I GET COMPARED TO THE PRICE I PAY:

	Number	Percent
1 Very Dissatisfied	247	25%
2 Dissatisfied	227	23%
3 Neutral	282	28%
4 Satisfied	126	13%
5 Very Satisfied	115	11%

RELIABILITY OF YOUR INTERNET SERVICE

	Number	Percent
1 Very Dissatisfied	179	18%
2 Dissatisfied	182	18%
3 Neutral	212	21%
4 Satisfied	249	25%
5 Very Satisfied	174	18%

8. Who is your current cable provider?

	Number	Percent
AT&T	20	2%
Comcast	266	27%
Mediacom	12	1%
Sparklight (Cable One)	5	1%
CASSCOMM	7	1%
i3 Broadband	10	1%
Satellite	250	25%
Watch only online (such as Netflix)	322	32%
Antenna/Over-the-air	50	5%
Do not watch TV	20	2%
Do not have any TV service available	36	3%

9. If you have a telephone landline, who provides your telephone service?

	Number	Percent
AT&T	99	12%
Frontier	30	4%
Consolidated Communications	1	<1%
CASSCOMM	2	<1%
Comcast	85	10%
Mediacom	9	1%
i3 Broadband	7	1%
Rise Broadband	1	<1%
Royell Communications	3	<1%
Voice over Internet Protocol	17	2%
Don’t have a landline	594	70%

10. What do you currently pay for the following?

Bundle

`	Number	Percent
$25 - $50	3	1%
$51 - $75	7	2%
$76 - $100	23	7%
$101 - $125	15	5%
$126 - $150	28	9%
$151 - $200	89	28%
$201 - $250	78	25%
$251+	70	23%

Standalone Cable TV:

	Number	Percent
$1 - $25	2	1%
$26 - $50	2	1%
$51 - $75	13	10%
$76 - $100	19	13%
$101 - $125	30	21%
$126+	77	54%

Standalone Telephone:

	Number	Percent
$1 - $20	14	13%
$21 - $50	26	24%
$51 - $74	16	14%
$75+	54	49%

Standalone Internet:

	Number	Percent
$1 - $25	7	2%
$26 - $50	65	14%
$51 - $75	129	28%
$76 - $100	169	37%
$101 - $125	48	11%
$126+	36	8%

11. What would you consider an affordable price to pay for Internet service?

	Number	Percent
$0 - $25	103	11%
$26 - $50	422	43%
$51 - $75	301	31%
$76 - $100	105	11%
$100 - $150	34	3%
$150+	7	1%

12. In general how do you feel about the idea of a new broadband network in the County?

	Number	Percent
I support the idea	664	66%
I do not support the idea	12	1%
I need more information.	328	33%

13. What are the reasons for your support?

	Number	Percent
More competition	560	88%
Lower prices	493	77%
Faster Speeds	441	69%
Better Customer Service	316	49%
Availability	25	4%
Reliability	9	1%

14. What are the reasons you do not support the new fiber network?

	Number	Percent
Broadband in the county is adequate	3	38%
The County should not be involved in a commercial business	4	50%
The cost of a network	1	12%

15. What factors would influence your decision to move your services to a new network?

	Number	Percent
Faster speeds for the same price	615	64%
Lower price than I pay today	671	70%
Same price but better customer service	241	25%
Availability	28	3%
Reliability	32	3%

16. 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	373	39%
Probably	280	29%
Maybe	251	26%
Probably not	47	5%
Definitely not	2	1%

17. Would you buy a landline telephone service from a new network in the County if they could offer affordable prices?

	Number	Percent
Yes, definitely	80	8%
Probably	64	7%
Maybe	163	17%
Probably not	302	32%
Definitely not	336	36%

18. Do you currently subscribe to cell phone service?

	Number	Percent
Yes	940	99%
No	12	1%

19. Is the cellular coverage at your home adequate?

	Number	Percent
Yes	671	71%
No	273	29%

20. How regularly is the Internet used in your home?

	Number	Percent
Daily – more than a few hours per day	804	85%
Daily – a few hours per day	120	13%
A few days per week	8	1%
Only occasionally	7	1%

21. Does anyone in your family ever work at home using Internet access?

	Number	Percent
Yes, full-time	187	20%
Yes, a few times a week	262	28%
Yes, a few times a month	94	9%
Yes, very occasionally	120	13%
No	287	30%

