Regional Broadband Study

Shelby County, Missouri

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Finley Engineering
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EXECUTIVE SUMMARY

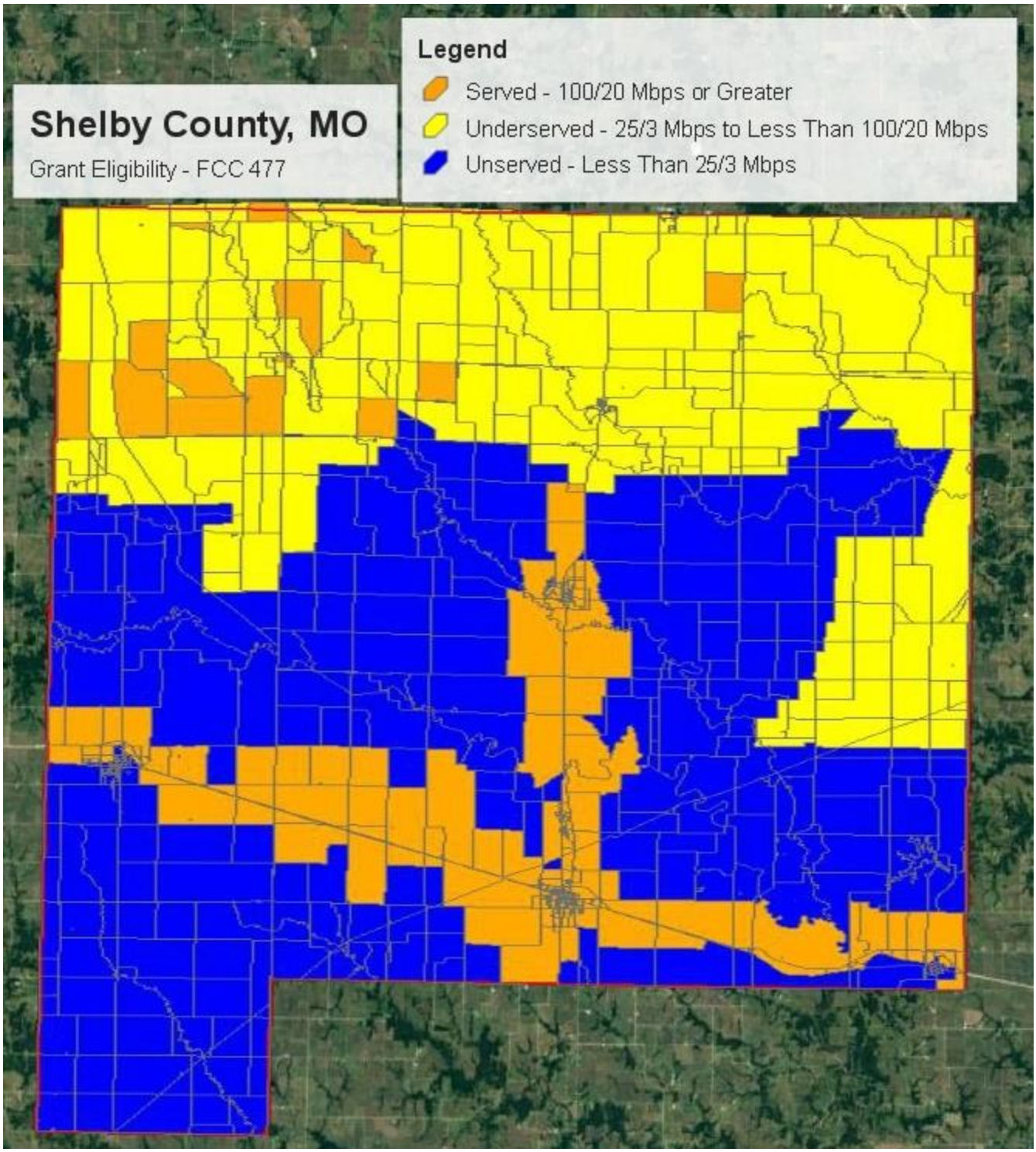
This study was funded by the Mark Twain Regional Council of Governments. The purpose of the study was to provide a detailed analysis of the state of broadband in Shelby County. We believe that this report will provide the raw facts needed for any Internet Service Provider (ISP) that wants to pursue additional broadband grants to upgrade broadband infrastructure in the county. One of the first requirements of any broadband grant is the requirement to show the need for better broadband.

We analyzed the state of broadband in several ways. We started by looking at the speeds that existing ISPs report to the FCC. This is relevant because most grants start with the assumption that the speeds reported to the FCC are accurate.

We then investigated the actual broadband speeds in the county in several ways. We talked to the ISPs about the broadband they offer today and their plans for the future. Our engineers made a physical inspection of broadband technology available in the county to see if it matched what ISPs are reporting to the FCC. We conducted surveys, speed tests, and interviews to understand the broadband experiences of people in the county. We also gathered county GIS mapping data that showed us the location of every home and business in the county. This data enables us to count the number of homes and businesses served by each ISP and technology.

The ultimate goal of this research was to quantify the parts of the county, along with the number of homes and businesses in those areas that are eligible for broadband grants. We started this analysis by looking at the parts of the county that would be considered to be grant-eligible using existing FCC mapping data. When we overlay the GIS household location data over the FCC broadband mapping, anybody considering a grant today would count the possible locations that could be funded as follows. These counts match the first map below, which classifies the county's broadband into three tiers of speed.

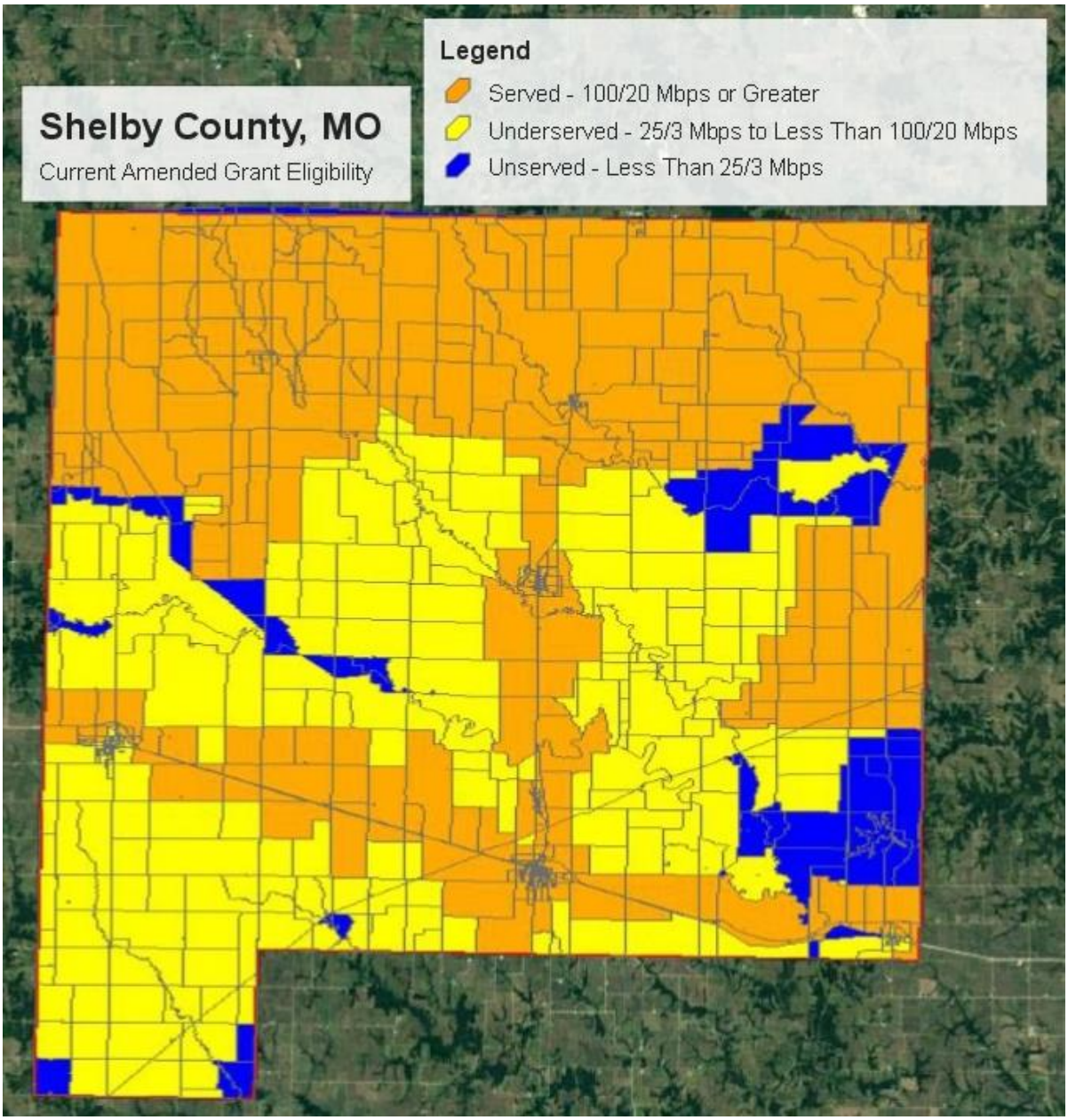
	Speeds	Passings
Unserved	Less than 25/3 Mbps	1,225
Underserved	From 25/3 Mbps to 100/20 Mbps	767
Served	100/20 Mbps or faster	1,677
Total		3,669



However, there has already been a lot of activity undertaken by ISPs to bring faster broadband. Several local ISPs have won broadband grants. A few others have been provided with long-term federal subsidies that are helping them to build faster broadband. One of the biggest changes in looking at grant eligibility today is recent. The NTIA recently defined fixed wireless technology that uses licensed spectrum to be considered as broadband if the speeds are fast enough. This would mean, for example, that a fixed wireless

connection of at least 100/20 Mbps would be considered as served and could not be overbuilt with a federal broadband grant. All of these changes modify the traditional grant-eligible areas significant and result in the revised count of passings and the second map below.

	Speeds	Passings
Unserved	Less than 25/3 Mbps	0
Underserved	From 25/3 Mbps to 100/20 Mbps	784
Served	100/20 Mbps or faster	2,885
Total		3,669



The biggest change between the two maps is that there are already grants or upgrades on the way that will bring faster broadband to the unserved areas. But there are still 784 households and businesses in the county that have broadband speeds between 25/3 Mbps and 100/20 Mbps that are eligible under today's grant rules for broadband grants.

One of our most interesting findings is that people in the county do not seem to know that better broadband is coming. Perhaps one the most beneficial things the County could do is to work with the existing ISPs to get the word out that areas with poor broadband will be getting upgrades over the next few years.

I. Existing ISPs

There are a number of ISPs operating in Shelby County today. The following is a short description of each ISP, along with the broadband products and prices each offers in the county today.

Telephone Companies

CenturyLink[1] is the third-largest telephone company in the country, with headquarters in Shelby, Louisiana. Several years ago, the company purchased Qwest, which was formerly Mountain Bell and US West, and was part of the Bell Telephone system. At the end of the fourth quarter of 2021, the company had 4,519,000 broadband customers. The company has a small number of cable TV customers but announced in 2020 that it is phasing out of that business line. For most of the areas it serves, the company bundles with DirecTV.

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

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

The big news for CenturyLink is that it is selling its business in Missouri and nineteen other states to Apollo Global Management, a private equity firm. The sale is for $7.5 billion for what is described as seven million passings. All but 200,000 fiber passings are served by telephone copper.

The new company will almost certainly spin off from Apollo as a new corporation. The new business will be marketing under the name Brightspeed. The new management team is led by veterans who helped to build Verizon's FiOS business, including Bob Mudge, Chris Creager, and Tom McGuire. Brightspeed says it has plans to aggressively build fiber, but only time will tell if that includes rural counties like yours. There is a lot of speculation that most of the fiber will be built in county seats and larger cities. However, the company might aggressively pursue the upcoming federal grants for rural areas. The sale is not expected to be approved by regulators until the third or fourth quarter of this year.

CenturyLink DSL

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

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

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

Residential DSL

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

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

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

CenturyLink Business DSL

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

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

Telephone Rates

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

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

These rates do not include the Subscriber Line Charge, which is currently $6.50 for both a business and a residential line and would be added to the above rates. The rates also do not include the

Access Recovery Fee (ARC), which is an FCC fee that is currently capped at $1 per month, and CenturyLink could be charging any amount up to and including the $1 rate.

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

Chariton Valley Telephone Cooperative was founded in 1952 and is headquartered in Macon, Missouri. Historically Chariton Valley has provided DSL service to its 18 telephone exchanges located throughout northeast Missouri. In 2017, the company began upgrading all of its telephone exchanges to fiber with an investment of approximately $42 million. The company provides service in the northeast corner and expects to complete a fiber upgrade in 2023.

Residential Fiber	
100/100 Mbps	$ 47
500/500 Mbps	$ 67
1000/1000 Mbps	$ 97

Television	
Basic Service	$ 78
Standard Service	$108
4 Streams	$ 5
6 Streams	$ 7
8 Streams	$ 10
Cloud DVR	$ 12
HBO	$ 17.99
Cinemax	$ 12.99
Starz/Encore	$ 12.99
Showtime	$ 10.99

Telephone	
Basic	$ 20
Premium	$ 30

Mark Twain Rural Telephone Company is headquartered in Hurdland, Missouri and was formed in 1952. MTRC provides telephone and broadband service in 14 exchanges, covering 1,031 square miles and 10 counties in Missouri. The company is the incumbent telephone company in the northern part of the county. Mark Twain Rural Telephone Company provides DSL broadband in the county but has started the process of upgrading all customers to fiber.

Residential DSL Internet	
10/1 Mbps	$44.95
15/1 Mbps	$54.95
25/3 Mbps	$64.95

50/5 Mbps	$74.95
Installation (modem included)	$65.00

The company does not advertise business DSL prices.

Fiber Internet

Plans start at	$49.95
Installation (modem included)	$65.00

Customers must contact the company for pricing and speed quotes.

Business Fiber

Plans start at	$99.95
Installation (modem included)	$65.00

Customers must contact the company for pricing and speed quotes.

Fiber Overbuilders

Chariton Valley Communications is the competitive arm of Chariton Valley Telephone Cooperative and provides fiber outside of the historic telephone exchanges. In Shelby County, it provides service in the northwest corner.

Residential Fiber

100/100 Mbps	$ 47
500/500 Mbps	$ 67
1000/1000 Mbps	$ 97

Television

Basic Service	$ 78
Standard Service	$108
4 Streams	$ 5
6 Streams	$ 7
8 Streams	$ 10
Cloud DVR	$ 12
HBO	$ 17.99
Cinemax	$ 12.99
Starz/Encore	$ 12.99
Showtime	$ 10.99

Telephone

Basic	$20
Premium	$30

Cable Companies

Charter Communications (Spectrum)[2] is the second-largest cable TV company in the country, with over 28.1 million broadband customers and 15.2 million cable TV customers at the end of the fourth quarter of 2021. Charter/Spectrum had revenues of $51.6 billion in 2021. The company reached its current size after its 2016 acquisitions of Time Warner Cable and Bright House Networks. The company has rebranded its triple-play products as "Spectrum."

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

Charter/Spectrum says it has upgraded all systems nationwide to a new technical standard DOCSIS 3.1. This technology from CableLabs allows the bonding of an unlimited number of spare channel slots for broadband. This will allow the company to increase data speeds and market a gigabit data product. A gigabit data path requires 24 channels on a cable network using the new DOCSIS protocol.

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

Broadband Pricing

While Charter/Spectrum is a giant company, its broadband pricing structure is one of the simplest in the country. The company currently has only a few broadband products. As mentioned above, the base product ranges in speeds in various markets between 50 Mbps and 200 Mbps. It now markets a gigabit product in most markets.

	Speed	Price
Spectrum Internet	Up to 50 Mbps	$ 59.99
Spectrum Internet	Up to 200 Mbps	$ 74.99
Spectrum Internet Ultra	Up to 400 Mbps	$ 94.99
Spectrum Internet Gig	Up to 940 Mbps	$114.99
Activation Fee		$ 49.99
WiFi Router (optional)		$ 9.99

The company gives a $10 discount when bundling with other products, although this can be negotiated. Charter/Spectrum has raised rates twice within the last year. Note that the basic and bundled Internet prices above increased by $5 at the beginning of 2022.

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

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

Telephone Pricing

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

Fixed Wireless Companies

Mark Twain Communications is a subsidiary of Mark Twain Rural Telephone Company that provides fixed wireless broadband outside of the telephone company boundaries.

Residential Fixed Wireless	
5 Mbps / 512 Kbps	$ 49.95
10/1 Mbps	$ 59.95
20/2 Mbps	$ 69.95
30/3 Mbps	$ 79.95

Business Fixed Wireless	
5/1 Mbps	$ 99.95
10/2 Mbps	$109.95
15/3 Mbps	$119.95
25/5 Mbps	$129.95

For Both	
Installation (no contract)	$250.00
Installation (1-year contract)	$150.00
Installation (2-year contract)	$100.00
Modem included in installation	

Fixed Cellular Data

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

In addition to the three primary cellular carriers, Shelby County is also served by U.S. Cellular.

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

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

U.S. Cellular was founded in 1983 by TDS and is headquartered in Chicago, IL. The company is the fourth-largest cellular provider, with a little less than five million customers at the end of the fourth quarter of 2021. The fixed cellular products are sold by the amount of data provided rather than speeds.

Residential Internet

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

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

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

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

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

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

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

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

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

Satellite Broadband

There are two geostationary satellite broadband providers available across the county. Both Viasat and HughesNet use satellites that are parked in 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 can be seen by the pricing below, monthly data caps range from 10 gigabytes to 150 gigabytes. To put those data caps into perspective, OpenVault announced recently that the average U.S. home used 536 gigabytes of data per month in the fourth quarter of 2021, up from 434 gigabytes of data per month in the second quarter of 2021, up from 380 gigabytes

in 2020 and 344 gigabytes in 2019. The small data caps on satellite broadband make it impractical to use for a household with school students or for a household that wants to use broadband to work from home.

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

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

	Price	Speed	Data Cap
Unlimited Bronze	$ 84.99	12 Mbps	40 GB
Unlimited Silver	$119.99	25 Mbps	60 GB
Unlimited Gold	$169.99	100 Mbps	100 GB
Unlimited Platinum	$249.99	100 Mbps	150 GB
Equipment Fee	$ 12.99		

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

HughesNet is the oldest satellite provider. They have recently upgraded their satellites and now offer speeds advertised as 25 Mbps download and 3 Mbps upload for all customers. Prices vary according to the size of the monthly data cap. These packages are severely throttled after meeting the data caps. The packages are as follows:

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

Low Orbit 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 is 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 – a great upgrade for customers using rural DSL or fixed wireless broadband. These are not competitive prices or speeds in the city.

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

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.

II. THE MAPPING STORY

The easiest way to visualize the current state of broadband in a 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 out of date or inaccurate. CCG Consulting and Finley Engineering have together created maps that we think portray the real state of broadband in the county.

The primary source of broadband data comes from the Federal Communications Commission (FCC). This section of the report will begin with the broadband data as reported to FCC. We'll then modify the FCC maps to layer on known corrections and updates. The final map (included in the Executive Summary) shows the parts of the county that should be eligible for future broadband grants.

A. The FCC Defines Broadband

Any analysis of the availability of broadband begins with broadband data collected by the FCC. The FCC has been tasked by Congress to report every year on the state of broadband in the country. That responsibility has prompted the agency to take two important steps, which will be discussed below. First, the FCC felt compelled to create a definition of broadband – otherwise, the agency couldn't report 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 Shelby 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. 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.[3] In these reports, the FCC compiles data about broadband speeds and availability and offers an opinion on the state of broadband in the country. In every report to date, the FCC has acknowledged that there are broadband gaps of various kinds, but the FCC has never determined that the problems are so bad that they need to take extraordinary measures to close any broadband gaps. Most recent FCC reports have acknowledged that there are broadband gaps but claim that the broadband situation is improving due to actions taken by the FCC. As you will see in the following report, the annual reports to Congress are largely fictional and don't describe the state of broadband in places like Shelby County.

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

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

The FCC Measures Broadband Speeds

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

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

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

Unfortunately, the FCC rules mean that the fastest speed available to one customer in a Census Block is considered to be available to all customers. For example, if an ISP has one customer in the corner of a

[3] 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.

Census Block that can buy 100 Mbps broadband, then the FCC interprets that result to mean that every customer in that Census Block can get that same 100 Mbps speed.

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

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

The FCC doesn't monitor what is reported and has allowed big reporting errors 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 they had deployed fiber to 62 million residents in New York. Even after the FCC required the effort to be corrected, it still drew the same conclusion that broadband was getting better, even though the revised report showed millions of fewer homes with good broadband. This raises a question about what defines "reasonable and timely deployment of broadband" if having fiber to 62 million fewer people doesn't change the answer.

All these factors taken together mean that the FCC broadband databases and maps are dismal. The broadband speeds in towns might be reported correctly, although the speeds reported sometimes reflect 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 Shelby County.

FCC to Revise Maps

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

As often happens in the government, this bill didn't provide any funding to make the needed changes. The FCC started the process of formulating new rules around the Act but didn't take any action to fix the maps due to lack of funding. Congress finally provided $98 million in funding from the American Rescue Plan Act (ARPA) in December 2020, which included $65 million to create better maps. The new updated FCC maps are expected to be issued by around 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 launch sometime in 2023.

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

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

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

Consequences of Inaccurate FCC Maps

Unfortunately, the speeds reported by the FCC maps have real-life implications. For example, the FCC constantly cites the statistics from the broadband mapping system when developing various policies or making decisions that impact rural broadband. The FCC is fully aware of the inadequacies of their mapping data, and yet they still cite their own faulty data as proof that broadband isn't as bad in rural America as critics might suggest. The biggest impact of poor FCC mapping is that the FCC maps are used to define where federal broadband grants can or cannot be awarded. Areas with overstated speeds in the FCC maps can be excluded from being eligible for federal grant money. In Shelby County, we think that many of the speeds claimed by CenturyLink are overstated. We also think the FCC maps exaggerate the Charter coverage and exclude homes that are close to the cities from being eligible for grant funding.

B. FCC 477 Data In Shelby County

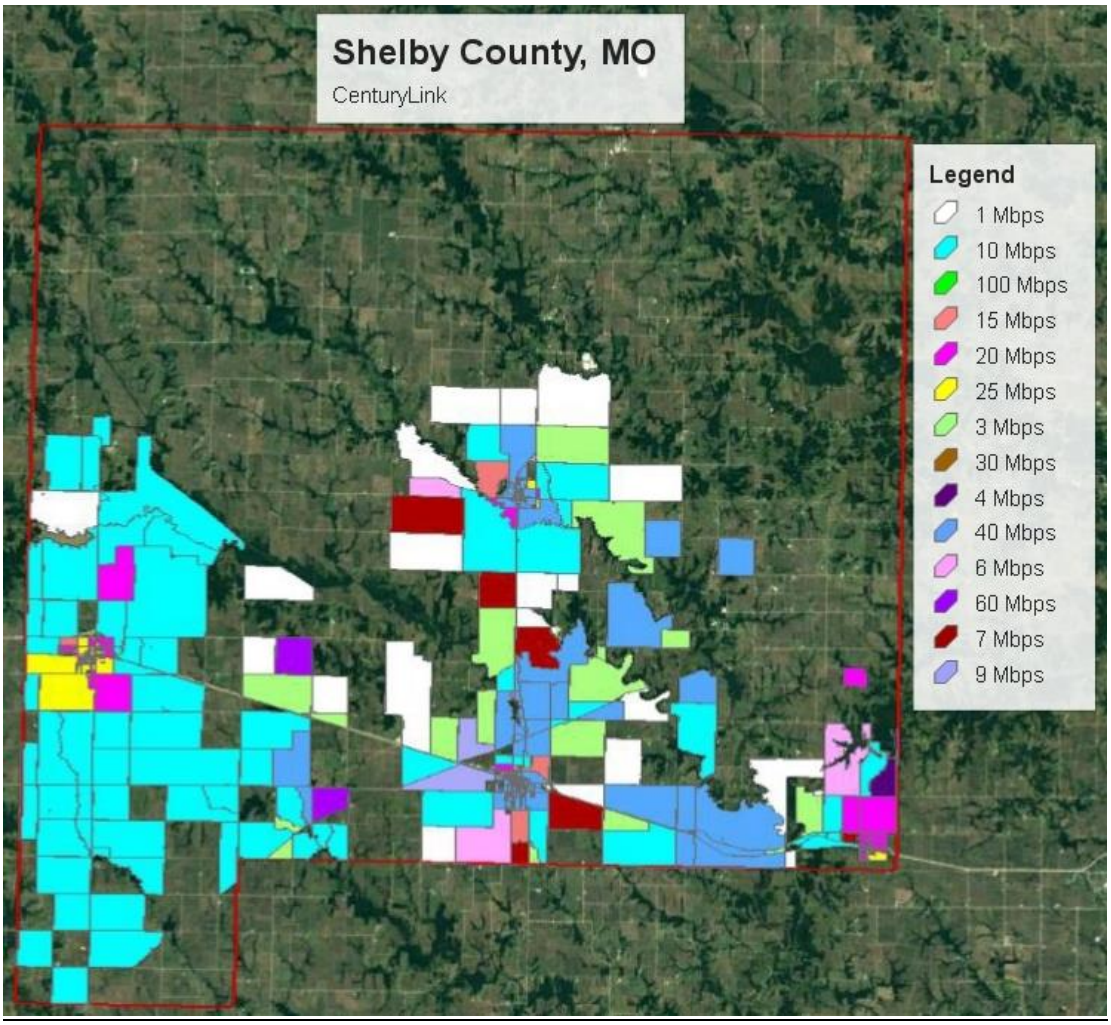
Even with the many faults, there is still some good information in the FCC broadband data. If nothing else, the FCC 477 maps are a starting point for trying to define the ISPs that serve any given area and the speeds they claim to be providing.