22. Would you or your family member work from home more if you had faster Internet?

	Number	Percent
Yes	349	38%
No	578	62%

23. Do you have school-age children at home who use the internet to do their homework?

	Number	Percent
Yes	243	26%
No	706	74%

24. If the answer is yes, is your Internet connection good enough to support their homework?

	Number	Percent
Yes	198	64%
No	110	36%

EXHIBIT II: SUMMARY OF FINANCIAL RESULTS

		Year 5 Assets	Take Rate	Loan	Equity	Grant	Total Financing	Year 5 Cash	Year 10 Cash	Year 15 Cash	Year 20 Cash
	Whole Study Area										
1	Base 60%	$43.8 M	60%	$45.7 M	$ 8.1 M		$53.8 M	$ 0.14 M	($11.86 M)	($23.34 M)	($33.89 M)
2	60% Breakeven Grant	$43.8 M	60%	$19.1 M	$ 3.4 M	$24.7 M	$47.1 M	$ 0.16 M	$ 0.12 M	$ 0.61 M	$ 1.83 M
3	50% Penetration	$43.1 M	50%	$45.8 M	$ 8.1 M		$53.9 M	$ 0.15 M	($13.88 M)	($27.43 M)	($40.19 M)
4	50% Penetration Breakeven	$43.1 M	50%	$14.2 M	$2.5 M	$29.2 M	$45.9 M	$ 0.16 M	$ 0.29 M	$ 0.91 M	$ 2.10 M
5	55% Penetration	$43.5 M	55%	$45.8 M	$ 8.1 M		$53.8 M	$ 0.16 M	($12.87 M)	($25.38 M)	($37.03 M)
6	55% Penetration Breakeven	$43.5 M	55%	$16.6 M	$ 2.9 M	$27.0 M	$46.5 M	$ 0.16 M	$ 0.22 M	$ 0.81 M	$ 2.04 M
7	65% Penetration	$44.2 M	65%	$44.2 M	$ 8.1 M		$53.8 M	$ 0.14 M	($10.89 M)	($21.34 M)	($30.78 M)
8	65% Penetration Breakeven	$44.2 M	65%	$21.1 M	$ 3.7 M	$22.9 M	$47.7 M	$ 0.16 M	$ 0.20 M	$ 0.84 M	$ 2.29 M
9	70% Penetration	$44.6 M	70%	$45.8 M	$ 8.1 M		$53.8 M	$ 0.14 M	($ 9.86 M)	($19.30 M)	($27.65 M)
10	70% Penetration Breakeven	$44.6 M	70%	$23.2 M	$ 4.1 M	$20.9 M	$48.2 M	$ 0.14 M	$ 0.24 M	$ 0.92 M	$ 2.52 M
	Based on Line 2										
11	Higher Interest Rate	$43.8 M	60%	$19.5 M	$ 3.4 M	$24.7 M	$47.6 M	$ 0.14 M	($ 0.79 M)	($ 1.18 M)	($ 0.84 M)
12	Lower Interest Rate	$43.8 M	60%	$18.7 M	$ 3.3 M	$24.7 M	$46.6 M	$ 0.16 M	$ 0.95 M	$ 2.28 M	$ 4.32 M
13	15-Year Term	$43.8 M	60%	$20.0 M	$ 3.5 M	$24.7 M	$48.2 M	$ 0.14 M	($ 2.10 M)	($ 3.82 M)	$ 3.07 M
14	25-Year Term	$43.8 M	60%	$18.6 M	$ 3.3 M	$24.7 M	$46.6 M	$ 0.15 M	$ 1.26 M	$ 2.91 M	$ 5.27 M
15	Higher Prices	$43.8 M	60%	$18.8 M	$ 3.3 M	$24.7 M	$46.8 M	$ 0.17 M	$ 1.20 M	$ 2.82 M	$ 5.20 M
16	Lower Prices	$43.8 M	60%	$19.4 M	$ 3.4 M	$24.7 M	$47.5 M	$ 0.15 M	($ 0.90 M)	($ 1.46 M)	($ 1.33 M)
	Open-Access										
17	County	$43.8 M	60%	$21.1 M		$24.7 M	$45.8 M	($ 4.25 M)	($ 8.97 M)	($13.79 M)	($18.35 M)
18	ISPs	$ 0.1 M	60%	$ 1.2 M	$ 0.2 M		$ 1.4 M	$ 0.22 M	$ 1.86 M	$ 4.04 M	$ 6.23 M
	Lease Network										
19	County	$43.7 M	60%	$21.0 M		$24.7 M	$45.7 M	$ 1.73 M	$ 0.51 M	($ 0.90 M)	($ 2.14 M)
20	ISPs	$ 0.2 M	60%	$ 4.9 M	$ 0.7 M		$ 5.7 M	($ 1.15 M)	($ 4.24 M)	($ 3.31 M)	($ 2.10 M)