Map 1 - CenturyLink

The map below shows the broadband data reported by CenturyLink to the FCC in the Form 477 process. As the incumbent telephone company in the central and southeastern parts of Shelby County, the company provides DSL technology on copper telephone wires. CenturyLink claims to provide speeds between 1 and 1000 Mbps.

Our field review shows that it is not likely that there are many customers who can get DSL speeds over 25 Mbps. They do exist, but not throughout all of the areas shown as covered in the maps below. This is typical of mapping issues we see with most of the large telephone companies. CenturyLink is reporting marketing speeds and not actual speeds – something that is allowed in the FCC mapping process. The company might be providing speeds over 25/3 to a few customers, but the FCC mapping shows whole Census blocks getting the fast speeds. We think the CenturyLink coverage is exaggerated and is not as fast as shown.

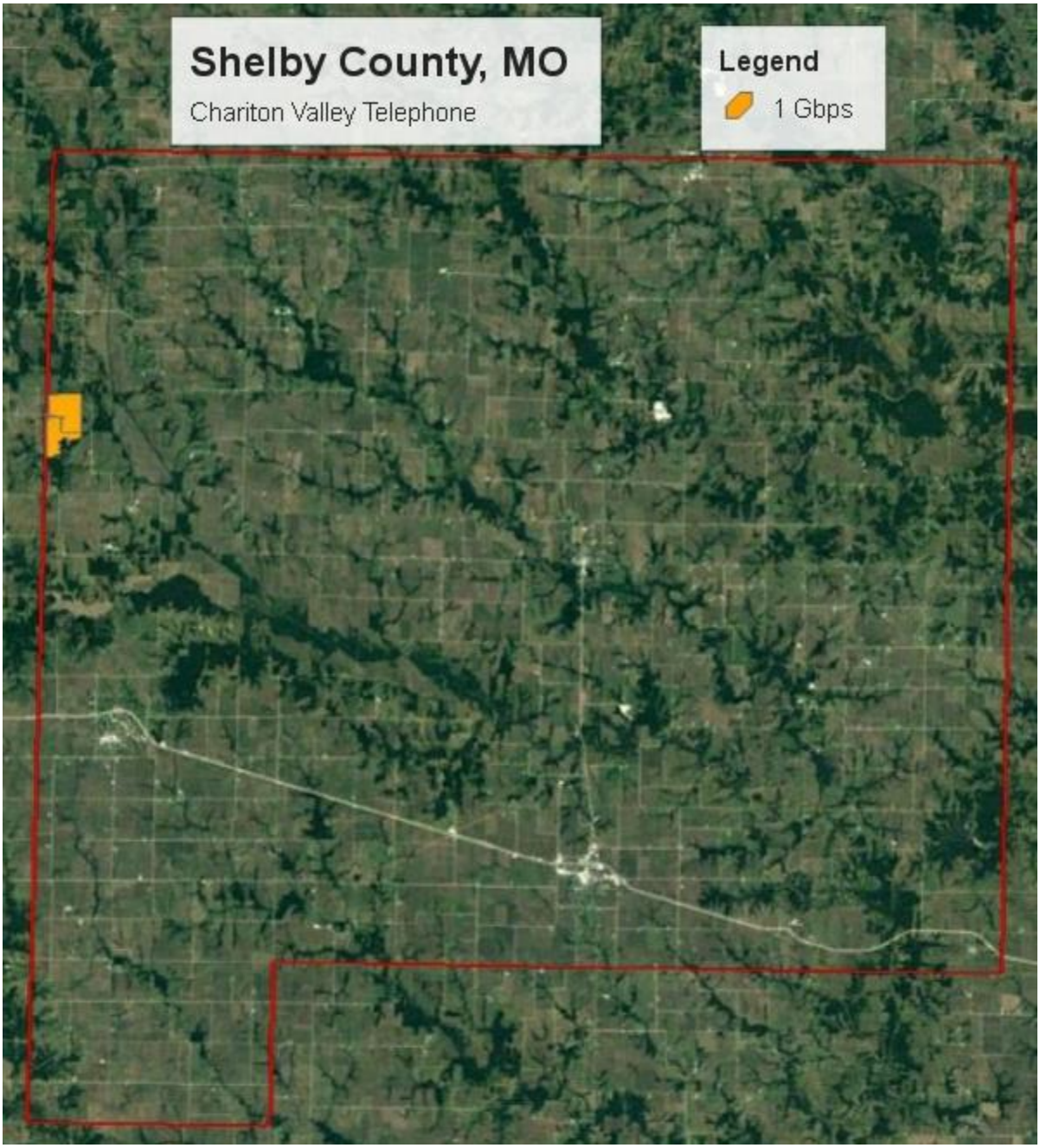
Map 1 – CenturyLink FCC 477 Data



Chariton Valley Telephone

The map below shows the broadband speeds reported by Chariton Valley Telephone Company to the FCC in the Form 477 reporting process. Chariton Valley Telephone offers 1 Gbps to two census blocks on its fiber network in the western part of the county.

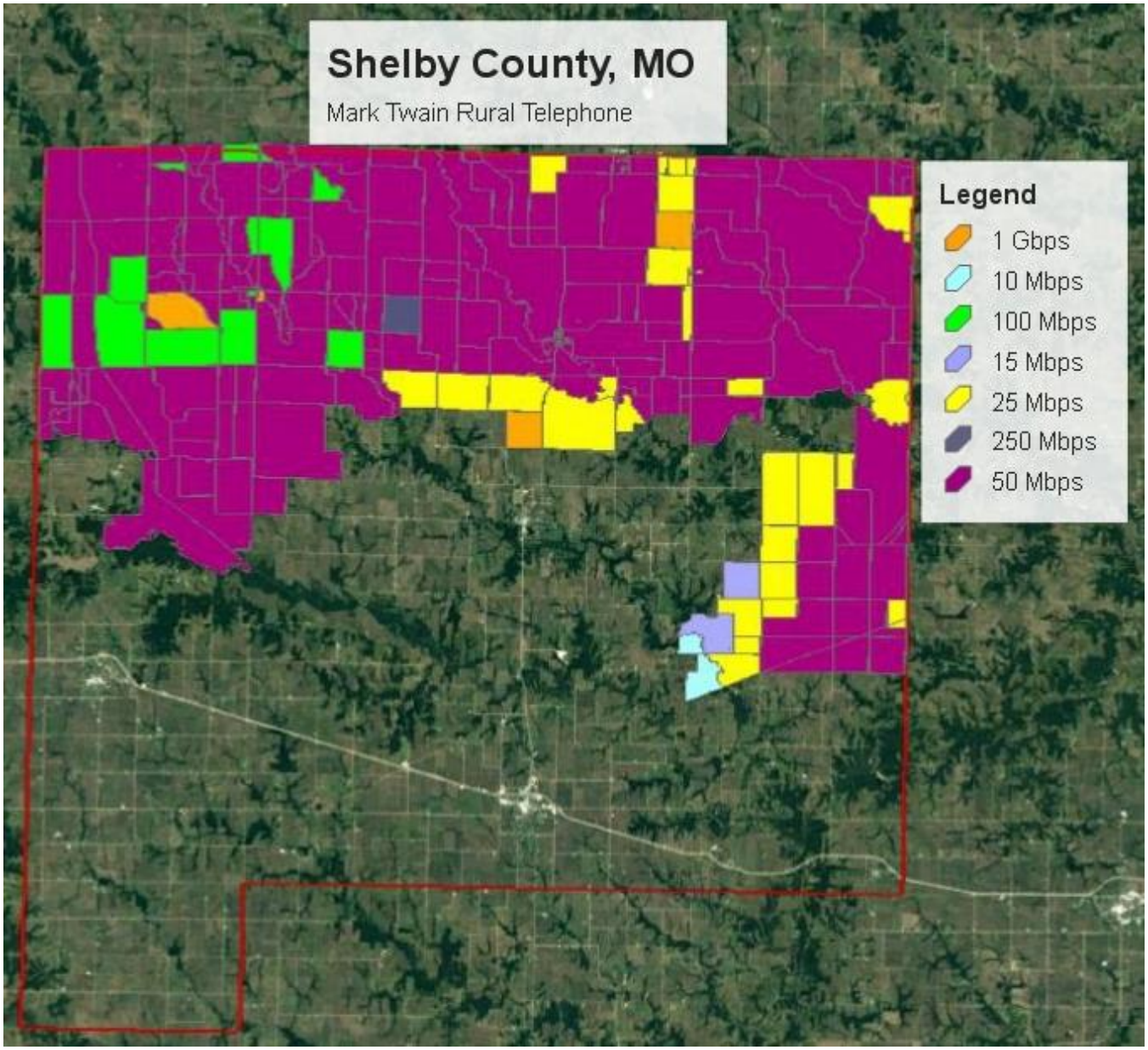
Map 2 – Chariton Valley Telephone FCC 477 Data



Mark Twain Rural Telephone

Mark Twain Rural Telephone Company is a DSL provider operating in northern Shelby County. The map below shows the latest broadband reporting by Mark Twain to the FCC in the Form 477 process. The company still offers DSL in most of its serving areas, but as can be seen by the orange areas on the map, the company has started the process of upgrading to fiber. The company plans to upgrade the entire historic telephone serving areas to fiber.

Map 3 – Mark Twain Rural Telephone FCC 477 Data

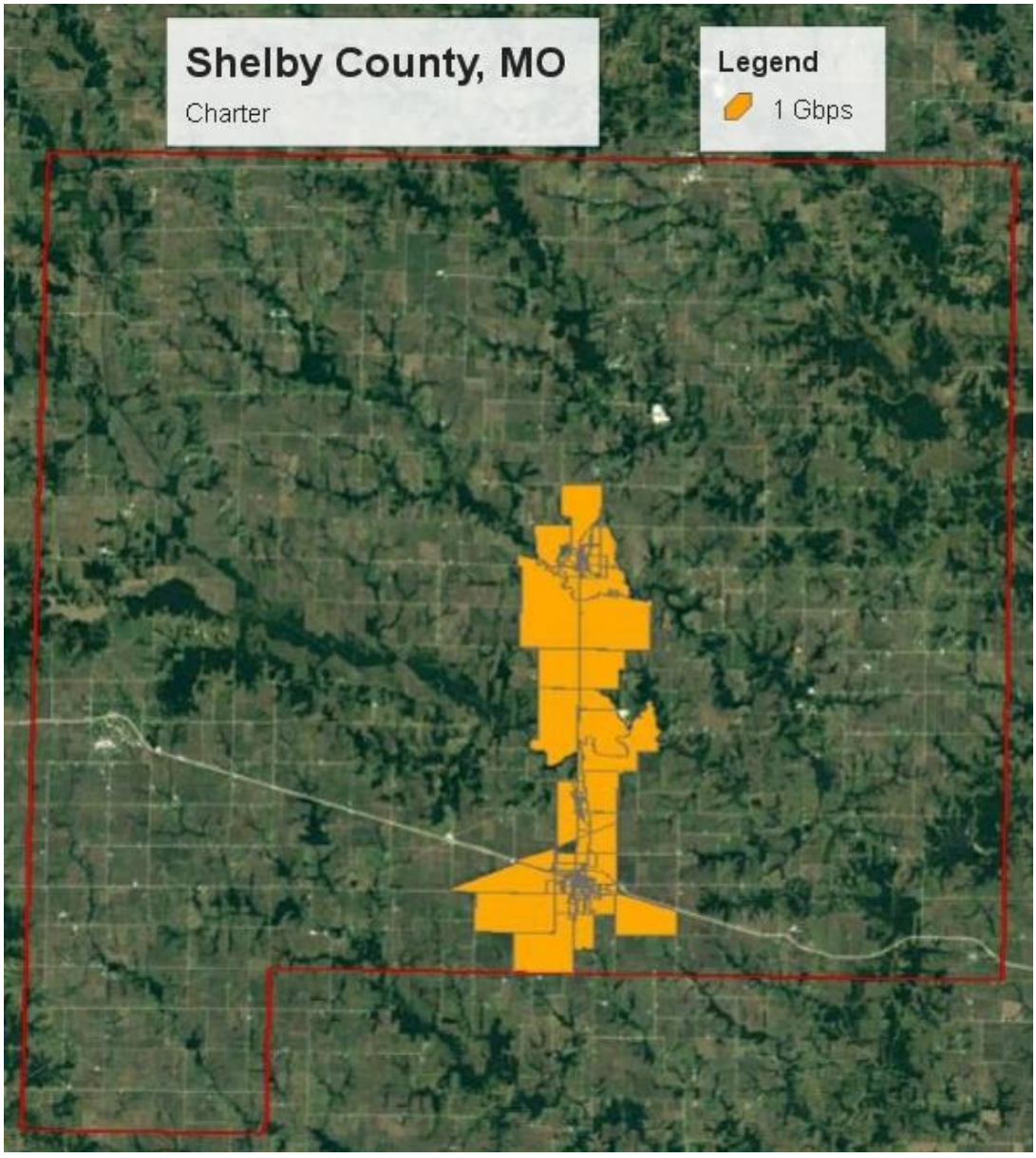


Charter/Spectrum

Following is the broadband reporting made by Charter to the FCC in the Form 477 process. Charter is the incumbent cable company in the county. Charter primarily serves the cities of Shelbyville and Shelbina. According to the FCC 477 data, Charter reports a speed capability of up to 1 Gbps across its entire service area.

The border areas around the edge of the Charter coverage area are exaggerated. The FCC reporting rules show Charter serving entire Census blocks where it may only have a few customers. It is likely that Charter only provides service within the cities, and the Census blocks surrounding the cities exaggerate the total coverage of Charter.

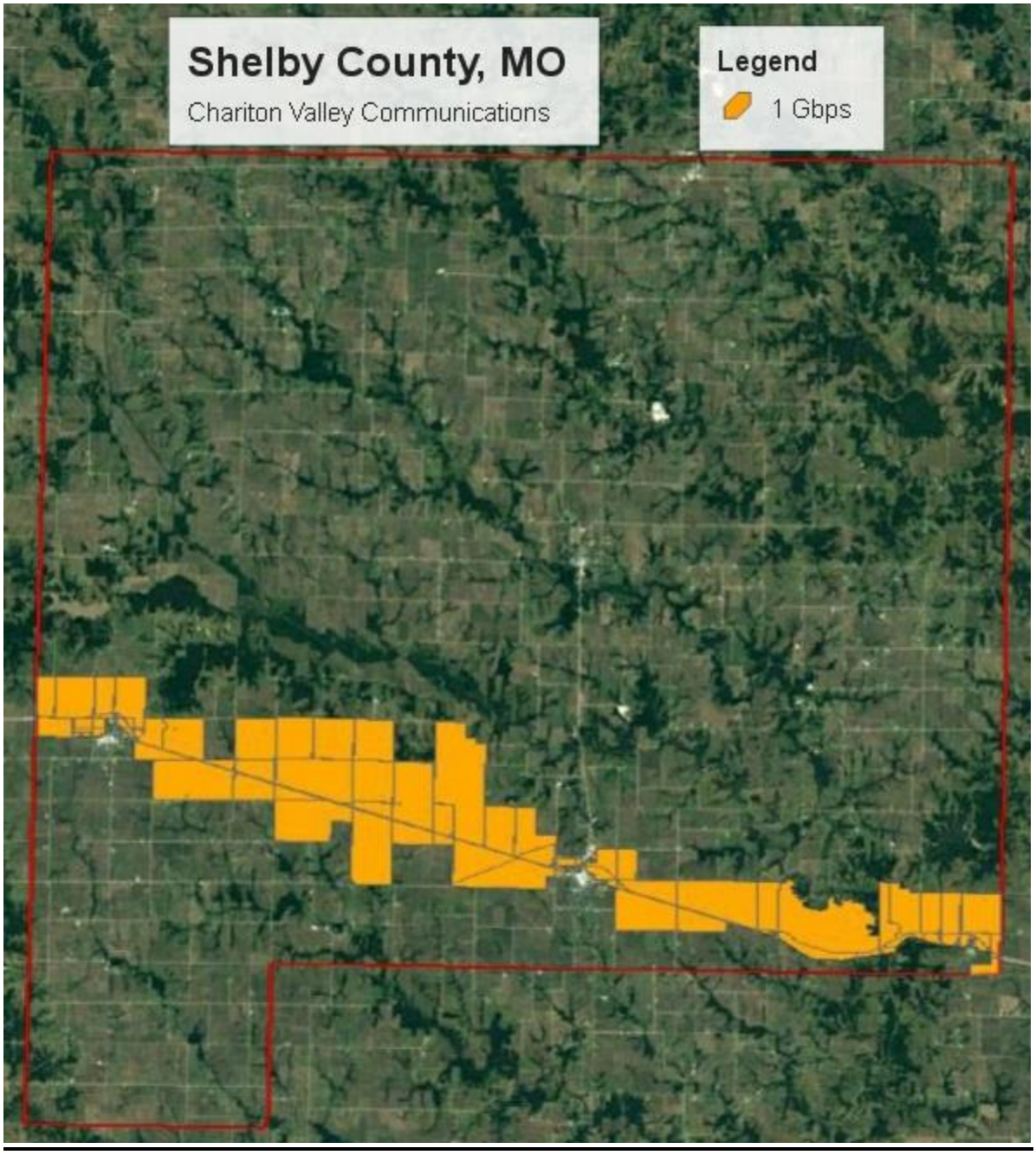
Map 4 – Charter FCC 477 Data



Chariton Valley Communications

The following map shows the broadband reporting by Chariton Valley Communications to the FCC in the Form 477 process. Chariton Valley Communications is the competitive arm of Chariton Valley Telephone and builds fiber outside of the historic telephone exchanges. In the most recent FCC 477 reporting, Chariton Valley Communications claims to provide 1 Gbps on its fiber network in the southern part of the county.

Map 5 – Chariton Valley Communications FCC 477 Data

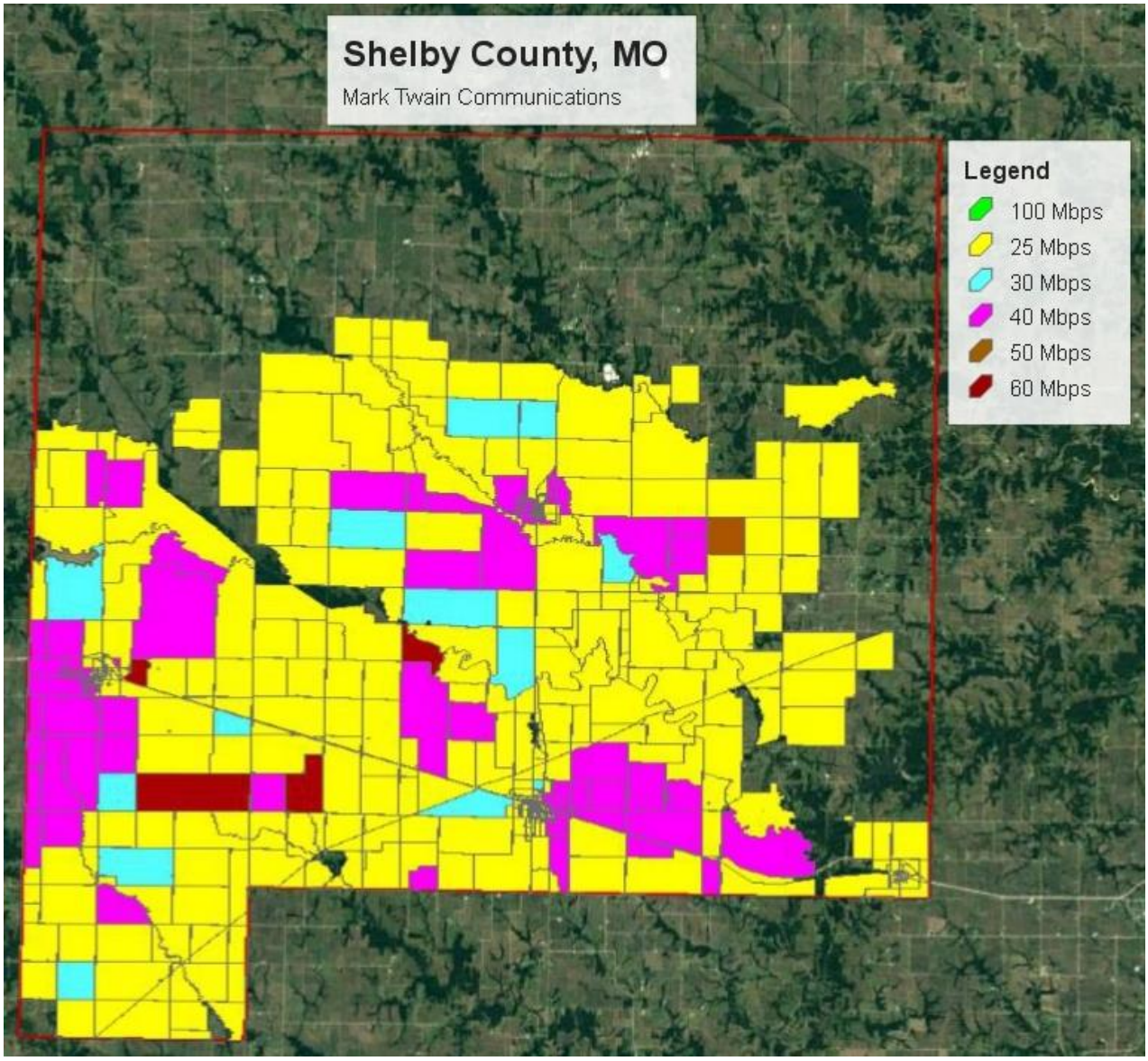


Mark Twain Communications

The map below shows the latest broadband reporting by Mark Twain Communications to the FCC in the Form 477 process. Mark Twain Communications is the competitive arm of the Mark Twain Rural Telephone Company and reports broadband coverage separately from the telephone company. The company provides fixed wireless broadband in the central and southern parts of the county using licensed spectrum.

The map uses different colors to show the different speed tiers the company reports to the FCC. Mark Twain Communications provides multiple speeds in Shelby County: 25 Mbps, 30 Mbps, 40 Mbps, 50 Mbps, 60 Mbps, and 100 Mbps.

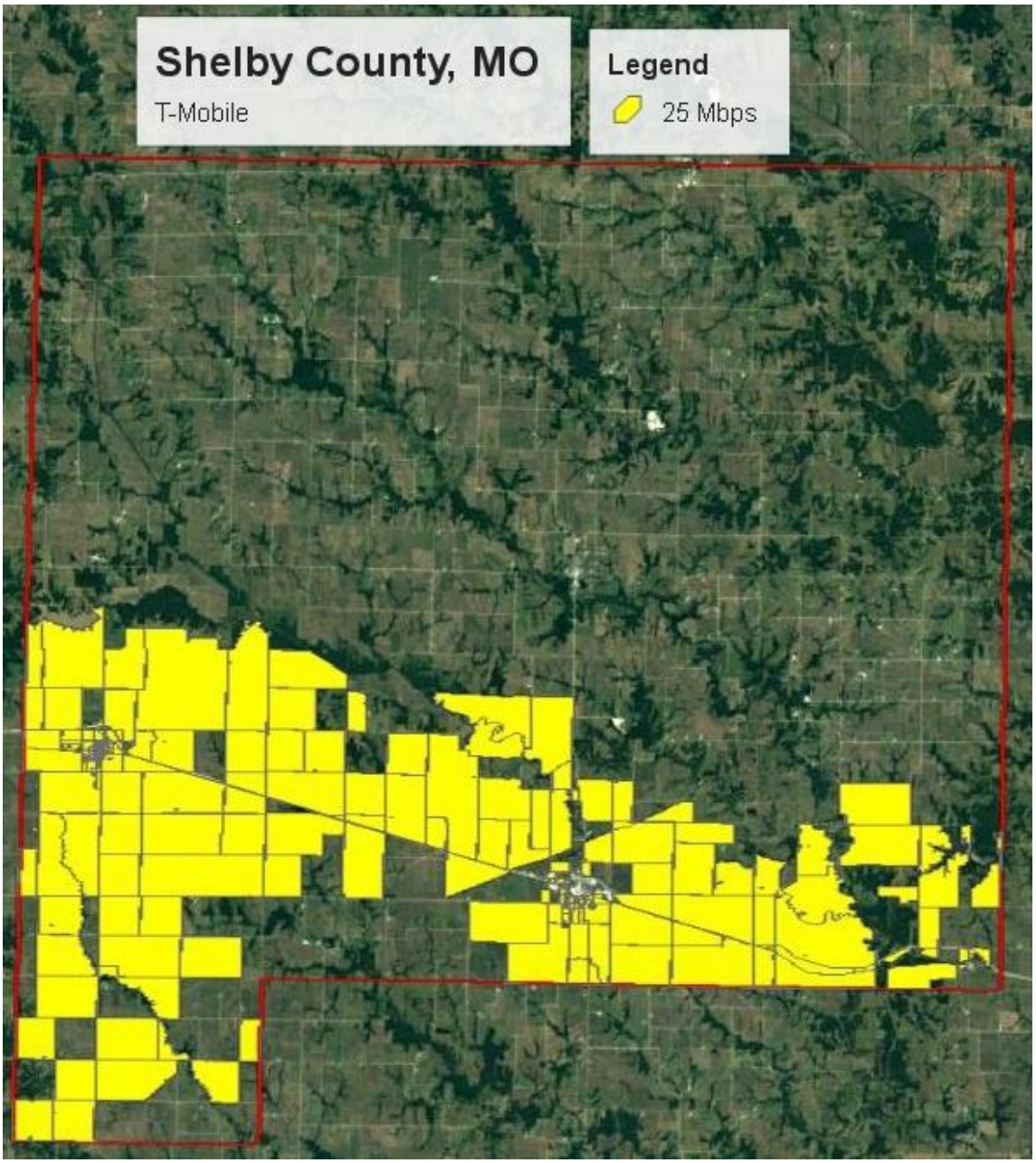
Map 6 – Mark Twain Communications FCC 477 Data



T-Mobile

T-Mobile reports coverage of the southern portion of the county using its 5G, 4G LTE or 3G EVDO cellular spectrum. The company sells a fixed home broadband connection. While this uses the same cell towers as cellular broadband for cellphones, the technology used to receive the broadband signal is different. According to the FCC 477 data, T-Mobile is reporting speeds of 25 Mbps. It's likely that these speeds are not available everywhere since there are places in the county with poor cellular coverage. We've heard that T-Mobile 5G speeds have improved to over 100 Mbps in some parts of the country.

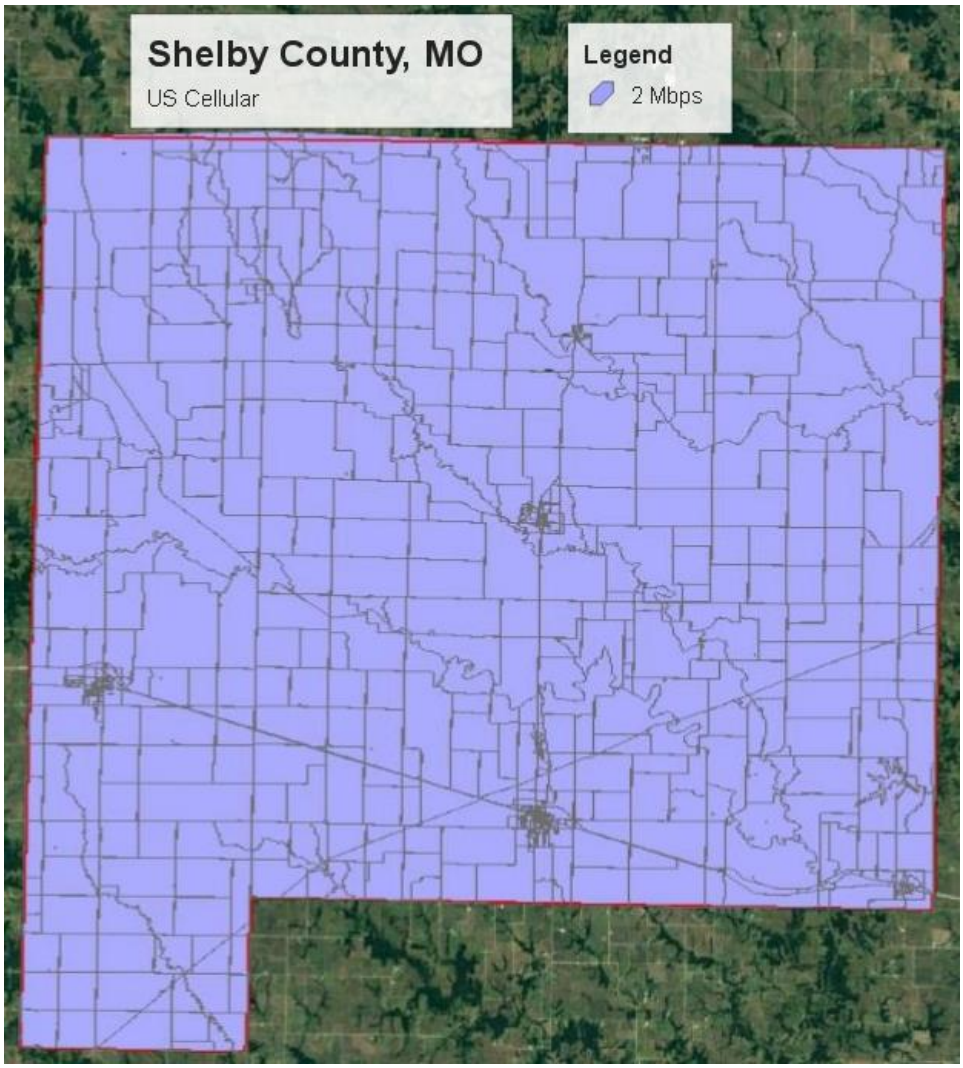
Map 7 – T-Mobile FCC 477 Data



U.S. Cellular

U.S. Cellular claims coverage for the entire county with broadband using its 4G LTE or 3G EVDO cellular spectrum. The company sells a fixed home broadband connection. While this uses the same cell towers as cellular broadband for cellphones, the technology used to receive the broadband signal is different. According to the FCC 477 data, U.S. Cellular is reporting speeds of 2 Mbps for the entire county. It's likely that these speeds are not available everywhere since there are likely places in the county with poor cellular coverage.

Map 8 – U.S. Cellular FCC 477 Data

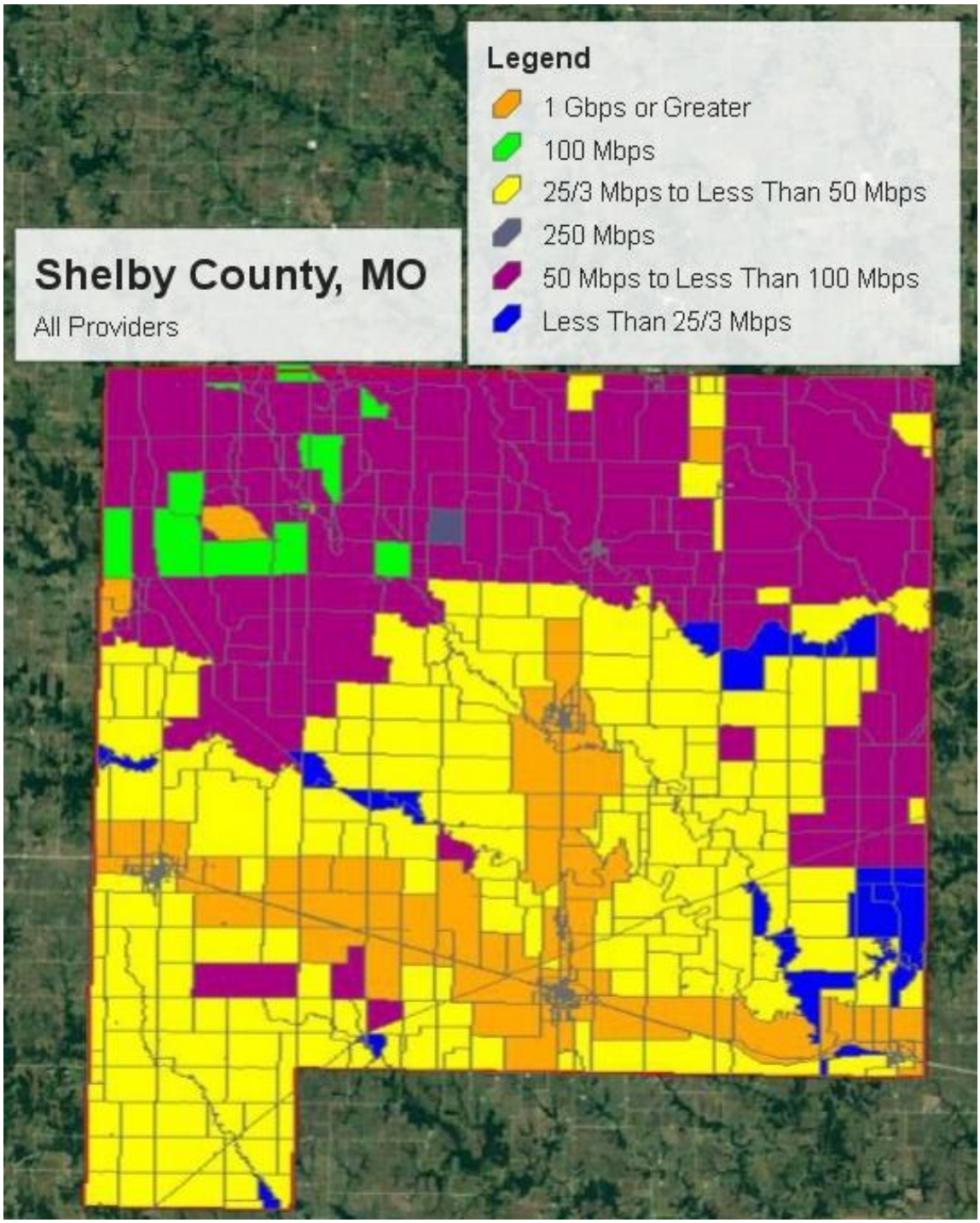


Composite FCC Maps

The following map shows the fastest broadband speed that is reported for each Census Block in the county. If this map was accurate, the only areas where customers can't buy 25/3 Mbps broadband are the areas shown in blue. This is an important map because it is a visual summary of what the FCC is telling Congress

– that almost the entire county has access to broadband faster than 25/3 Mbps – something that we know to not be true.

Map 9 – Composite of all FCC 477 Broadband Reporting



Updating the Landline Broadband Map

There are a number of changes that must be made to Map 10 to properly show the state of landline broadband.

Edge Distortions. The map includes distortions along the edges of the ISP service areas. This is true around the areas served by Charter and Chariton Valley Communications, but also the areas served by CenturyLink and Mark Twain Rural Telephone. The reason for this is simple – the service areas of the various ISPs don't follow or match up with Census block boundaries. This means that most Census blocks along a border of two ISPs have many Census blocks that have some customers from both ISPs. Map 10 should be corrected to remove FCC broadband coverage that doesn't exist.

Known Upgrades. We know of upgrades to broadband coming due to federal and subsidy awards. These upgrades are either underway or will be coming in the next few years. Map 10 should be upgraded to reflect the following:

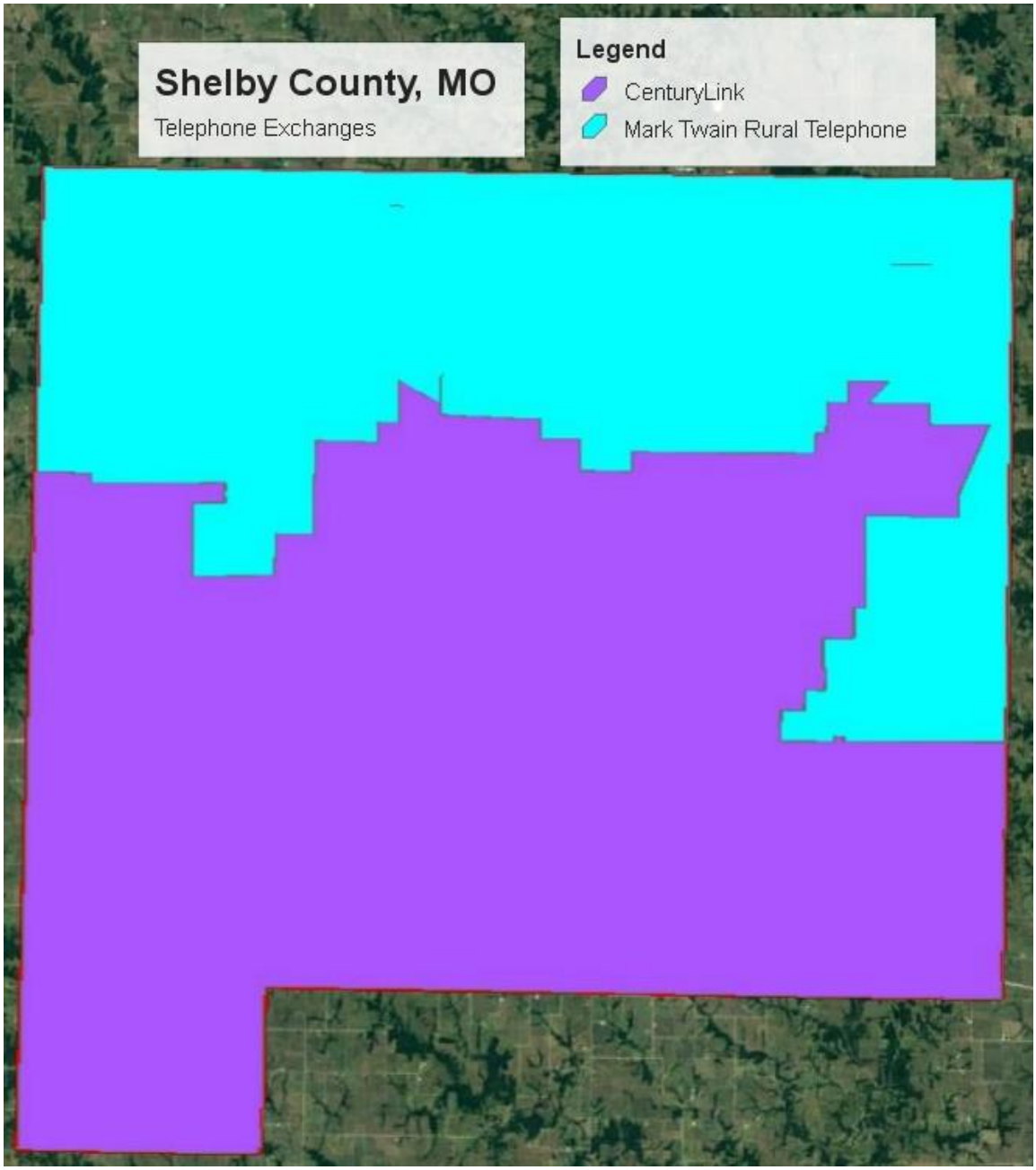
- Mark Twain Rural Telephone has received federal ACAM funding to build fiber in its entire service area on the north and east sides of the county.
- Chariton Valley Communications has won CAF II funding to bring fiber to a single census block in southern Shelby County.

Possible Upgrades. In early 2022 Chariton Valley Communications was awarded funding from the NTIA Broadband Grant Program to build fiber in and around the City of Clarence. As of the date of writing this report, the NTIA has not authorized the funds.

Telephone Company Exchange Boundaries.

The incumbent telephone companies in the county are Mark Twain Rural Telephone and CenturyLink. The map below shows the historical monopoly boundaries for each telephone company. These boundaries were formally recognized by the Missouri Public Service Commission and each telephone company was given monopoly status within the borders shown on the map.

Map 10 – Telephone Exchange Boundaries



Grants and Upgrades

Following are maps that show where grants have already been awarded to provide faster broadband.

ACAM Program. The ACAM program is a subsidy program created by the FCC to assist rural telephone companies like Mark Twain Rural to upgrade rural broadband. Telephone companies had several options

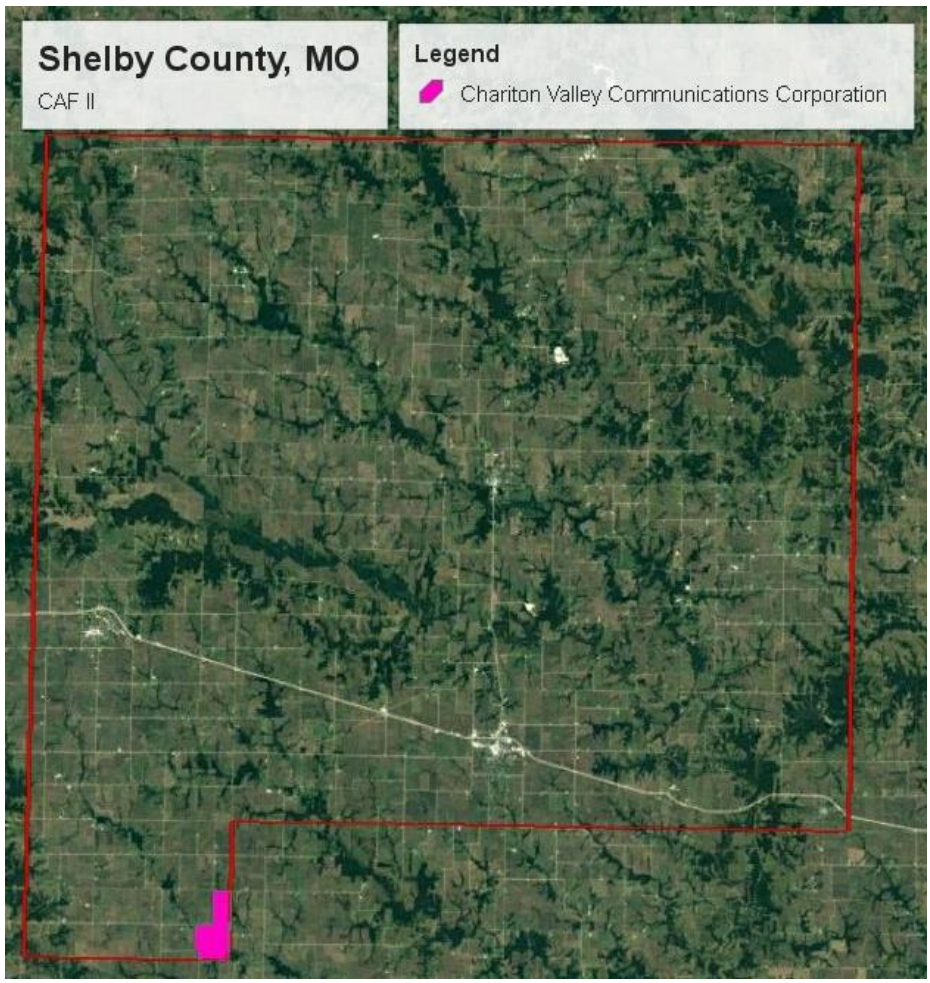
on how to collect these subsidies. The FCC subsidies are flowing to the telephone companies over ten years, starting in 2017 and ending in 2026.

The ACAM program expects the telephone companies to use the funding to improve broadband speeds in rural areas to speeds of at least 25/3 Mbps. However, many telephone companies, including Mark Twain elected to use this subsidy to borrow the money to upgrade from telephone copper to fiber. Telephone companies have until 2026 to complete any planned upgrades, but there are completion deadlines for some portion of completion for each year starting in 2022. Many small companies, including the one in this county, are upgrading faster than the FCC upgrade schedule.

CAF II Reverse Auction

In August of 2018, the FCC held a reverse auction to award broadband funding to some of the most rural places in America. In that auction, Chariton Valley Communications, a fiber provider, won $41,545 in Shelby County to be collected over ten years for bringing broadband to 6 rural homes in the county. That's an award of $6,924 per home. The areas won by Chariton Valley Communications are shown in the map below:

Map 11 – CAF II Reverse Auction Winners



C. The Broadband Speed Story

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

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

Speed Tests

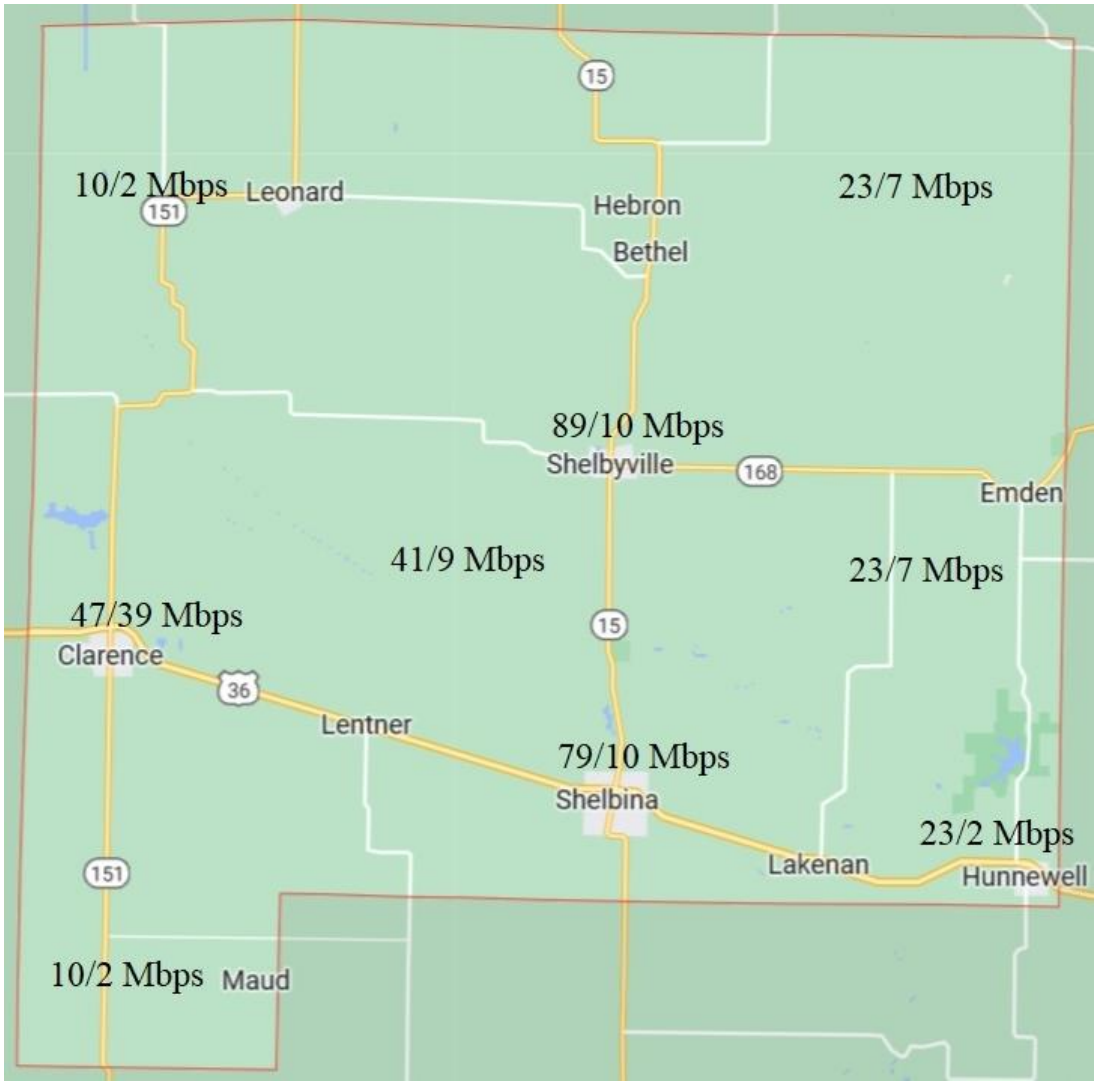
As part of the study, we collected speed tests from residents. We were able to also pull speed test data from the biggest nationwide speed test from Ookla (speedtest.net) – this is the speeds being used by the National Telecommunications and Information Administration (NTIA). This is the most popular speed test on the web and the one that many people take when investigating their computer speeds. The speed test results are summarized in the map below and show how widely the speeds vary across the county.

The speed tests below represent speeds by Census Tract, which are groups of the smaller Census blocks. The speed test results average together the results from all technologies in a given part of the county, meaning one area might include DSL, fixed wireless, and cellular hotspot. Even accounting for the averaging, the speed tests show dramatically different speeds available around the county.

- For example, the speeds are fastest in and around Shelbyville and Shelbina at 89/10 Mbps and 79/10 Mbps, respectively. This is due to the presence in that area of customers served by Charter on a coaxial network.
- Other parts of the county have relatively fast speeds, such as around Clarence. The average speed test result in that area are 47/39 Mbps. That upload speed indicates that the average includes some fiber customers. This is the only part of the county showing upload speeds faster than 10 Mbps.
- The slowest parts of the rural county are showing average speeds of 10/2 Mbps. These are the areas where people have only the slowest possible technology options like DSL, satellite, and cellular hotpots.
- Some of the other part of the county show higher speeds, and this is mostly due to the fact that there is a mix of faster technologies like licensed fixed wireless that helps to pull up the average speeds – although these areas also include residents using the slower technologies.
- Finally, the eastern part of the county is showing average speeds of 23/7 Mbps. This faster download speed is influenced by fixed wireless customers.

This map demonstrates visually that parts of the county have a broadband gap where residents have slower broadband than their neighbors,

Map 12 – Ookla Speed Tests



Speed tests provide a way to judge the quality of broadband and to provide a different way to judge ISP performance. The speed tests can show if ISPs are delivering the broadband speeds they advertise and show if speeds vary across the market.

A given speed test is not 100% reliable and doesn't always deliver a true picture of the broadband being delivered to a given address. However, we've found that administering speed tests in mass for a whole community can provide a good comparative picture of different neighborhoods. Following are a few of the criticisms that ISPs rightfully make about any individual speed test:

- A speed test only measures the speed of a ping and a short-term connection of less than a minute between a user and the test site router used by the speed test. That doesn't necessarily indicate the speed of every activity on the web, such as downloading files, making a VoIP phone call, or streaming Netflix.
- Every speed test on the market uses a different algorithm to measure speed. In this study, we used the speed test from Ookla, which is one of the most popular speed tests. Ookla's algorithm discards

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

- Home broadband can be slowed due to network issues within the home, such as problems with a home WiFi router or faulty wire inside a home. A slow speed test doesn't always mean that the ISP is providing a slow connection.
- Internet speeds vary throughout the day, and anybody that takes multiple speed tests during the same day will see this. Taking only a single speed test might not tell the real story about a given customer. For example, some ISP networks bog down and get slower during the busiest times of the day, and a speed test taken when the network is busy might give a different answer than when the network is idle.
- Some ISPs use something called "burst" technology. This provides a faster Internet connection for one or two minutes. ISPs know that a large majority of Internet activities are of short duration – things like opening a web page, downloading a file, reading an email, or taking a speed test. The burst technology increases the priority of a customer during the burst window, and the Internet connection then slows down when the temporary burst is over. This raises an interesting question – what's the real Internet speed of a customer that gets 100 Mbps during a 2-minute burst and something slower after the burst – there is no consensus in the industry.

Ookla Speed Test by State

Ookla collects speed tests all over 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. It is the speed test we used in the speed test survey to analyze the speeds in Shelby County. In 2020, Ookla started to report median download and upload speeds and latency by state. Below is what Ookla reports as the median download and upload speeds and latency for Missouri.

	Download	Upload	Latency
Quarter 1 2021	94.49 Mbps	14.44 Mbps	15 ms
Quarter 2 2021	101.42 Mbps	15.96 Mbps	16 ms
Quarter 3 2021	106.97 Mbps	16.96 Mbps	16 ms
Quarter 4 2021	113.72 Mbps	18.33 Mbps	15 ms
Quarter 1 2022	120.02 Mbps	19.56 Mbps	14 ms

As seen in the table above, broadband speeds have been increasing in Missouri. In Q1 of 2021, speeds were 94.49 Mbps, and a year later (Q1 2022), speeds have increased by 27% to 120.02 Mbps. Upload speeds have also increased, moving from 14.44 Mbps in Q1 of 2021 to 19.56 Mbps in Q1 of 2022, a 35% change. Currently, Missouri is ranked 30 for download speeds in the Country.

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

Microsoft measured downloads starting in September 2018 and found:

- The 2019 FCC data claimed that 14.5 million people in the U.S. don't have access to download speeds of at least 25/3 Mbps. In October 2020, Microsoft claimed that 120.4 million people were downloading data at speeds slower than 25/3 Mbps.
- The FCC claimed in 2020 that 92.8% of households in Shelby County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reported that 80.5% of all downloads in the county are made at speeds of less than 25 Mbps. That is an eye-opening difference between the Microsoft numbers and the FCC numbers.

It's important to note that the FCC and Microsoft are not measuring the same thing. The FCC is measuring the percentage of homes that have access and can purchase 25/3 Mbps broadband. Microsoft is measuring the actual speeds of downloads. There are a few reasons why the speeds might be different:

- Some people opt to buy broadband products slower than 25/3, even when faster broadband is available.
- Some households receive slower speeds due to issues in the home, like poor-quality WiFi routers.
- The biggest difference is due to the ISPs overstating the speeds to the FCC that they make available to the public. As stated elsewhere in this report, the FCC doesn't challenge speeds reported to them by ISPs. The Microsoft data highlights the problems in the FCC data.

FCC Adoption Rate

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

Homes buying at least 10/1 Mbps	65.1%
Homes buying at least 25/3 Mbps	57.1%
Homes buying at least 50/5 Mbps	55.5%
Homes buying at least 100/10 Mbps	50.0%
Homes buying at least 250/25 Mbps	9.7%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (65.1%) puts Missouri in the lower end of broadband adoption compared to other states. Only Alabama (62.8%), Arkansas (55.3%), Idaho (59.6%), Iowa (61.3%), Louisiana (64.0%), Mississippi (50.4%), New Mexico (55.7%), Oklahoma (62.0%), and West Virginia (51.7%) are lower than Missouri. The highest adoption rate is in Delaware at 92.7%. It's worth noting again that these numbers are based upon faulty FCC 477 data reported by the ISPs, and the actual speeds being purchased are not nearly as good as the numbers shown.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that could buy broadband at various speeds. This is where the FCC data and the faulty nature of the maps are quickly evident. The following is what the FCC reported to Congress in 2021 about Shelby County. These numbers are based on 2019 477 data from the ISPs.

Rural population:	5,930
% that can buy at least 25/3 broadband	92.8%
% with 4G LTE coverage at 5/1 Mbps	98.1%
% with both	91.7%

The rural percentages are startling because the FCC data shows that 92.8% of the households in the rural parts of the county can buy 25/3 Mbps broadband. According to the FCC, about 427 people or 178 rural households cannot buy broadband. We know from the analysis above that the FCC claimed broadband coverage is overstated significantly and that there are a lot more homes with poor broadband than are being counted by the FCC.

Comparing Shelby County with the Rest of Missouri

According to FCC data, two counties in the state – Bollinger and Ozark – have less than 10% broadband coverage. In total, Missouri has 12 counties under 50% coverage. At the other end of the scale, the FCC says that there are 15 counties that have 100% coverage of 25/3 Mbps broadband. According to the FCC data, Shelby County has one of the higher amounts of broadband coverage in the state – which we now know is not true.

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 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 could count the number of potential customers to match each of the various maps included in the section above.

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

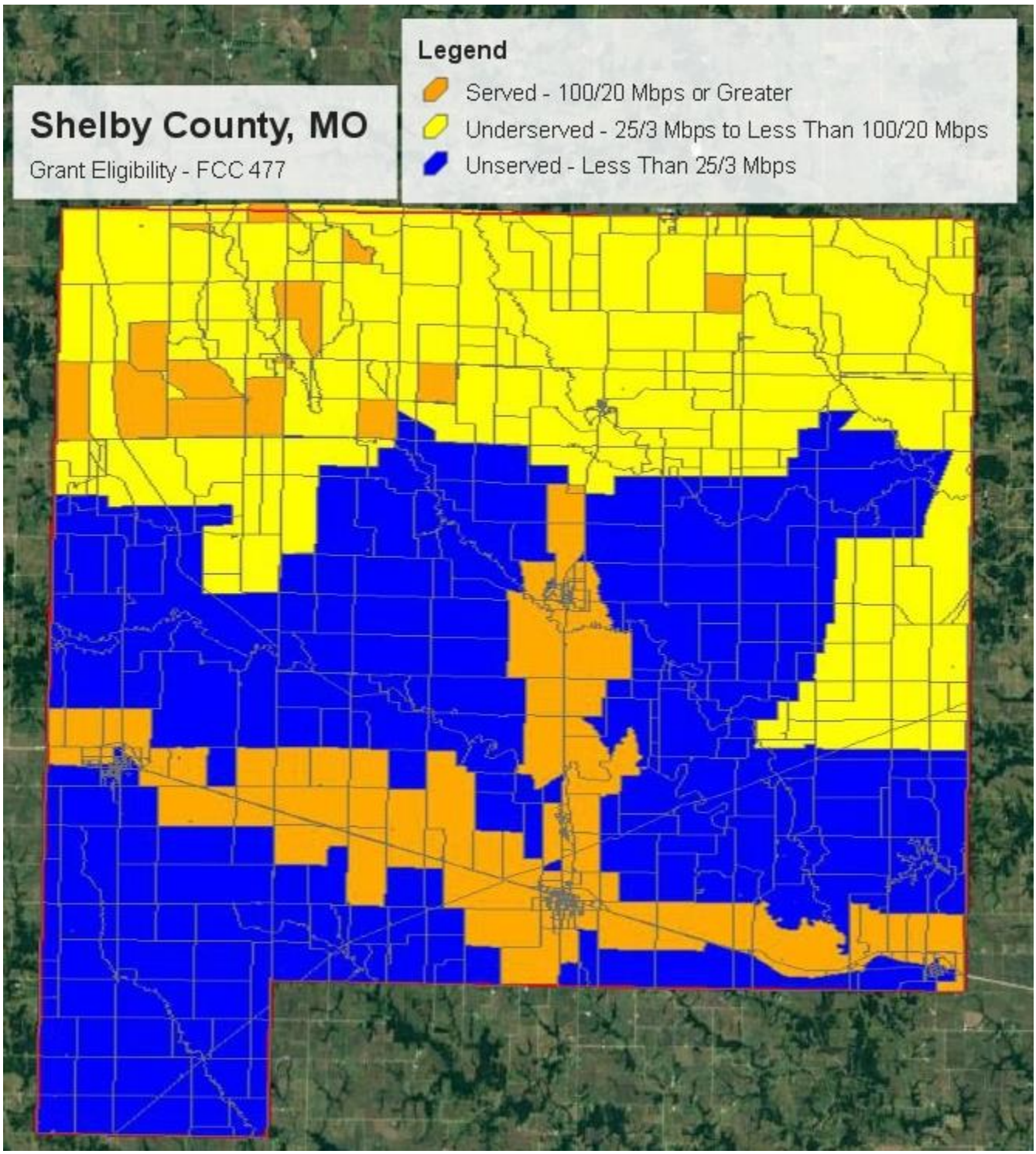
- Unserved – Any place that has speeds of 25/3 Mbps or slower.
- Underserved – Any place that has speeds between 25/3 Mbps and 100/20 Mbps
- Served – Anyplace with broadband of 100/20 Mbps or faster.

Until very recently, federal broadband grants considered grant-eligible areas to mean the fastest speeds available for landline-based technologies such as DSL, cable modem, or fiber. When an ISP in the county considered asking for a grant a year ago, they would have started with the following data and the map below. This map only includes passings where households or businesses can buy broadband from DSL, coaxial copper, or fiber.

Finley used the GIS data and calculated the number of passings that have historically been considered as unserved, underserved, and served as follows:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	1,225
Underserved	From 25/3 Mbps to 100/20 Mbps	767
Served	100/20 Mbps or faster	1,677
Total		3,669

May 13 – Historical Definition of Grant-eligible Areas



Today's Definition of Grant-eligible

One of the primary purposes of this study was to identify those places in the county that need better broadband and for which grants might now be available.

There has been one big change in the industry that defines grant-eligible areas. The map above excluded all fixed wireless technology. However, the NTIA has now declared that areas served by licensed fixed wireless technology are considered as having broadband if the speeds are fast enough. That does not mean that all fixed wireless is considered as broadband because many wireless ISPs use WiFi spectrum to transmit broadband to homes. The NTIA has ruled that the unlicensed wireless technology is not reliable – and they are right. Unlicensed spectrum is subject to interference, meaning the signals that can be delivered to a household will vary according to the amount of interference at any given moment.

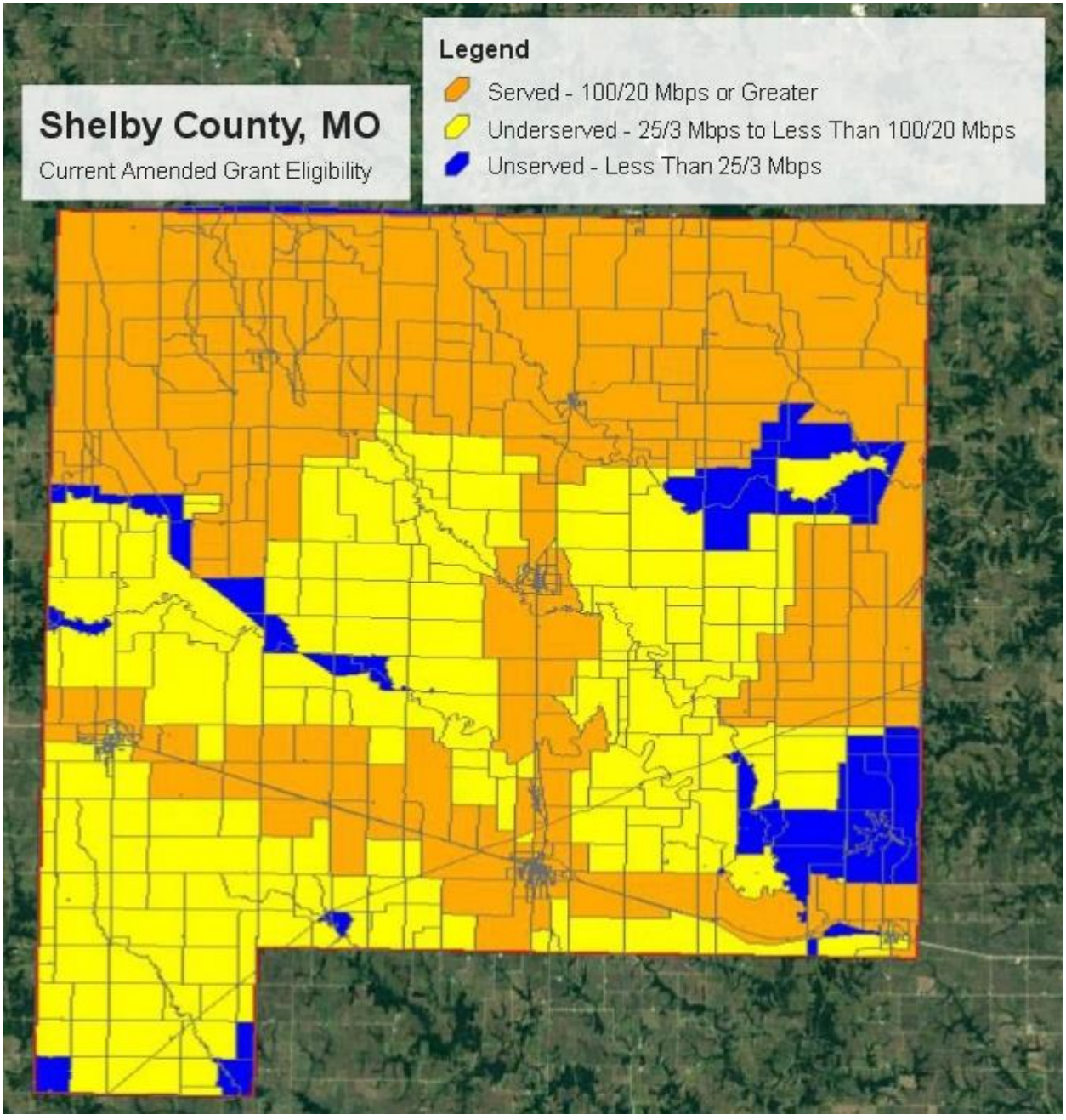
There are a few other changes that must be considered when looking at the current grant-eligible areas. For example, any areas where we know that a broadband upgrade is coming is not grant-eligible. In the County this would include places like areas where Mark Twain Rural Telephone and Chariton Valley Communications is expanding broadband from their own funds. It also would exclude areas that are being upgraded due to grants or subsidies, such as the ACAM and CAF II areas, and any other federal and state grants.

This means that the current definition of grant-eligible areas consist of the following:

- Landline technologies that don't deliver speeds of 100/20 Mbps or faster. In the county these areas mostly represent where there is DSL but no other landline technology.
- Areas with fixed wireless technology that use unlicensed spectrum with speeds slower than 100/20 Mbps.
- Areas served only by other non-wireline technologies such as satellite broadband.

Following is a map that shows the areas that we believe are eligible for grants today. Federal grants can be used to serve both unserved areas (blue) and underserved areas (yellow).

May 14 – Current Areas Eligible for Grants



Using the GIS data, the count of households currently eligible for grant funding are as follows:

	Speeds	Passings
Unserved	Less than 25/3 Mbps	0
Underserved	From 25/3 Mbps to 100/20 Mbps	784
Served	100/20 Mbps or faster	2,885
Total		3,669

The first thing to notice when comparing this current eligibility map to Map 13 above, there are no unserved homes. We know that they exist in the County today, and we heard from people served by cellular hotspots, DSL, and satellite broadband. There are several reasons why there are fewer grant-eligible areas in Map 14:

- Much of the area is covered by licensed fixed wireless that has speeds claimed at faster than 25/3 Mbps. Such areas are considered as underserved, and not unserved.
- There are areas which are planned to be upgraded to fiber through the ACAM subsidy or some other funding source. While that fiber hasn't been built yet, it is on the way. Areas that will be getting fiber are counted on this second map as served.

III. Other Research

A. Surveys / Interviews

As part of the study, we reached out to the public in several ways. This included online surveys asking about broadband as well as interviews with members of the community. Following are some of the things we learned during the community outreach:

Online Residential Survey

The key thing to remember about an online survey is that the results are not statistically valid – meaning that the results only represent the responses of those who took the survey and not necessarily of the whole county. What that means in practical terms is that the surveys cannot be relied on in terms of absolute numbers. For example, the first graph below shows the percentage of respondents who don't have home broadband. That number cannot be assumed to be the same for the whole county. However, online surveys are good for understanding sentiment. For example, an online survey can tell you if residents are more concerned about broadband prices or broadband speeds.

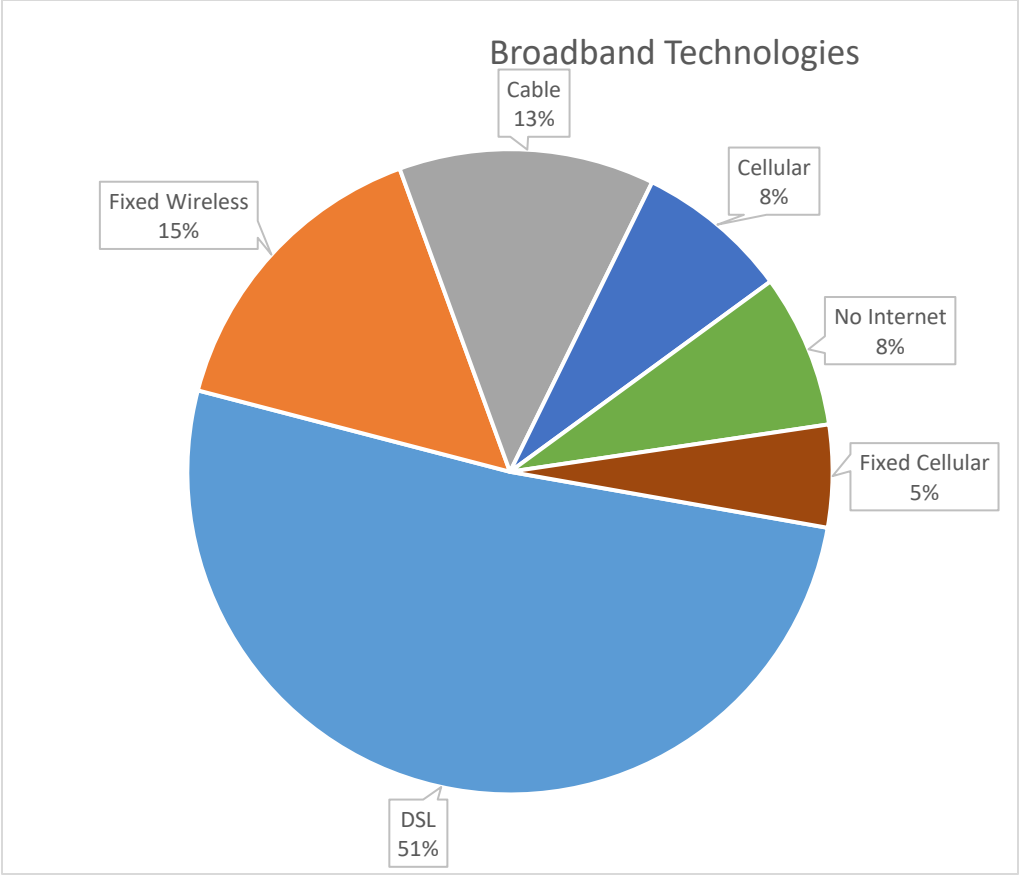
The survey produced some interesting results. Here are highlights of the survey results:

<u>Broadband Customers</u>

87% of survey respondents said that they have a home broadband connection today. 13% have no home broadband, which includes 8% who only use their cellphones for broadband. The following pie chart shows broadband subscriptions by technology. This chart below shows the wide variety of types of broadband residents are using today. This is a more varied list than what we normally see.

- The largest group of survey respondents, at 51%, are using DSL from telephone companies.
- 13% are using cable broadband.
- 15% are using fixed wireless.
- 5% are using fixed cellular, often referred to as hotspots.

We know there are residents in the county with fiber broadband, but none took the survey.



Cable TV Penetration

54% of survey respondents report the purchase of traditional cable TV, meaning TV from a cable company, telephone company, or satellite provider. That is almost identical to the nationwide average, which dipped below 55% by the end of 2021. 37% of households use satellite, and 17% use Charter.

29% 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 true cord-cutters, but most estimates put it at around between 35% and 40%. The percentage of cord-cutters is growing rapidly, so it is expected that the number of homes with traditional cable will continue to drop over time.

Telephone Penetration

45% of homes still report having a landline telephone. This is significantly higher than the nationwide landline penetration rate that has dropped below 25%.

Broadband Prices

We asked respondents how much they were willing to pay for residential Internet service.

- 43% would like to spend under $50
- 49% would like to pay between $50 - $75

- 9% would be willing to pay between $76 - $100

Uses of Broadband

We asked how often people use broadband. 55% use it daily for many hours per day. 39% use it daily, but only a few hours per day. 6% use the Internet only several days per week.

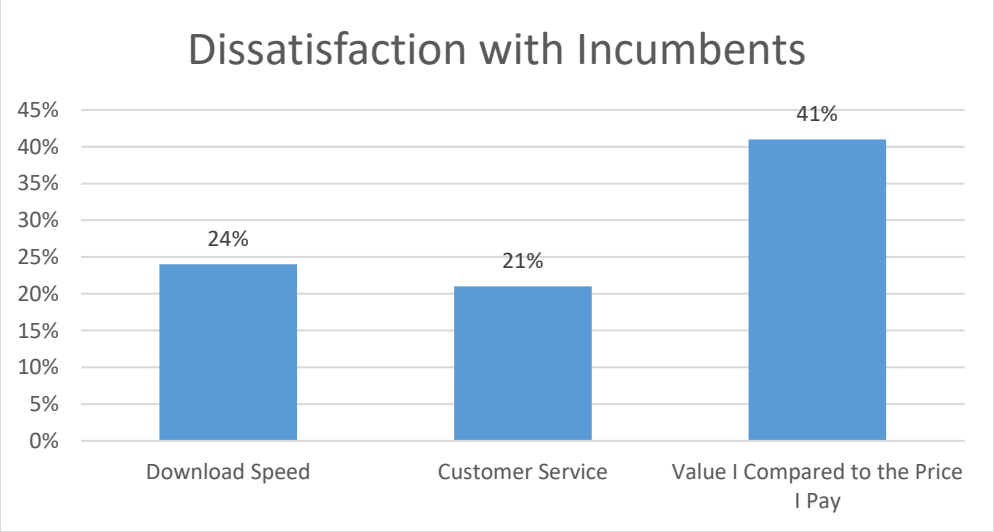
84% of respondents say that somebody in their homes uses the Internet to work from home. That is made up of those working at home full-time (6%), those that work several days per week (31%), and those that work from home occasionally (46%). The number of people working from home has increased significantly during the pandemic – before the pandemic, we rarely saw more than 10% of homes with somebody working from home. 45% of respondents said they would work from home more often if the Internet connection was faster.

26% of respondents report having somebody in the home using broadband for schoolwork. 27% of these homes said the broadband connection was not adequate for students to do their homework.

We've learned during the last year that most of the problems encountered when working and schooling from home came from inadequate upload speeds. This is something that many people don't yet understand, and many assume download speeds are inadequate when they have problems using the upload link.

Satisfaction with Existing Broadband

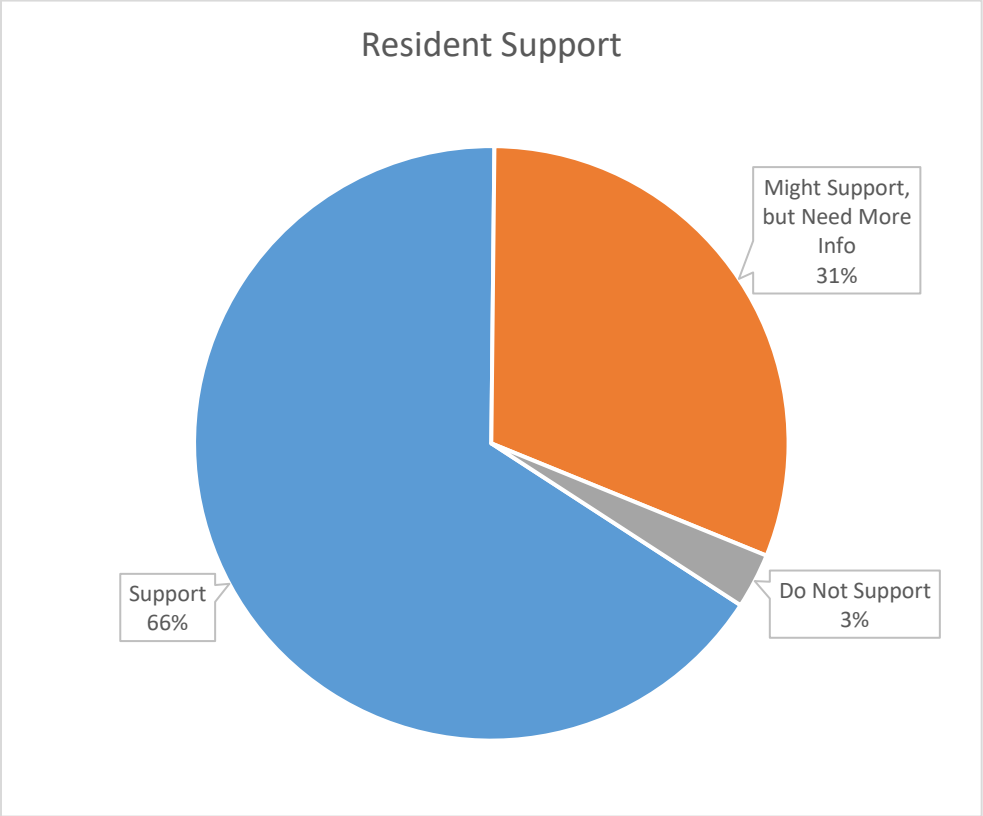
Below is a graph of the survey responses highlighting the levels of dissatisfaction with some aspects of home broadband.



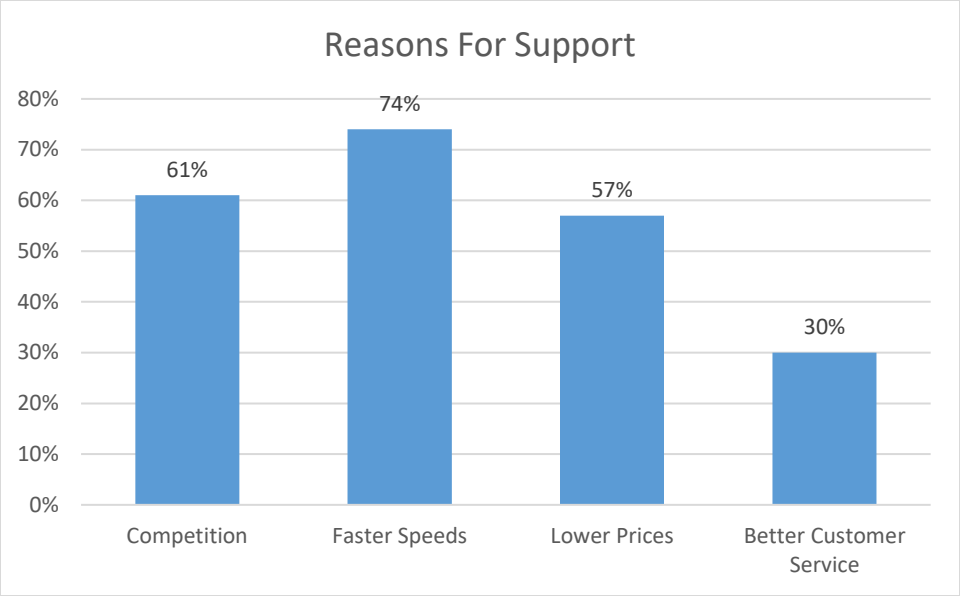
We interpret these results to show that a moderate number of homes are unhappy with broadband speeds and customer service. 41% of survey respondents are dissatisfied with the value received compared to the prices paid by residents – which we interpret to mean price.

Support for a Fiber Network

One of the key questions asked how respondents feel about getting a new broadband option in the county. The pie chart shows overwhelmingly positive support for the idea of a better broadband network. 66% of survey respondents support the idea, with another 31% said they might support the idea but need more information. Only 3% of respondents actively dislike the idea.



We asked the reasons why respondents support bringing a new network to the county. Respondents could choose more than one response to the question. The graph below summarizes the reasons for those who support the expansion of the network.



61% of households hope for more competition – meaning getting another ISP at their home. 74% would like to see faster speeds. 57% would like to see lower prices. Only 30% care about better customer service.

Switching Service to a New Network

In probably the most important question of the survey, we asked households if they would buy Internet service from a new if it offered faster speeds.

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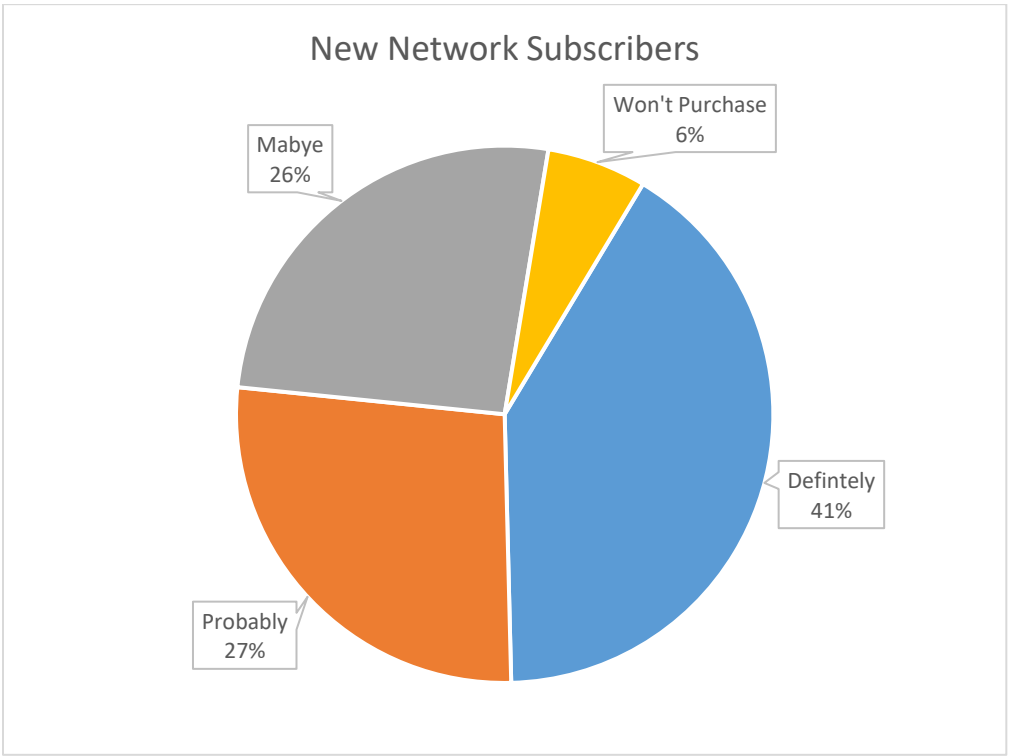
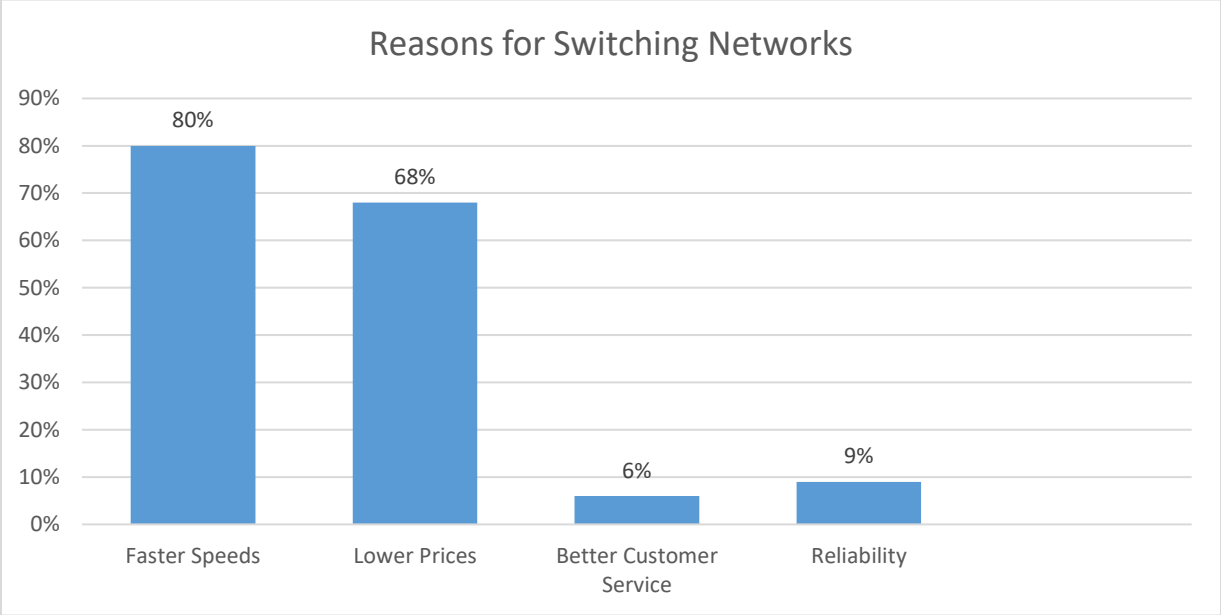


41% of respondents said they would definitely buy service from a new network. Another 27% would probably buy service, and 26% would consider buying service. Only 6% of respondents wouldn't consider buying broadband from a new fiber network.

15% of respondents said they would consider buying a landline telephone from a new network provider – meaning 85% would not likely buy telephone service.

When asked why they would consider a new network:

- 80% put a priority on faster speeds
- 68% want lower prices
- Only 6% want better customer service
- 9% want better network reliability



Interpreting the Results of the Survey

It's often a challenge to interpret survey results. There are several issues that came through with clarity in this survey. Following are our observations of what the survey tells us:

> Speed Sensitivity. It became clear as we learned about the county that a lot of rural places have extremely slow broadband speeds. We can see this when we see there are still households buying broadband from cellular hotspots, satellites, and slow rural DSL. The wish for better speeds also came clear in the survey. Surprisingly, only 24% of respondents said that they are dissatisfied with current download speeds. However, 74% cited faster speeds as a reason to support a new network. 80% said speed would be an important consideration in deciding to change to a new broadband provider.

Lower Prices. Prices were important to survey respondents. 41% of respondents said that they were unhappy with the value they are receiving compared to the price they pay for broadband. That finding is likely related to both the price and quality of the broadband connection.

43% of respondents said they would like to spend under $50 per month for broadband – an unrealistic wish since all current broadband is priced higher than that.

57% of respondents said the reason they support the idea of a new network is to get lower prices. 68% said that getting a lower price would be a primary reason they would change to a new broadband provider.

Support for a New Network. ISPs should see the willingness of respondents to change to a new ISP as a positive. 41% of residents said they would absolutely switch to a new ISP, and another 27% said they would probably switch. Another 25% said they would consider switching and only 6% said they wouldn't consider switching.

Interviews

We interviewed some key stakeholders in the county. This included some businesses along with anchor institutions like a church, the library, and several non-profits. In these interviews, we also asked about the home broadband experience and picked up additional anecdotes about local broadband conditions from comments made in the surveys.

Here are some of the stories we heard about broadband. The interviews firmly validated the same stories we were gathering from the surveys and speed tests – and also validated by the engineering analysis of existing broadband infrastructure.

- Broadband in towns is decent. Businesses that have Charter/Spectrum are largely able to do what they want to do. The biggest issue we heard about Charter broadband was fairly regular outages. Businesses told us that it often takes a long time to restore service, and that outages are completely disruptive for businesses.
- We heard that a number of residents were left with no broadband option when Chariton Valley discontinued its wireless service.
- We heard from a non-profit in Bethel who said that the only option is DSL. It generally works okay but will go out of service unexpectedly for hours at a time.
- We heard that a few rural residents have such poor options that they are using dial-up Internet.
- We heard from a rural resident who can no longer buy a landline telephone because of the poor quality of the copper wiring. They also have poor cellular coverage in the neighborhood. They looked into Starlink but can't afford the price. They feel like they have no broadband or voice options at their home.
- We heard from a business that uses voice-over-IP (telephone on the Internet) that loses both the ability to talk or to use the Internet when there are broadband problems.
- We heard from a teacher who lives about half a mile from where there is good Internet. They can't convince the ISPs to come the last half-mile.
- Businesses all are paying significantly higher prices than residents, but often for the same speeds.

- We heard from several businesses and residents who can only perform one data-intensive thing at a time. If they do something like making a Zoom call, they can't use the broadband for anything else or else they lose the connection.
- We heard repeatedly that the lack of good broadband is causing a problem for young people, who then often leave the area after they graduate from high school.
- Nobody we talked to seem to be aware that there were plans underway to bring fiber to their rural neighborhoods.

B. Field Review

Providers

Charter Communications. In Shelby County, Charter offers cable and broadband service in Shelbina, Shelbyville, and between the two cities along Hwy. 15.

Charter, in their latest FCC 477 reporting, indicates they can provide 940Mb/35Mb service in the service areas in and around Shelbyville and Shelbina. Finley's onsite review of the systems confirmed the presence of a full DOCSIS 3.1 deployment.

Our review of the Charter infrastructure and corresponding FCC 477 reported data support the ability of Charter to offer broadband speeds greater than 100/20Mb. We note that upload speeds on the Charter system may be constrained for services such as video for Zoom and video healthcare. We also note that some coverage in rural areas may be overstated due to the nature of FCC 477 reporting by census block.

Charter Communications (Shelbyville) coax cable lashed to existing cable strand

Charter Communications (Shelbina) powered cable amp and Fiber over lashed to existing cable strand

Charter Communications (Shelbina) fiber over lashed to coax cable and existing cable strand

CenturyLink. The CenturyLink regulated service area in Shelby County encompasses approximately 64.2% of the landmass and 81% of the residential/business locations in Shelby County. From our analysis and field review, we believe that CenturyLink can provide broadband speeds of 25/3Mb or greater to no more than 5% of customers in their regulated service area.

In late 2021 Lumen (previously CenturyLink) sold its telecom assets in Missouri and 19 other states to Apollo Funds, a private equity fund operated by Apollo Global Management. Apollo indicates they have plans to make upgrades, including investments in fiber. No details were given, and it is doubtful that Apollo would target any fiber investments in Shelby County.

CenturyLink accepted Connect America Fund (CAF) obligations to upgrade rural DSL to at least 10/1Mbps broadband to many locations in the county. That work was to be completed by the end of 2020. Finley located CenturyLink assets that indicate that CenturyLink has made the required investments in Shelby County.

CenturyLink 48-Port Sealed DSL Unit near Shelbina - Shelby County

The picture above is of a DSL unit which is a typical deployment made by CenturyLink to meet to meet the requirements of CAF to provide 10/1Mb.

CenturyLink Aerial Cable in Clarence - Shelby County

The picture above is of a large aerial copper cable near the Central Office in Clarence, MO. It is important to note that aerial copper seems old and degraded and is not as reliable as buried copper.

Mark Twain Telephone (MTRT). MTRT has received Universal Service Funds (USF) since 1996 to help provide telephone and broadband service. In 2016 as these funding programs changed, Mark Twain participated in the FCC program Alternative Connect America Cost Model (ACAM). With this program,

Mark Twain could elect to receive a specific amount of capital to build broadband infrastructure within its service territory. The program requires ISPs to provide speeds of 25/3Mbps, 10/1Mbps, or 4/1Mbps and complete the project in eight years. MTRTC used the funds to upgrade its network to FTTH, and the project is expected to be completed by the end of 2026. The Mark Twain regulated service area encompasses approximately 35.8% of the landmass and 19% of the residential/business locations in Shelby County.

By upgrading to a fiber network, Mark Twain will be capable of providing 1 Gbps broadband to any customer inside their regulated service area. In Shelby County, Mark Twain has completed 100% of the mainline FTTH construction in the Leonard regulated exchange service area and has begun switching customers over to the fiber service. The company is currently constructing the FTTH network in the Bethel exchange, and Steffenville and Philadelphia exchanges have yet to be started. The remainder of customers who have not yet been converted to FTTH has access to broadband service with speeds up to 50Mb, which is provided over the legacy Mark Twain copper telephone network.

Mark Twain has developed a comprehensive multi-year plan to complete the FTTH network. Through planning and forecasting with vendors and contractors, Mark Twain has avoided any of the current supply chain issues facing the broadband industry.

Funding to continue network upgrades and expansion is always needed, and Mark Twain notes that funding is required to continue its broadband network expansion.

MTRT is eager to work with Shelby County to understand how they may work together to enable robust broadband solutions in Shelby County.

Mark Twain Communications (MTCC). In 2003, MTCC began providing fixed wireless Internet in areas outside its regulated telephone exchange. MTCC can transmit wireless services from over 25 locations in northeast Missouri. MTCC has continued to invest in fixed wireless broadband technology by investing in tower structures for fixed wireless access points and, most recently, in licensed spectrum and a fiber backhaul network.

In 2020, the FCC conducted an auction for 80 MHz of spectrum in the Citizens Band Radio Spectrum (CBRS). The spectrum does not require a clear line of sight, which is desirable for fixed wireless technology. Fixed wireless is often limited by its ability to have a clear line of sight from the transmitter to the receiver. Since the CBRS spectrum does not require a clear line of sight, it is necessary for areas with dense trees and rolling terrain like Shelby County.

In the 2020 FCC auction, MTCC was the winning bidder for 40mhz of CBRS spectrum in Shelby County, with an investment in spectrum totaling close to $4,000. The investment, along with other required investments in tower structures and fiber backhaul facilities, will give MTCC the ability to offer up 100Mb broadband service in some areas. Mark Twain is currently undertaking a wholesale swap and upgrade of the fixed wireless equipment in its network to take advantage of the newly purchased spectrum.
In Shelby County, it will be difficult for MTCC to offer 100 Mbps to every customer in its service area. This is due to limitations of radio frequencies and terrain impediments like heavily wooded areas and rolling hills. Customers closest to the transmitting towers will get the fastest speeds. Those far away from

the tower are unlikely to receive speeds of 100 Mbps but will still get faster speeds than are available today.

MTCC is committed to pursuing additional grant funds for expanding broadband and is eager to work with Shelby County to understand how they may work together to enable robust broadband solutions.

Chariton Valley Communications Corporation. Chariton Valley Communications Corporation (CVCC) is the competitive arm of Chariton Valley Telephone Corporation and provides broadband outside the regulated service areas of Chariton Valley Telephone.

Chariton Valley Communications began a rapid fiber expansion project to unserved areas across multiple counties in northeast Missouri. In Shelby County, CVCC has deployed fiber assets along Hwy 36 along Hwy. 36 across Shelby County; CVCC plans on the continued expansion of their all-fiber network in Shelby County over the next several years.

In 2018, CVCC won the FCC CAF II auction and was awarded funding to serve a single census block in southern Shelby County with gigabit low latency broadband. This area is contiguous to CVTC exchange areas in Shelby County.

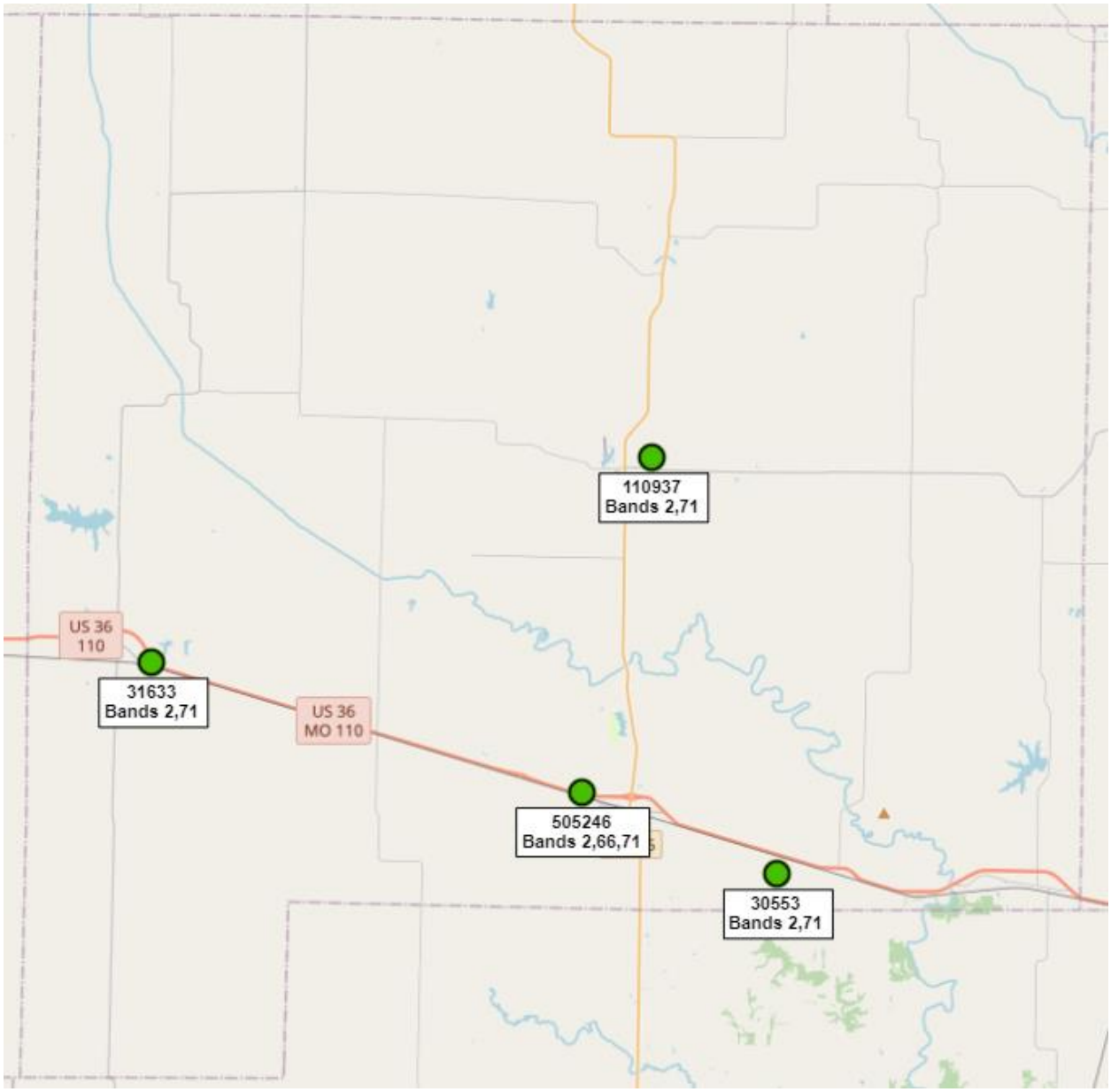
In early 2022, CVCC was awarded $1,002,000 from the NTIA Broadband Grant Program to build a fiber-to-the-premise network in and around Clarence. The funding for this project has not been fully authorized to CVCC at the completion of this report; however, CVCC expects to proceed with this project as soon as funding is authorized and released.

CVCC is more than happy to discuss expansion plans with the Shelby County Commission and stakeholders to understand the specific timeline and plans for the ongoing fiber network expansion.

T-Mobile USA. 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 Shelby County, T-Mobile primarily offers service with 600Mhz LTE technology and some limited AWS spectrum in Shelby City. Backhaul facilities are a mixture of fixed wireless and fiber backhaul facilities.

T-Mobile indicates they can provide 25/3Mb fixed wireless coverage to some portions of the southern part of Shelby County. The FCC 477 data reported by T-Mobile aligns with the cell tower map coverage reported through crowd-sourced coverage data.

T-Mobile Fixed Wireless Access Point Locations in Shelby County



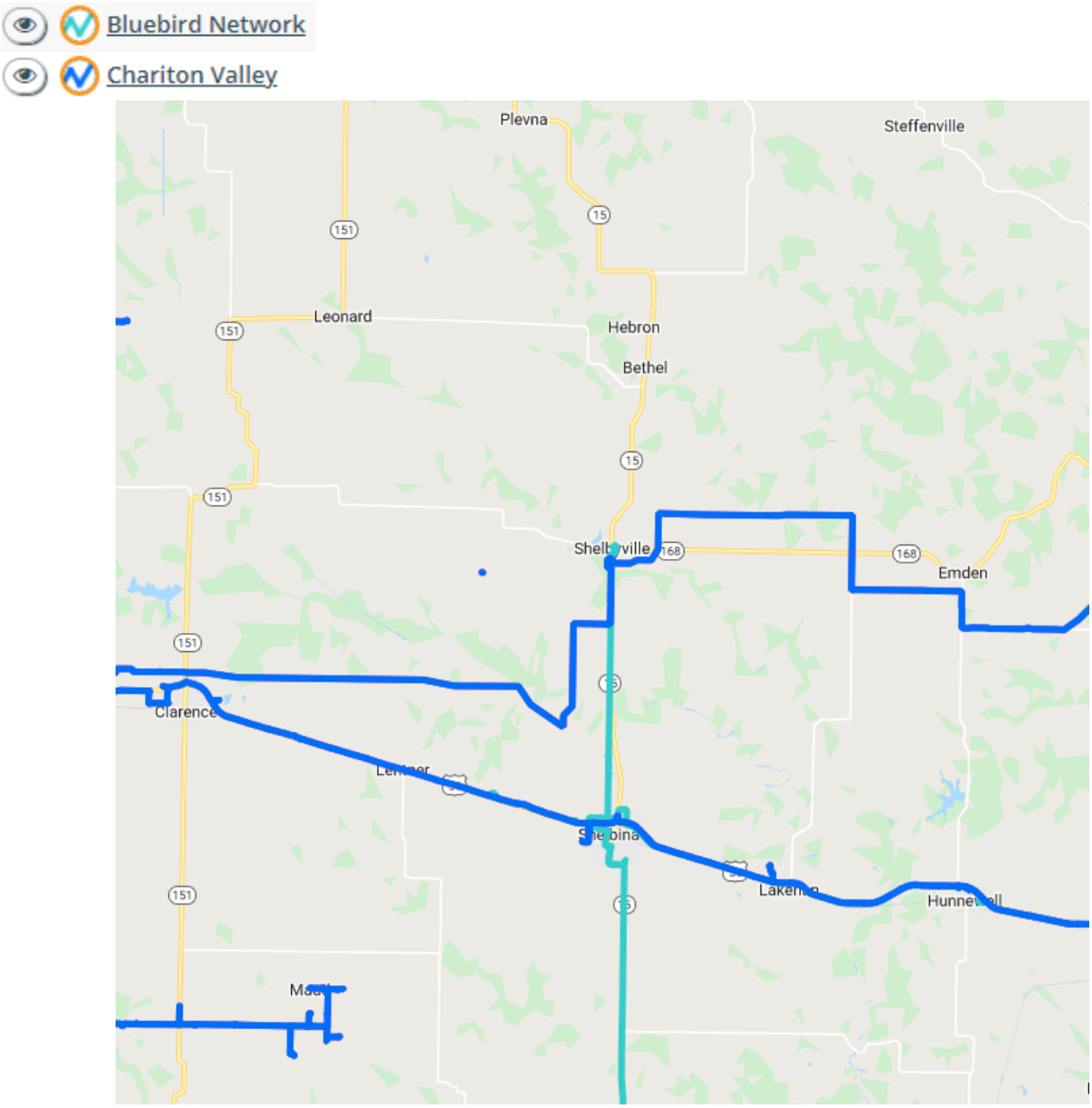
Business Only Providers

The FCC 477 Data report lists several providers offering business only services:

- Verizon Business Global claims delivery of ethernet services over copper in a single census block.
- Level 3 Communications offers service with fiber in six census blocks.
- Missouri Network Alliance, LLC offers service with fiber in multiple census blocks.

Level 3 Communications and Missouri Network Alliance can offer dark fiber leases, lit transport and Ethernet solutions for broadband middle mile and backhaul purposes. It is not known which specific service solutions they provide in Shelby County.

Below is a snapshot of some of the known fiber routes that pass through Shelby County, this image is at a high scale to show the routing of the fiber outside of the county.



C. 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 Availability. There are homes with no landline broadband available.
- The Gap in Broadband Affordability. In every community, there are households that don't subscribe to broadband because of the cost.

- The Gap in Computer Ownership. There are households that don't subscribe to broadband because they can't afford a computer.
- The Gap in Broadband Skills. There are citizens who don't buy broadband because they lack the skills needed to operate in the digital age.
- Future Broadband Gaps. Even where there is adequate broadband today, we can expect the natural growth of broadband usage to create new broadband gaps in the future.

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

The Gap in Broadband Availability

The broadband availability gap was the focus of mapping analysis. Map 14 shows the areas of the county where there is no existing option for buying broadband of at least 25/3 Mbps.

Discussions of the broadband availability gap are often tied to the terms 'unserved' and 'underserved.' These terms have been used in the past to describe two different levels of broadband availability. The two terms were first introduced in 2009 in the grants that were issued as a result of the American Recovery and Reinvestment Act of 2009, colloquially called the stimulus grants. In those grants, unserved was defined as any home that had broadband slower than 10/1 Mbps. Underserved was defined as a home with broadband over 10/1 Mbps but below 25/3 Mbps. The grants provided higher levels of funding for serving unserved locations.

Over time, the definition of the terms unserved and underserved has changed. These terms only apply to grant funding – there is no official FCC definition of the two terms, and various state and federal grants define the terms differently. It's always vital when considering a grant to understand what the specific grant accepts in terms of eligible speeds.

Broadband availability has also been looked at in other ways. For example, the National Telecommunications and Information Administration (NTIA) released the results of a survey in 2019 that looked at households that don't use the Internet.[4] The survey says there were around 28 million households in the U.S. that don't use broadband at home. Some of these homes fall into the following circumstances:

- The most drastic case is homes that have no landline broadband options. Such homes are limited to getting broadband from high-orbit satellites (assuming they can see the portion of the sky with the satellite), or from cellular data from their cellphone plans. Every rural area has some homes that have no landline broadband options.
- The broadband availability gap also refers to homes that can't get broadband that meets the FCC definition of broadband – 'unserved' homes.

[4] The NTIA survey results are at: https://www.ntia.gov/blog/2019/unplugged-ntia-survey-finds-some-americans-still-avoid-home-internet-use

The Gap in Broadband Affordability

The FCC reports that broadband adoption in the country is around 87%. Even after accounting for the rural areas that have no broadband option, there are many millions of customers that can get broadband at their homes but do not buy it. Numerous studies and surveys have asked why people don't buy broadband when it's available. The number one reason is 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 is buying broadband of at least 10/1 Mbps. The percentage that buys faster broadband speeds 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.[5] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[6] This report looks at a study conducted in three low-income neighborhoods of Detroit.

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

The Pew Research Center shows a direct correlation between income and broadband adoption. They've had an ongoing investigation into broadband-related issues since 2000[7]. 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.

Income Statistics for Shelby County

One of the best sources of demographic data comes from the Department of Housing and Urban Development (HUD) and the American Community Survey (ACS). Both resources collect nationwide data that is often used when awarding broadband grants. Both sets of data are used to identify lower-income parts of a community – areas that are often given preference in grants related to housing, economic development, and broadband deployment. Following is what HUD and the ACS say about Shelby 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 addresses America's housing needs, enforces fair housing laws, and looks 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 benefit may take form in housing, jobs, and service. 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 for statistical information to calculate income levels around the country. The two sources are:

- The American Community Survey (ACS), and

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

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

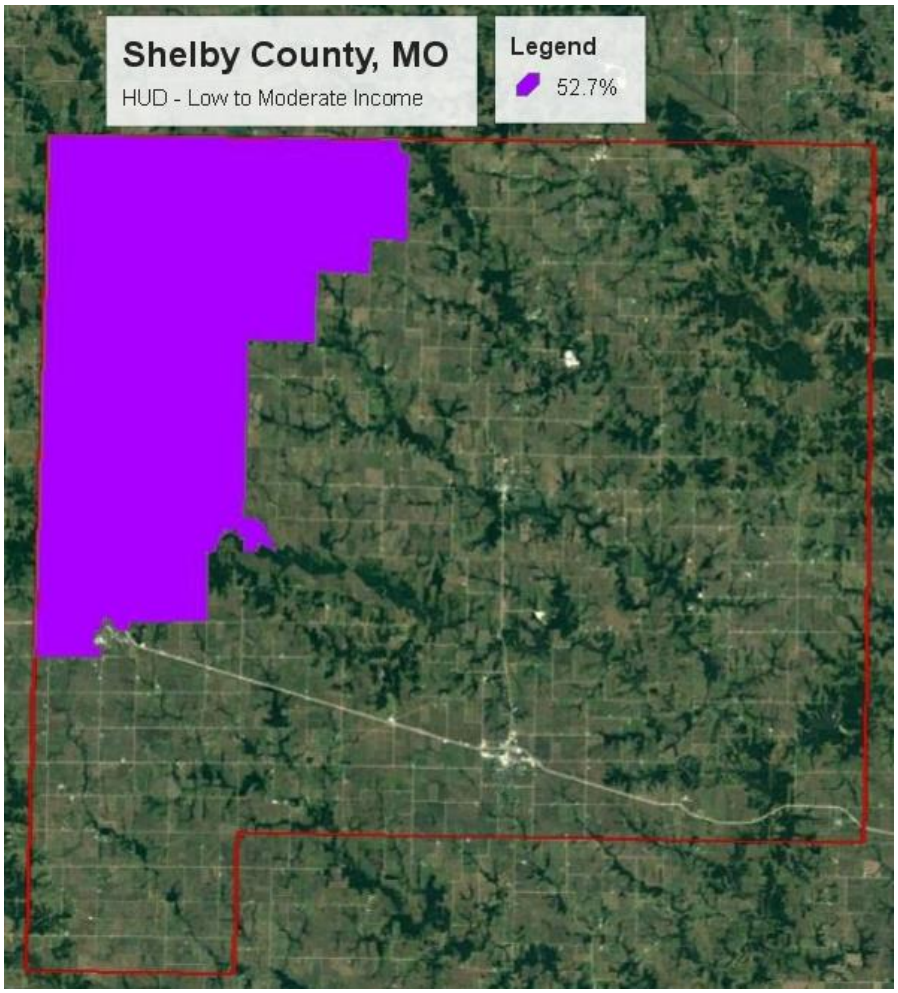
[7] Demographics of Internet and Home Broadband Usage in the United States | Pew Research Center

- The income limits for metropolitan and for non-metropolitan counties.

HUD calculates the area median income by neighborhood and classifies neighborhoods into three income levels:

- 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)

Below is a map of the portions of the county that HUD identifies as low-income or moderate income.

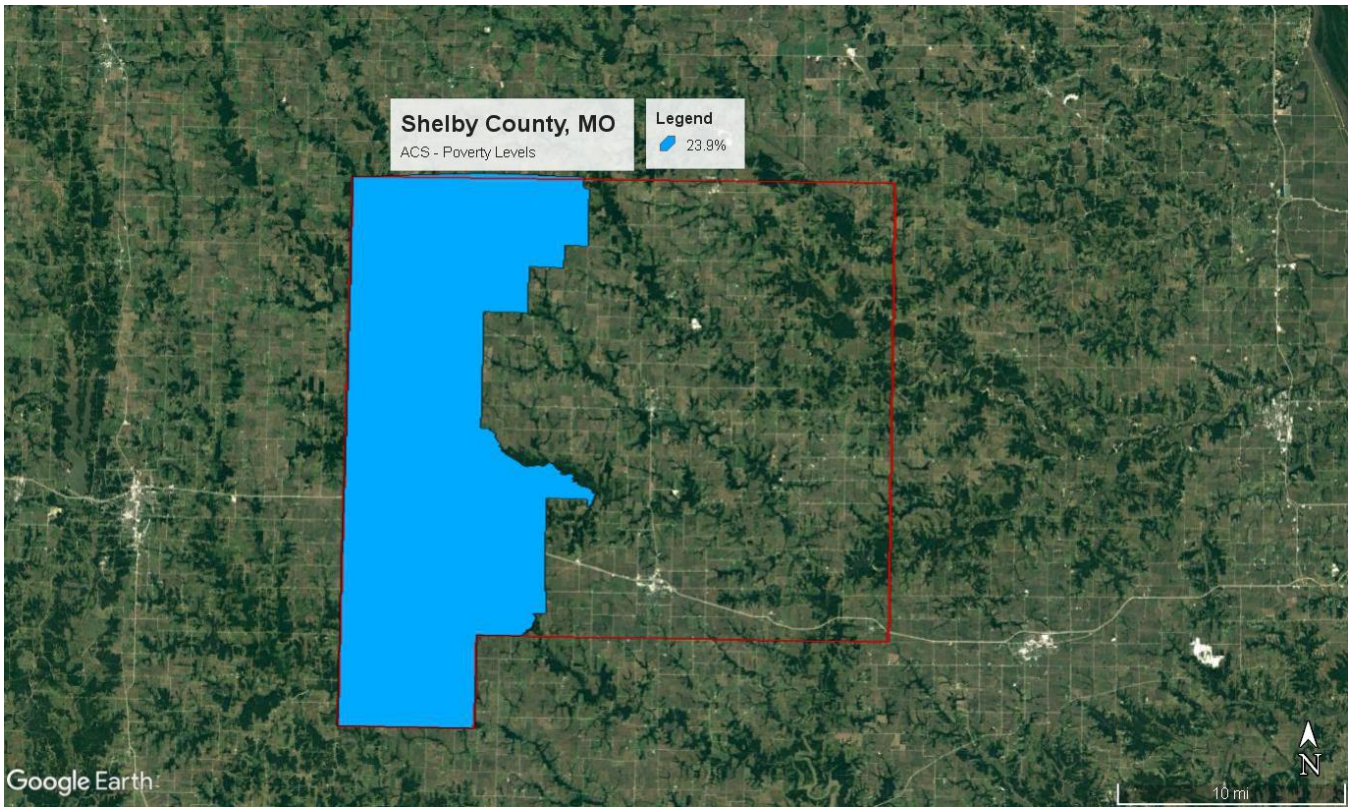


American Community Survey (ACS)

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.

ACS Poverty. Household incomes are collected as part of the ACS in order for the government to measure areas with poverty. This report has detailed the correlation between incomes and broadband adoption. Lower-income homes often want broadband but can't afford it. The report has also described the importance of having broadband for both students and adults.

The ACS has identified that the Census Tract in the western part of Shelby County has over 20% of the population living in poverty. Families are classified as being in poverty if their household income is less than their poverty threshold calculated as a result of the ACS survey. The areas that are considered to be high-poverty can be seen on the following map:



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

Poverty Thresholds for 2020 by Size of Family and Number of Related Children Under 18 Years

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

Summary

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

The Computer Gap

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

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

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

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

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

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

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

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

The Gap in Broadband Skills

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

Workers with upper-income jobs are faring extremely well. For example, starting demand for a new computer scientist, engineering, and similar tech graduates 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 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 the best way to describe the broadband skills gap. These are not jobs that need coders but 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 is assumed that students graduate from high school with these skills. However, a student who has never had a home broadband connection or a computer and who only did homework on a cellphone 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 3 to 4 years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over time, households needed more speed, and the 1 Mbps connections started to feel too slow; ISPs introduced faster generations of DSL and cable modems that delivered speeds like 6 Mbps, 10 Mbps, and 15 Mbps. Cable modem speeds continued to grow in capacity and eventually surpassed DSL, and in most cities, the cable companies have captured the lion's share of the market by offering Internet speeds starting between 100 Mbps and 200 Mbps.

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

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

Download Speeds in Megabits / Second

2015	2016	2017	2018	2019	2020	2021	2022
25	30	37	44	54	65	79	95

This is somewhat arbitrary because it assumes that the broadband needs in 2015 were exactly 25 Mbps. What is not arbitrary is that the need for bandwidth and speed increases over time.

If we accept the premise that 25 Mbps was the right definition of broadband in 2015, then it's reasonable to believe that the definition of download broadband by the end of 2022 ought to be almost 100 Mbps. 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 of at least 100 Mbps download do not have a broadband option.

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

1st Quarter 2018	215 Gigabytes
1st Quarter 2019	274 Gigabytes
1st Quarter 2020	403 Gigabytes
1st Quarter 2021	462 Gigabytes
2nd Quarter 2021	433 Gigabytes
3rd Quarter 2021	435 Gigabytes
4th Quarter 2021	536 Gigabytes

This data shows several things. First, it shows extraordinary growth in the average use of broadband across the county. From the first quarter of 2018 to the first quarter of 2019, the average use of household broadband grew by 27%. Usage skyrocketed due to the pandemic. From the first quarter of 2019 to the first quarter of 2020, during the pandemic, the average use of household broadband grew by an astonishing 47%. During the pandemic in 2020, the average household broadband usage grew by another 20%. In 2021 the use of broadband has grown 23% from the end of the first quarter through the end of the year.

OpenVault only recently began reporting upload and download speeds separately. At the end of the third quarter of 2020, the average home downloaded 359 gigabytes of data and uploaded 25 gigabytes of data. By the end of 2020, average usage had grown to an average of 483 gigabytes of download data and 31 gigabytes of upload data. OpenVault reports an average monthly upload usage of 26 GB at the end of 2021.

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

4th Quarter 2018	4.0%
4th Quarter 2019	7.3%
1st Quarter 2020	10.0%
4th Quarter 2020	14.1%
2nd Quarter 2021	12.3%
3rd Quarter 2021	10.1%
4th Quarter 2021	15.1%

Within these numbers are also what OpenVault calls extreme power users, which are households that use more than two terabytes of data per month. That's grown from 0.3% of households in 2019 to 2.5% at the end of 2021.

The most interesting recent statistic is the migration of customers to faster broadband tiers. The following table shows the percentage of nationwide households subscribed to various broadband speed plans in 2020 and 2021.

	June 2020	June 2021	Sept 2021	Dec 2021
Under 50 Mbps	18.4%	10.5%	9.8%	9.4%
50 – 99 Mbps	20.4%	9.6%	8.0%	7.6%
100 – 199 Mbps	37.8%	47.5%	38.4%	36.9%
200 – 499 Mbps	13.5%	17.2%	27.4%	28.5%
500 – 999 Mbps	5.0%	4.7%	5.1%	5.5%
1 Gbps	4.9%	10.5%	11.4%	12.2%

In just the last year, the number of households subscribed to gigabit broadband has doubled, while the number subscribed to slower speeds is dropping precipitously. Many millions of homes over the last year upgraded to faster broadband plans.

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

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

The percentage of homes using less than 100 gigabytes per month has dropped by 43% over three years. At the same time, the number of homes using more than a terabyte of data per month has grown by 500% over three years. While there may be no direct correlation between having a faster broadband plan and using more broadband, total broadband usage is one of the factors leading residential customers to upgrade. Another key factor pushing upgrades is customers looking for faster upload speeds to support work and school from home.

The OpenVault data validates what's been reported widely by ISPs – that the pattern of broadband usage is changing by the time of day. In the recent past, the peak period for broadband usage – the busy hour – was always in the evenings. During the pandemic, the amount of usage in the evenings has remained flat, and all of the increased usage came during the daytime as employees and students used broadband and video conferences to function.

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

employees that realize they can be productive at home are likely to work more from home, even if only on a part-time basis.

These various statistics are a clear indication that the FCC should be periodically increasing the definition of broadband. The agency looked at broadband speeds in a docket in 2018 and 2020 and decided to keep the definition at 25/3 Mbps. However, there were a lot of compelling filings in that docket that argued that the definition of broadband should be 50 Mbps to 100 Mbps.

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

It's also important to look towards the future when considering broadband needs. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband requirements a decade from now. Consider the following chart that predicts broadband needs moving forward. This applies the 21% historical annual growth rate for broadband speed assuming that 100 Mbps is the right definition of broadband in 2022. Forward 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 1980, 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.

It's not hard to put this prediction into perspective. The large cable companies that serve around 65% of all broadband customers in the country almost all advertise that minimum speeds are 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. Last year the agency rejected pleadings asking them to increase the 25/3 Mbps definition to 100/20 Mbps.

There is a political downside if 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.

The Consequences of the Broadband Gaps

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

Impact of Poor Broadband for Citizens

Lack of good broadband causes major problems for rural homeowners:

- Lower Property Values: There are numerous studies showing that homes without broadband are worth less than similarly placed homes with broadband. Realtors have been reporting across the country that broadband is at or near the top of the wish list for most homebuyers today. From everything we hear, it is now difficult to attract people to move to rural places that don't have good broadband. That is a big negative for the small towns without good broadband. Without a broadband solution, the rural parts of Shelby County will become undesirable places to live, and this is only going to get worse over time as broadband speeds keep increasing in the places that have broadband.

- Education: The concern for the schools is that they are unable to send computer-based work home with students since they know that many of them don't have good home Internet. It's incredibly hard to raise kids in a home without adequate broadband. The issue is not just data speeds but also the total amount of downloaded data that even elementary school students need to do homework. This is one of the major problems with satellite broadband, which has speeds up to 50 Mbps, but with tiny data caps and high latency, the satellite broadband is inadequate for doing homework. The same is true with cellular data; we have heard horror stories of people with kids ending up with astronomical broadband bills for using broadband from cellphone hotspots for homework.

  Schools want students to be able to use broadband outside the school. An increasingly widespread practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from

watching videos in class. The whole education process is increasingly moving to the web, and kids without access to the web lack the tools that their peers take for granted.

There was a major study performed to look at what is being called the homework gap by the National Center for Education Statistics (NCES),[8] an agency within the U.S. Department of Education. That study compared test scores for 8th-grade students both with and without a home computer. The results showed:

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

Education is not only for K-12. Adults are using broadband to train for new job skills or to take advanced courses online. There is a vast range of undergraduate and advanced degrees that can be achieved mostly online. Online training courses require decent broadband speeds but also low latency since the training is usually done live.

The COVID-19 crisis has highlighted the need for good home broadband for students since in many places in the country, both K-12 and college students were sent home to complete the school year online. This has instantly created a crisis in rural homes that don't have enough broadband to allow students to successfully do schoolwork from home.

A connection between a student and a school is typically activated through the creation of a VPN (virtual private network). This is a dedicated connection of bandwidth that is carved out of the Internet path, and that remains open for as long as the connection to the school WAN is in use. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. Most of the types of broadband available in Shelby county have much slower upload speeds than download speeds, and even homes with adequate download bandwidth might not be able to establish a VPN connection due to the inadequacies of the upload path.

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

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

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

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

Another recent survey[9] was released by the Pew Research Center that looked at the problems uncovered when we sent kids home to learn.

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

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

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

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

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

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

Hopefully, the pandemic is now behind us, and we won't close so many schools again – although even now, schools are closing temporarily due to Covid outbreaks. But even as we return to a normal school year, we need to pause and recognize that the students without home broadband and

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

computers are at a disadvantage compared to their peers even when school is back to normal. Hopefully, we won't stop caring about the homework gap.

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

  Working from home is one of the fastest-growing parts of the national economy. Many of your residents could find work that would allow them to work at home and to make a larger income than they can make today locally – if they have great broadband. After years of experiments with telecommuting, companies have seen that employees are often more productive from home due to missing the various distractions that are in the work environment.

  The COVID-19 crisis highlighted the need for good home broadband when as many as 30% of the nationwide workforce was sent home to work in early March. Across the country, employees that live in rural areas were unable to work from home due to inadequate broadband.

  Working at home requires an encrypted VPN connection for most corporate and government WANs, in the same manner as described above for connecting to school WANs. Working at home is also coming to mean connecting by video conference with others as an alternative to face-to-face meetings. This requires a dedicated 1 – 3 Mbps connection for both upload and download – again, something that is a challenge for somebody working from home with a slow Internet connection.

  Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. This makes it impossible to make either kind of connection reliably over satellite broadband.

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

  As this report was being written, *U.S.A Today* reported on the results of the fifth annual survey of the State of Remote Work[10] conducted by Owl Labs and Global Workplace Analytics. The nationwide survey was done last summer at a time when almost one-fourth of workers continued to work at least partially from home.

  The survey showed a strong desire of employees to work from home, at least part-time. Here are a few of the most interesting findings from the survey:
  - A little more than half of all employees would choose to work full-time from home. 74% of those interviewed said that working at home made them happier.

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

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

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

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

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

I have rural clients that operate rural fiber networks who tell me that their communities are seeing a new demand for building new homes and that housing prices are increasing as people want to move to the community. This presents an interesting challenge to rural communities wondering how to get the word out to prospective work-from-home employees. This is a new challenge that is a 180-degree turn from traditional economic development efforts, but communities that master it ought to grow and thrive and bring fresh breath into aging communities.

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

broadband. The biggest benefit of telemedicine is being able to talk to a specialist without having to make a long trip to some distant city.

One of the best uses that have been found for telemedicine is for administering non-intrusive assistance for things like counseling. Patients can make scheduled appointments without major disruption to work schedules.

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

The coronavirus crisis has highlighted the need for telemedicine. Doctor's offices and clinics all across the country have shifted some of their office "visits" to video meetings on Zoom or other video platforms in order to reduce contact between doctors and patients when it can be avoided. There have been widespread reports that some doctors require video connections for all non-emergency visits. Counselors and mental health workers also report migrating most or even all contacts with clients online. It's immediately become clear that patients without home broadband or without a strong cellular signal can't make the needed video connection. There is a lot of speculation that video meetings and telemedicine are going to become mainstream by the end of the coronavirus crisis once doctors understand how effective it can be in many cases.

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

  Taking part in the modern world has grown to mean a lot more than just watching videos. Consider some of the following ways that a lot of households routinely use bandwidth:
  - Security. Millions of homes now have video cameras at the front door or elsewhere on their property that they can view remotely. A video camera requires a 1 – 3 Mbps upload connection for low-resolution cameras and up to 16 Mbps upload for an HD quality camera.
  - Machine-to-Machine Traffic. Our devices often connect with the Internet without human intervention. Our computers and smartphones automatically upgrade software and apps. Many homes have files automatically backed-up in cloud storage. Numerous appliances and devices in our home periodically connect with the cloud, whether providing updates or just to make sure that the connection is still live. Many cars now communicate with the

cloud when they get into range of a home broadband connection to provide a log of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that this traffic would represent over 50% of all the traffic on the web by 2023.

- Online Everything. Many of the functions we do have migrated to being only online – we couldn't even begin to make a full list of things that are largely now online. This includes both major and minor functions, including things like applying for a job, applying for government benefits, making insurance claims, making reservations for a restaurant, banking, and a slew of other activities. Homes without broadband are being left out of numerous activities that everybody else takes for granted.

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

Impact of Poor Broadband for Businesses

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

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

- To Communicate with Customers. Businesses routinely have portals that make it easy for customers to place and track orders and to communicate with the business. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly passing away, and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. Businesses that operate busy eCommerce ordering sites need big amounts of bandwidth to make sure that all customers have a successful purchasing experience. A concern for rural businesses is that current slow technologies often don't provide enough bandwidth to process credit card transactions.
- To Communicate with Vendors. Businesses also routinely use the portals of their own vendors to buy whatever they need to operate.
- To Communicate with Other Branches of the Company. Many businesses are branches of a larger corporation and maintain open data connections to communicate with other parts of the company and with headquarters.
- Working in the Cloud. It's now common for companies to work in the cloud using data that's stored somewhere offsite. This can be in one of the big public clouds like the ones offered by Amazon, Google, or Microsoft, or it can be a private cloud available only to employees of the business. This is the change in the way that companies operate that has created the most recent growth in bandwidth. A business doesn't need to be highly sophisticated to work in the cloud.

Today banking is routinely done in the cloud. A lot of basic software like Microsoft Office has migrated to the cloud. Even interfaces with local, state, and federal governments have migrated to the cloud.

- Security Systems. Businesses often have their network and computer security monitored by offsite firms. Security today also means the use of video surveillance cameras, which require uploading video streams to be viewed outside of the business.
- Sending and Receiving Large Data Files. Most businesses report that the size of data files they routinely transmit and receive has grown significantly larger over the last few years. Some surprisingly small businesses like photographers, architects, engineers, and others routinely want to send and receive big data files.
- VoIP. Many businesses now provide voice communications between their various branches using Voice over IP. A reliable VoIP system needs to have dedicated bandwidth that is guaranteed, and that won't vary according to other demands for bandwidth within the business.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video both inside and outside the business. We saw a huge surge in this during the COVID-19 crisis as students and employees increasingly used video conferencing services, but these services had already become routine for businesses before the crisis.
- Email and Advanced Communications. While many businesses still rely on email, many have gone to more advanced communications systems that let parties connect in a wide variety of ways. Businesses are using collaborative tools that let multiple employees from various locations work on documents or other materials in real-time. These services require good download and upload bandwidth.
- Supporting Remote Employees. Many businesses now save money by allowing employees to work from home full or part-time. They need reliable broadband links to provide home-based employees the same access to systems that are on site. A complaint heard from rural businesses is that they must physically carry files to their homes or other places with good broadband to conduct routine business.
- Data Back-Up. Companies are wary of hacking and ransomware and routinely maintain several remote copies of all critical data to allow them to restore data after a problem. Data back-up requires a steady and reliable upstream broadband connection.
- Internet of Things Sensors. Companies of all sizes now routinely use devices that include sensors that communicate with the Internet. One common function of this sort is burglar alarm systems that monitor physical security and sensors inside equipment that monitors data security. Routinely used office equipment like printers, copiers, postage machines, and many others only function when connected to the Internet.

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

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

Future Uses of Broadband for Businesses. There are several trends that we are seeing that require world-class broadband. For example, consider the emergence of smart factories. The pandemic uncovered major

problems in the U.S. supply chain, and both political parties are now talking about a big government push to bring manufacturing back to the U.S., particularly in vulnerable areas like medicines and electronics. Any factory built today will likely rely on robotics and automation, including relying on cloud connectivity to direct and monitor the manufacturing, marketing, and shipping processes. Smart factories will still require employees, so losing out on this market segment will keep good-paying technical jobs out of the county. Over the past decade, the U.S. has created over 900,000 jobs in newly built "smart" factories.

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

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

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

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

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

One of the more interesting trends in farming is to record and report on every aspect of the food chain. When the country stopped eating romaine in late 2018 because of contamination at one farm, the industry started to develop a process where each step of the production of crops is recorded, with the goal being to report the history of food to the consumer. In the not-too-distant future, a consumer will be able to scan a package of lettuce or other crops and know where the crop was grown, how it was grown (organic or

not), when it was picked, shipped, and brought to the store. This all requires creating a blockchain with an immutable history of each crop, from farm to store, and making this history immediately available to stores and to consumers.

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

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

IV. BACKGROUND INFORMATION

A. Competing Technologies

Existing Technologies

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

- CenturyLink and Mark Twain Rural Telephone serve Shelby County with copper telephone wires using DSL technology.
- Charter uses Hybrid Fiber Coaxial (HFC) technology.
- Mark Twain Communications is delivering broadband using point-to-multipoint fixed wireless technology.
- Some rural homes buy broadband from satellites.
- Some rural homes get broadband using the data on their cellphone plans.
- Cellular carriers are launching faster fixed cellular data plans labeled as 5G.
- We surprisingly heard that there were still rural households in the county using dial-up.
- 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. The public doesn't realize how the vendors in this industry keep improving technology.

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

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

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

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

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

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

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

While you never hear much about it, DSL technology over copper has gotten better. There are new versions of G.Fast that are being used to distribute broadband inside apartment buildings with speeds up to 500 Mbps – for short distances.

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

DSL over Copper Wires

CenturyLink and Mark Twain Rural Telephone provide broadband using DSL (Digital Subscriber Line). DSL is used to provide a broadband path over telephone copper wire. These networks were mostly built between the 1950s and early 1970s. The copper networks were originally expected to have an economic life of forty years and have now far exceeded the economic life of the assets. The copper networks are deteriorating as a natural process of decay due to sitting in the elements. Even more importantly, the copper networks have deteriorated due to neglect. The big telcos started to cut back on the maintenance of copper in the 1980s as the companies were deregulated from some of their historical obligations.

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 Monroe County is of older varieties and delivers slower speeds.

The most important characteristic of DSL is that data speed delivered to customers decreases with the distance the signal travels. The general rule of thumb is that most of the types of DSL can deliver a decent amount of bandwidth for about two miles over copper – that's miles of copper wires, not two miles as the crow flies. DSL signal strength is also affected by the quality of the copper – newer copper and larger gauge copper wires mean better bandwidth. Many of the copper wires in the country are now 50 to 70 years old and have outlived their original expected service life.

Hybrid Fiber Coaxial Network

Charter uses is Hybrid Fiber Coaxial (HFC) technology. Hybrid refers to the fact that an HFC network uses a fiber backbone network to bring bandwidth to neighborhoods and a copper network of coaxial cable to deliver service to customers. HFC networks are considered lean fiber networks (meaning 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 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 transmitted more than about 2.5 miles over a coaxial network from a network node. This limitation is based 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 less than five 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 250 Mbps download. By now, most big cable companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically could produce broadband speeds as fast as 8–10 Gbps if a network carried only broadband and had zero television channels. Since there are still a lot of TV channels on most cable systems, most cable companies have increased the maximum broadband speeds to between 500 Mbps and 1 Gbps using DOCSIS 3.1.

One limitation of a DOCSIS network is that the standard does not allow for symmetrical data speeds, meaning that download speeds are much faster than upload speeds. This is an inherent design characteristic of DOCSIS 3.0 and DOCSIS 3.1 where no more than 1/8 of the bandwidth can be used for upload. Most cable companies have allocated even less than the 1/8 to upload. Earlier in the report was a lengthy discussion about the upgrade speed crisis that has become apparent during the pandemic. The cable companies are 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 a captive radio network kept inside of the copper coaxial wires. As such, the signals inside a coaxial system share the same characteristics as any wireless network. Higher frequencies carry more data bits than lower frequencies. All of the signals are subject to interference if external frequencies leak into the cable transmission path.

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

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

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

CableLabs has developed the new DOCSIS 4.0 standard that was released in March 2020. The DOCSIS 4.0 standard allows for a theoretical transmission of 10 Gbps downstream and 6 Gbps upstream. Comcast just did a lab test of the technology and achieved symmetrical 4 Gbps bandwidth. Don't expect this to mean that cable companies will be offering fast symmetrical broadband any time soon. There is a long way to go from the first lab test to a product deployed in the field. Lab scientists will first work on perfecting the DOCSIS 4.0 chip based upon whatever they found during the trial. It typically takes most of a year to create a new chip, and it would be surprising for Comcast to spend several years and a few iterations to solidify the chip design. Assuming Comcast or some cable company is ready to buy a significant quantity of the new chips, it would be put into the product design cycle at a manufacturer to be integrated into the CMTS core and into home cable modems.

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

An upgrade to DOCSIS 4.0 isn't going to be cheap. It first means replacing all existing electronics in a rip-and-replace upgrade. That includes cable modems at every customer premise. DOCSIS 4.0 will require network capacity to be increased to at least 1.2 GHz. This 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 undertaking another costly upgrade on an aging copper network?

Fixed Wireless

This technology is used by the wireless ISPs (WISPs) in the county. When considering fiber for open farming areas, we automatically consider wireless technology to see if it might be a fit. We asked ourselves of the speeds that could be delivered by a new deployment. Our conclusion is that a new network built with the best wireless technology available could deliver broadband speeds between 50 Mbps and 150

Mbps to some customers in the county – but the network would still not reach everybody due to trees and terrain.

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

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

  In practical use, in wide-open conditions, these frequencies can be used to serve customers up to about 6 miles from a transmitter, although speeds can be slow at the far end of 6 miles. Many wireless carriers advertising speeds in the range of 25 to 50 Mbps. We know of networks doing speeds over 100 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 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 spectrum is 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 low, non-line of site frequencies can fill in the gaps (valleys, back side of ridges, dense tree cover, etc.) that defeat any of the GHz frequencies. Range is also significantly longer; however, the throughput per channel is much lower than WiFi or CBRS. The extended range comes with a burden, TVWS will interfere with television stations 100s of miles away, limiting deployment in areas with numerous active TV broadcast stations. The FCC order refers to whitespace radio devices that will work in the spectrum as TVBD devices.

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

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

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

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

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

- Using Multiple Frequencies. The newest radios are much improved over radios from just a few years ago because they use spectrum bands including 2.4 GHz, 3.5 GHz, and 5.0 GHz. Radios are now starting to integrate white space spectrum and CBRS spectrum. Having more spectrum matters because each frequency band has different operating characteristics in terms of distance and ability to penetrate obstacles. Using multiple frequencies provides an increased opportunity to find a workable solution for each customer in the service area.
- Adequate Backhaul. The best fixed wireless coverage comes when there is fiber at the transmitter that supplies the needed bandwidth. Customer broadband speeds are diminished if a tower doesn't receive enough bandwidth – lack of backhaul bandwidth is the primary reason why many WISPs deliver speeds under 10 Mbps.
- Terrain/Topology. There are often physical barriers like hills or heavy woods that can limit or block customer bandwidth. With the exception of TVWS, the spectrum used for this technology requires a good lines-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 can't get service. If the signal passes through trees to reach a customer, the strength of the signal is diminished.

- Height of the Tower. The taller the transmitting radio, the better, because the high placement of the antenna provides a better opportunity to look down on homes without having to pass through trees.

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

- There are already several WISPs operating in the county, and that means there is going to be interference with the radio signals. Interference translates into slower broadband speeds, and so speeds could be even lower than discussed above. This network also relies on the CBRS spectrum to achieve faster speeds.
- Wireless electronics have a short economic life. Most of our clients have found that customer radios have to be replaced roughly every seven years.
- It's highly unlikely that any of this equipment would be eligible for federal or state grants. Theoretically, federal grants will probably support technologies that can claim 100/20 Mbps speeds. While wireless can reach those speeds, current grants typically give priority to faster technologies.
- The biggest concern about making this investment is that there might be enough grant money coming to build fiber. We believe that when fiber is built to a rural area that WISPs will be unable to compete and will fade away over time. Wireless would be a poor investment if somebody else built fiber within a few years to compete with a wireless network.

Geostationary Satellite Broadband

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

The most limiting aspect of GEO satellite broadband is latency, which means a delay in the signal. These satellites are parked at over 22,000 miles above the earth, and when an Internet connection must travel to and from a satellite, there is a noticeable delay; that delay makes it hard or impossible to do real-time transactions on the web. Current satellite latency can be as high as 900 milliseconds. Any latency above 100 milliseconds creates a problem with real-time applications such as streaming video, voice-over-IP, gaming, online education, or making connections to corporate WANs (for working at home). When the latency gets too high, such services won't work at all. Any website or service that requires a constant connection will perform poorly, if at all, with a satellite connection. Satellite broadband also comes with tiny data caps, meaning a customer is highly limited by the amount of data they can send or receive during a month.

Low Earth Orbit Satellites

The newest satellite option is low earth orbit (LEO) technology with satellites that orbit between 200 and 800 miles above the earth. Low-orbit satellites have one major benefit over geostationary satellites. By being significantly closer to the earth, the data transmitted from low-orbit satellites will have a latency of between 25 and 35 milliseconds—about the same as experienced in a cable TV broadband network. This is much better than the current latency for high-orbit satellites. The low-orbit satellites can easily support real-time applications like VoIP, video streaming, live Internet connections like Skype, or distance learning.

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

There has been a lot of recent news concerning the three primary companies that are vying in the market. Starlink and SpaceX are all over the news. Starlink has been in beta test mode since 2020. Starlink has over 1,900 satellites in orbit and says it will cover the whole U.S. by the end of 2022. The company has signed over 100,000 customers in a beta test mode. The monthly rate is $99, and the receiver costs $500. Starlink has also taken over 500,000 deposits of $99 for customers on a waiting list. There is no guarantee that any customer will be able to receive service. Starlink claims it will eventually launch 30,000 satellites, with over 11,000 in the first constellation.

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

Starlink's biggest challenge will be in having enough frequency to be able to pass data between the cloud and the earth. The company lost a battle at the FCC trying to get access to frequency owned by Dish Networks. The battle is over the spectrum between 12.2 – 12.7 GHz. Dish wants to use this spectrum for terrestrial 5G, and this would curtail Starlink's backhaul capabilities. A recent FCC ruling warned Starlink that it might not get access to the spectrum.

The other active satellite company is OneWeb. Eutelsat, one of the world's largest operators of satellites, recently made an investment and took a 24% stake in the company. This adds to the existing ownership by the U.K. government and Bharti Global, a large cellular carrier in India.

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

The final big player is Jeff Bezos and Project Kuiper, which is still likely to get a brand name at some point, something as simple as Amazon Broadband. The company has contracted with United Launch

Alliance, a joint Boeing-Lockheed Martin venture, to launch the first nine broadband satellite launches. It's been speculated that these launches will carry around 500 satellites into orbit – including the company's first test satellites. There have been no announced dates for the nine launches, but speculation is that launches will start this year.

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

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

4G LTE Cellular Broadband

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

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

	Nationwide Average		26 Major Cities	
	Download	Upload	Download	Upload
AT&T	28.9 Mbps	9.4 Mbps	103.1 Mbps	19.3 Mbps
T-Mobile	32.7 Mbps	12.9 Mbps	74.0 Mbps	25.8 Mbps
Verizon	32.2 Mbps	10.0 Mbps	105.1 Mbps	21.6 Mbps

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

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

5G Cellular Broadband

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

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

Currently, there are no cellular deployments that can be legitimately called 5G. Full 5G will not arrive until the carriers have implemented the bulk of the new features described in the 5G specifications. For now, none of the key features of 5G have been developed and introduced into the market. 5G deployment will come in stages as each of the 5G features reaches markets – the same thing that happened to 4G. The latest estimate from vendors is that real 5G is still five or six years away. The same thing happened with 4G, and it took most of a decade to see 4G fully implemented – in fact, the first U.S. cell site fully meeting the 4G standards was not activated until late 2018.

These broadband products that are being called 5G are still using 4G LTE technology but are being deployed on new bands of spectrum. New spectrum does not equal 5G – the 5G experience only comes with 5G features. Older cellphones cannot receive the new spectrum bands, and so the carriers have furiously been selling new phones that can receive the new spectrum and labeling this effort as 5G. We heard from a few customers in the county who are receiving speeds over 100 Mbps download on this product.

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

Metro Ethernet

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

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

5G Hot Spots

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

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

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

Millimeter-Wave Point-to-Multipoint Broadband

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

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

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

The biggest impediment to the business plan is that it requires building fiber along each street served, making this at least as costly as building fiber-to-the-home. The cost of putting fiber on poles can be expensive if there are already a lot of other wires on the poles (from the electric, cable, and telephone companies). In neighborhoods where other utilities are underground, the cost of constructing fiber can be

even higher. Another challenge for the technology is that the millimeter-wave spectrum requires a clear path between the transmitter and a dish placed on the home – and that means that 5G is best deployed on straight streets without curves, hills, or dense tree cover.

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

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

Verizon recently announced it is mixing millimeter-wave and CBRS spectrum as it expands the product. The company plans to pass 25 million homes with the technology by the end of 2025. Analysts expect this expansion to occur in major cities and surrounding suburbs and will not likely be extended to places like rural Shelby County.

Wireless Mesh Wireless - Starry

This is the technology that Starry uses. The company is owned by Chet Kanojia, an inventor and entrepreneur who has developed several proprietary wireless technologies. He's been operating wireless networks in major markets like Boston, Washington DC, Denver, New York City, and Los Angeles. Starry beams broadband to apartment units in high-rises through receivers placed in windows.[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 is ready to roll out a new wireless technology that is 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 area. The technology is available to anybody from high-rises to single-family homes and will cover downtown and stretch into nearby suburbs.

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

[11] https://starry.com/

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 soon get back to its standard $50 rate. Starry has big plans to eventually pass up to 40 million households with the technology.

B. Broadband Grants

Grants

It's hard to imagine the construction of fiber networks in rural areas without some grant support.

Federal Broadband Grants: There are several permanent federal broadband grant programs that might benefit this project.

ARPA State and Local Fiscal Recovery Funds (SLFRF)

This is the $350 billion of funding that is going directly to states, counties, cities, towns, and townships. The purpose of this funding is to provide state and local governments with the necessary resources to:

- Fight the pandemic and support families and businesses struggling with its public health and economic impacts,
- Maintain vital public services, even amid declines in revenue, and
- Build a strong, resilient, and equitable recovery by making investments that support long-term growth and opportunity.

While the funds can be used for a number of different types of programs, they must address one of the following four categories:

- Replace lost public sector revenue
- Support the COVID-19 public health and economic response
- Provide premium pay for eligible workers performing essential work
- Invest in water, sewer, and broadband infrastructure.

The final rules eliminate any consideration of existing broadband speeds. The final rules allow broadband to be constructed to reach households and businesses with an identified need for additional broadband infrastructure investment. There still must be a justification that the project addresses a problem highlighted by the pandemic. But rather than relying on speed as the justification, localities can consider broadband reliability, affordability, or access to a connection that meets or exceed symmetrical 100 Mbps. Localities can document this need using any available data, including local speed tests, federal or state data, interviews with residents and businesses in the affected areas, using any 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] that will go 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 FCC mapping in determining eligibility. A grant area must only be shown to not have reliable 100/20 Mbps broadband in order to be eligible – that is a very loose test. Treasury provides amazing leeway in defining eligible areas, and almost any reasonable form of proof of poor broadband can suffice to prove an area is eligible. Of course, states will have some say in defining eligible areas, and I foresee a huge tug-of-war over this issue between state grant offices and communities.

Grant projects must be able to provide symmetrical gigabit speeds. There is going to cause confusion all over the industry as different grant programs have different speed requirements. This might also require legislative changes in some states.

A project must meet all of the following requirements: A project must be spent on infrastructure that will enable work, education, or health monitoring. Projects must address a critical need that results from or was made obvious during the pandemic. Projects must address a critical community need.

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

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 is a new round of ReConnect grants currently underway in 2022 that will award $1.15 billion in funding, with grants due in February 2022. There will be an additional round of ReConnect grants in the summer of 2022 for an additional $2 billion. Following is a highlight of the rules for latest ReConnect grants.

- Speeds. This is the first federal grant program that will consider any area not served today by 100/20 Mbps broadband. But note that there is a big grant scoring penalty for serving areas with existing speeds greater than 25/3 Mbps. This means the grant allows serving areas with existing speeds greater than 25/3 but penalizes an applicant for doing so. The grants do not automatically adhere to FCC mapping data, but an applicant needs to be prepared to demonstrate why an area is eligible. To challenge the FCC mapping requires an opinion from an engineer who has examined technology in the field or a rigorous online survey that demonstrates slow speeds.
- Eligible Entities. Almost anybody is eligible, but a big preference is given to tribes and to "local governments, non-profits, and cooperatives as applicants and additional points to those applications (including for projects involving public-private partnerships where the local government, non-profit, or cooperative is the applicant)."
- Must be Rural. Grant-serving areas must be rural and remote. There is a ReConnect mapping tool[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

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

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

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 nondiscriminatory. 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. This is one of the more confusing rules and will need clarification. It seems likely that this will allow somebody already getting RDOF to use these funds if it accelerates the construction timeline.

HUD Community Development Block Grants (CDBG)

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

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

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

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

- The acquisition, construction, reconstruction, rehabilitation, or installation of public facilities and improvements (which include fiber or wireless infrastructure improvements).
- The acquisition, construction, reconstruction, rehabilitation, or installation of distribution lines and facilities of privately-owned utilities, which includes the placing underground of new or existing distribution facilities and lines.
- Digital literacy classes as a public service.
- Economic development – grants/loans to for-profit businesses, particularly businesses that focus on broadband/Internet access and technology.

It's worth noting that the CDBG program also makes block grants to states which then can administer grants. These state grants must still follow the same federal guidelines for eligibility as listed above.

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

Broadband Equity, Access, and Deployment Program (BEAD) Grants

This is the official name of the $42.5 billion grant program approved by Congress in November 2021. This grant program was established by the Infrastructure Investment and Jobs Act. Congress established the following high-level requirements for this grant program. The NTIA recently released updated rules to be used by each states to prepare its broadband plan.

- No Specified Starting Date. The best guess in the industry is that grants will not be awarded until late 2023 or into 2024. The NTIA has a number of steps to complete before these grants are awarded. This funding will flow between the NTIA and States, and the States will choose grant winners.
- 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.
- Technology Must be at Least 100/100 Mbps. Anything built with the network must deliver speeds of at least 100/100 Mbps – but there are waivers to build infrastructure that meets 100/20 Mbps.
- 5-Year Funding Period. States have five years to disperse the funds. We don't know what that means. It could mean a series of grants funding rounds over a few years, or it could mean one giant grant process at the beginning, with payments stretched out over time. Each state is likely to have a different solution.
- Other Uses of the Grants. Grants don't have to all go for broadband to unserved and underserved areas. Grants can be made to connect eligible community anchor institutions. States can use the money for data collection, broadband mapping, and planning. Funding can go to serve qualifying multi-family apartments with WiFi or low-cost broadband.
- Eligible to All. BEAD doesn't give priority to any class of grant recipients. The grants can't exclude cooperatives, non-profit organizations, public-private partnerships, private companies, public or private utilities, public utility districts, or local governments from eligibility.
- Several Grant Priorities. States must give priority to grants that are deployed in counties with persistent poverty. Projects that will deliver more than the minimum speeds will be given priority. Projects that are shovel-ready will be given priority. Projects that pledge to pay Davis-Bacon wages will get priority.
- Challenge Process. The grants are going to use the FCC broadband maps to define grant-eligible areas. The NTIA process allows local communities to challenge the FCC maps.
- 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. However, the NTIA still wants grants to go to ISPs that ask for the lowest amount of funding.

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

The amount of funding that will go to each state is formulaic. 50% will be awarded based upon the population of each state according to the 2020 Census. 25% will be awarded based upon the number of homes that have household incomes that are less than 150% of the poverty level, as defined by the U.S. Census. The final 25% will come from the comparative lack of broadband adoption as measured by the FCC 477 process, the American Community Survey conducted by the U.S. Census, and the NTIA Internet Use Survey.

The second new grant program is called the Digital Equity Competitive Grant Program. These are grants that will be administered by the NTIA and awarded directly to grant recipients. The budget for this grant program is $1.25 billion, with $250 million per year to be awarded in 2022 through 2026.

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

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

The two grant programs create an interesting choice for entities involved in digital inclusion. They can go after funding through the state or compete nationwide for grants. I doubt that anybody can make that decision until we see the specific grant rules coming out of each program.

State Grant Programs

Missouri Broadband Program.[15] The Office of Broadband Development is part of the Department of Economic Development in Missouri. The stated goals of the agency are to:

- Increase broadband data collection and utilization
- Accelerate broadband infrastructure and access.
- Leverage partnerships to accelerate broadband efforts.
- Increase broadband adoption & awareness
- Promote efficiencies and opportunities in broadband development

Missouri Broadband Grants.[16] This grant program was established in 2018. For now, this is only a rural broadband grant program because under current rules. In the past it has only funded projects in places where broadband speeds are 10/1 Mbps or slower.

The funding for the grants must be approved each year by the legislature. The projects funded in 2020 were all small, with the largest at less than $500,000 and many much smaller. The latest round of the grant applications ended in Jan 2022.

In January, Governor Mike Parsons recommended that the legislature approve $400 million in broadband grants be funded out of the State's share of ARPA funding. In April, the legislature approved $372 million for broadband development. The details of this grant program have not yet been announced, although it is likely that this will flow through the existing broadband grant program. The state still has $369 million of ARPA that has not been appropriated, so there could be additional funding for broadband.

C. Legislative / Regulatory Review

The following is a listing of regulations that would apply to any ISP offering service in the city to provide broadband or telephone services. This list does not cover cable TV regulations.

[15] https://ded.mo.gov/content/broadband-development

[16] https://ded.mo.gov/content/Missouri-broadband-grant-program

FCC Regulatory Requirements

Generic Regulations

The following regulations apply to any entity undertaking any one of the FCC's regulated business lines (broadband, telephone, cable TV, or cellular).

Federal Registration Requirement

All entities that want to do business with the FCC must obtain an FCC Registration Number (FRN). Additionally, entities entering the telecommunication market must receive a Form 499 identification number from the Universal Service Administrative Company (USAC) by filing a signed copy of FCC Form 499-A.

Customer Proprietary Network Information (CPNI) Compliance Certification

Section 222 of the FCC's rules require that telecommunications carriers and interconnected VoIP providers take specific actions to protect customer data. The FCC rules specify the customer data that must be protected. A telecommunications provider must file an annual certification that states that it is in compliance with the CPNI rules along with a statement each year that summarizes the carrier's CPNI practices and that discloses any customer complaints about violation of customer privacy. The FCC provides a detailed guide outlining the specifics of the CPNI rules.[17]

Infrastructure Access Rights

The FCC, as a result of the Telecommunications Act of 1996, provides carriers with nondiscriminatory access to poles, ducts, and conduits. This overall rule applies to any carrier doing business in Missouri since the State of Missouri still follows the FCC's rules for pole attachments.

Common Carrier Annual Employment Report - Form 395

Common carriers with sixteen or more employees must complete and file FCC Form 395, Annual Employment Report, by May 31 of each year. Data must reflect employment figures from any one payroll period in January, February, or March.

Disability Access and Recordkeeping

Section 255 of the FCC rules require that telecommunications equipment manufacturers and service providers make their products and services accessible to people with disabilities, if readily achievable. If accessibility for individuals with disabilities is not readily achievable, the provider must ensure that the equipment or service is compatible with existing peripheral devices or specialized customer premises equipment commonly used by individuals with disabilities to achieve access.

[17] https://www.fcc.gov/document/customer-proprietary-network-information-cpni.

In 2010, Congress enacted the Twenty-First Century and Video Accessibility Act (CVAA), which imposed additional recordkeeping and certification requirements relating to disability access. Affected providers must record and maintain information about the accessibility features of its products and services and about the provider's efforts to consult with individuals with disabilities. A service provider must certify annually with the FCC that it meets the accessibility requirements.

Truth-in-Billing Rules

The FCC adopted Truth-in-Billing rules that specify the level of detail that must be included on telecommunications bills. The Truth-in-Billing rules specify a lengthy list of requirements that must be included on customer bills. The rules also outline other ways that carriers must inform customers of their rights for billing issues.

Annual FCC Regulatory Fees – Form 499

Interstate telecommunications service providers, local exchange carriers, and other telecommunications service providers, as well as interconnected VoIP providers, must pay an annual FCC regulatory fee. Carriers subject to the rules must submit Form 499 annually showing revenues. The annual fee is based upon the amount of Interstate revenues.

Government entities and non-profit entities which are exempt under section 501(c) of the IRS Code are also exempt from regulatory fees but still have to file the 499 form.

Broadband Regulation

The FCC describes its regulation of broadband carriers as 'light-touch' regulation. What this means in practical terms is that the FCC no longer exercises any blanket regulatory authority over broadband providers for big topics like rate regulation. However, the FCC still maintains a few areas of broadband regulation, as discussed below.

Broadband Reporting - Form 477

All ISPs selling retail broadband service or interconnected VoIP must report details of the coverage to the FCC twice each year.[18] This currently involves reporting data like the number of customers, the broadband speeds that can be delivered, and the technology being used by Census block. The FCC is in the process of modifying the method of data collection including the use of mapping tools. This reporting is the most time-consuming regulatory requirement for many ISPs.

Communications Assistance for Law Enforcement Act (CALEA)

Providers of telecommunications service, facilities-based Internet access service, and interconnected VoIP are subject to the Communications Assistance for Law Enforcement Act (CALEA). The CALEA rules are to make certain that carriers have the technical capability to allow law enforcement to conduct

[18] The 214 forms ask for a lot of information. The forms are found at this link: https://apps2.fcc.gov/form477/login.xhtml.

electronic surveillance of customers after a valid subpoena.

Each ISP must create and keep updated a manual that describes how it complies with the CALEA rules and describe to law enforcement how to initiate a valid surveillance process.

Digital Millennium Copyright Act (DMCA)

The Digital Millennium Copyright Act of 1998 (DMCA) added several major provisions to the Copyright Act that delineate the rights and protections afforded to copyright owners and users in the digital age. Section 512 to the Copyright Act establishes safe harbors that can limit the type of relief that can be sought by copyright holders can bring against ISPs. The Act protects ISPs against copyright violations by an ISP's customers.

Regulatory Treatment of "Broadband Internet Access Service" (BIAS)

In its *Restoring Internet Freedom Order* issued in January 2018, the FCC rolled back portions of the *Open Internet Order* that had established net neutrality. In so doing, the FCC also reclassified broadband Internet access service from a Title II common carrier "telecommunications service" to an unregulated Title I "information service." However, there are a few requirements from the original net neutrality order that are still in effect.

The Restoring Internet Freedom Order established new transparency requirements that give the FCC insight into current ISPs practices and that are supposed to allow consumers to understand the business practices of their ISP.

The specific transparency obligations include the following:

Network Management Practices. The FCC requires an ISP to disclose its practices for the following:

- *Blocking.* Any practice that blocks or otherwise prevents end user access to lawful content or applications.
- *Throttling*. Any practice that degrades or impairs access to lawful Internet traffic.
- *Affiliated Prioritization.* Any practice that directly or indirectly favors some traffic over other traffic to benefit an affiliate.
- *Paid Prioritization.* Any practice that directly or indirectly favors some traffic over other traffic in exchange for consideration, monetary or otherwise.
- *Congestion Management*. ISPs should describe congestion management practices, if any.
- *Application-Specific Behavior.* ISP should disclose if it blocks or rate-controls specific protocols or protocol ports, modifies protocol fields in ways not prescribed by the protocol standard, or otherwise inhibits or favors certain applications, classes, or applications.
- *Device Attachment Rules*. An ISP should disclose of there are any devices that can't be connected to the network.
- *Security.* An ISP should disclose the goals of security practices, including types of triggering conditions that cause a mechanism to be invoked.

Performance Characteristics. The FCC requires an ISP to disclose information about the services it provides.

- *Service Description.* A general description of the service, including the service technology, expected and actual access speed and latency, and the suitability of the service for real-time applications.
- *Impact of Non-Broadband Internet Access Service Data Services.* An ISP should disclose any non-broadband services it provides and describe how any non-broadband service data may affect the last-mile performance of broadband.

Commercial Terms. The FCC requires an ISP to disclose the terms on which they make their services available:

- *Price.* An ISP must disclose monthly prices, usage-based fees, and fees for early termination.
- *Privacy Policies.* An ISP must disclose its privacy practices if any. For example, the ISP must disclose if it uses deep-packet inspection to monitor network traffic, whether traffic is stored or provided to third parties, or if customer traffic is used by the ISP for non-network management purposes.
- *Redress Options.* ISPs must describe how customers can resolve complaints.

Telephone Regulation

Section 214 Certification.

A carrier that wants to sell Interstate or International long-distance must be certified under Section 214 rules by the FCC. It is possible to avoid the need for 214 authority by reselling long-distance from a carrier that already has 214 authority.

A carrier with 214 authority must request permission from the FCC to discontinue service if that means walking away from existing customers.

Kari's Law and RAY BAUM'S Act

Kari's Law became a legal requirement on February 16, 2018, and it applies to multi-line telephone systems (MLTS), which are telephone systems that serve consumers in environments such as office buildings, campuses, or hotels. The law requires that users of MLTS phone systems must be able to dial 911 directly without any additional digits or codes.

On March 23, 2018, the RAY BAUM'S Act was signed into law. This law supplements Kari's law and requires that any call to 911 include 'dispatchable' information, so that first responders can quickly find somebody who dialed 911. If this can't be done as part of caller ID, then locations like campuses, hotels, and large businesses must provide this information directly to local 911 centers.

While these requirements apply to phone systems at MLTS locations, the FCC expects that carriers to make certain there is compliance.

Local Number Portability

The FCC requires that any carrier that sells telephone service must participate in number portability, which are the rules that allow customers to keep a telephone number when switching between providers. In most places in the country (some rural areas are excluded), numbers can also be ported between landline and cellular carriers.

Battery Backup Obligation

The FCC requires that anybody that provides telephone service offer an option for battery backup to customers. Traditionally, telephones served on copper wire continue to work when a home loses power, and the FCC has extended that to all other technologies. Carriers only need to offer the sale of battery backup equipment for sale at cost and are not required to provide battery backup as part of the monthly rate for telephone service

Broadband and Telephone Regulation

Federal Universal Service Program

Contributing to the USP. The FCC requires providers of "interstate" and "international" "telecommunications," "telecommunications service," or "Voice over Internet Protocol" to pay into the Universal Service Fund (USF). These fees can be passed on to end users at an ISP's discretion. All providers of these services must file FCC Form 499-A annually, including carriers that don't owe payments to the USF.

Providers must file FCC Form 499-Q quarterly to report qualifying revenues to the FCC that are subject to the USF fees. Each calendar quarter, the FCC announces the relevant percentage due for that quarter.

Drawing from the Universal Service Fund. Carriers can elect to participate in the programs in the fund that subsidize telecommunications services. Such participation is optional. There are a number of programs that operate under the Universal Service Fund:

- Schools and Libraries Fund. This fund provides subsidies for broadband provided to schools and libraries. Eligible schools and libraries are ranked according to the percentage of students eligible for subsidized school lunches. The program gives discounts to schools for buying broadband or related tasks – these payments are then made to the ISP providing the service.
- Rural Healthcare Fund. This fund provides discounted broadband to rural health care facilities and clinics. Recipients mostly must be non-profit entities, although exemptions exist. The program gives discounts to rural health care facilities for buying broadband or related tasks – these payments are then made to the ISP providing the service.
- Lifeline Program. This program provides a discount of $9.25 per month to customers that can be applied to telephone service, cellular service, or broadband. Households qualify by being eligible for various federal programs. Only one discount can be provided per household. The customer receives the $9.25 discount, and a participating ISP collects this amount from the Lifeline program.

- Various Grant programs. The FCC administers various grant programs through the universal service fund. For example, the current Rural Digital Opportunity Fund (RDOF) grants are being administered through the Universal Service Fund.

Federal Trade Commission Regulation

Red Flag Rules

Since 2003, the FCC has required telecom companies to adopt processes that ensure that customer data, including financial records like credit cards are protected. Telecom carriers must have a manual that describes the compliance to these rules and must hold at least one session per year with employees to review customer data protection.

Broadband Regulation

When the FCC reclassified broadband from a Title II telecommunications service to a Title I Information Service in 2018, the FCC gave some of its regulatory authority to the Federal Trade Commission. There are several consequences of this change. First, the FCC will no longer hear complaints about matters that it believes are under FTC jurisdiction. Second, it's worth understanding that the FTC regulates by enforcing specific violations of the law by specific carriers. The practical result of this is that a ruling against a big ISP doesn't necessarily apply to other ISPs – even though ISPs generally will modify practices to stay under the FTC radar.

Consumer Protection, Enforcement and Redress

In the *Restoring Internet Freedom Order*, the FCC suggests that consumer protection concerns should primarily be the function of the FTC. The FCC stated that the FTC already had broad authority to protect consumers from unfair or deceptive practices and that the FTC has the ability to apply consumer protection principles to the entire Internet ecosystem as opposed to only certain businesses.

Customer Privacy

In the *Restoring Internet Freedom Order* the FCC designated the FTC as the primary federal agency for ensuring customers' privacy.

Missouri State Regulations

The Missouri Public Service Commission regulates the telecommunications industry in Missouri. The Public Service Commission has jurisdiction over 649 telecommunication providers. The Public Service Commission does not regulate wireless telephone providers, internet providers, or cable television. The PSC's jurisdiction is described by state laws and basic laws codified in Chapter 392 of state law and as modified by several subsequent laws.

Commission Supervision– Chapter 386.320

- The PSC has general supervision of all telephone/telegraph corporations.
- The PSC can inspect the books, property, or records of any utility.
- The PCS may investigate and require hearings on any topic that falls under its jurisdiction.

Adequate Service/Just and Reasonable Charges – 392.200

- Telecommunication companies cannot discriminate through price or service to any person or business.
- Term agreements can be offered for up to 5 years.
- Promotional rates are allowed.

Public Schools have reduced rates – 392.205

- Public School Districts have access to reduced telecommunication rates. The public service commission must approve the tariff and can modify the tariff in the public interest.

Reports/Records of Telecommunication Companies – 392.210

- Telecommunication companies must produce yearly reports for the PSC to review.
- The PSC may establish a system of accounts to be used by telecommunication companies.
- The PSC has the right to examine any and all accounts, records, and memoranda of telecommunication companies.
- Failure to report in a timely manner set forth by the PSC will result in a $100 per day fee. The fee will be paid to the public school fund of the state.

Rates/Schedules/Suspension – 392.220

- Every telecommunications company must print and file its rates, rentals, and charges for service of each and every kind by or over its facilities between points in this state.
- The commission has the right to establish rules and regulations for keeping such schedules open to public inspection.
- Telecommunication companies must provide 30 days' notice for rate changes.
- Telecommunication companies cannot charge a different rate than what is on file with the PSC.
- Telecommunication companies may not provide reduced or free service with the exception of officers, employees, agents, surgeons, physicians, and attorneys at law and their families; to persons or corporations exclusively engaged in charitable and eleemosynary work and ministers of religions; to officers and employees of other telegraph corporations and telephone corporations, railroad corporations and street railroad corporations; public education institutions, public libraries, and not-for-profit health care institutions.
- If a telecommunication company has violated section 392.200, the PSC can revoke the certificate of service authority.

Charges for short and long-distance services – 392.230

- No telecommunications company can charge or receive any greater compensation in the aggregate for the transmission of any interexchange telecommunications service offered or provided for a shorter or a longer distance over the same line or route in the same direction.
- The PSC can suspend telecommunications companies for up to 60 days.

Rates/Rental/Service/Physical Connections – 392.240

- The PSC has the right to change unjust, unreasonable, or discriminatory rates and telecommunication rules.

Company Regulations – 392.245

- The PSC has the right to regulate any telecommunications company.
    - Ensuring rates, charges, tolls, and rentals are just, reasonable, and lawful by employing price cap regulation.
- Incumbent local exchange telecommunications companies with 55% or more of total subscribers in areas that have been considered competitive, the company will be deemed competitive and no longer subject to price-cap regulation.

Rate Relief – 392.246

- The PSC can grant rate relief to incumbent local exchange telecommunication companies if the financial condition is such that the company cannot attract capital on reasonable terms or if the ability of the company to provide safe and adequate universal service is threatened.

Universal Service Board – 392.248

- Universal service board is created to oversee the universal service fund. The fund may be used for telecommunication companies.
    - To ensure the provision of comparable essential local telecommunications service, as that definition may be updated by the PSC throughout the state, including high-cost areas, at just, reasonable, and affordable rates.
    - To assist low-income customers and disabled customers in obtaining affordable essential telecommunications services.

Power of Commission to Order Repairs or Changes – 392.250

- The PSC can require improvements or changes to telecommunication facilities.

Power of the Commission to Ascertain Property Value of Telecommunications Companies – 392.270

- The PSC can ascertain the value of the property for every telecommunications company in the state.

Depreciation Rates – 392.280

- Telecommunication companies must carry a proper and adequate depreciation account for fixed or minimum rates.

Right to Issue stocks, bonds, and notes – 392.290 and 392.320

- Telecommunication companies operating solely in Missouri that issue stocks, bonds, or notes are under the supervision and regulation of the commission.

Transfer of property and ownership of a stock – 392.300

- Telecommunications companies cannot sell, assign, lease, transfer, or mortgage part of its franchise, facilities, or system without first securing permission from the PSC.

Approval of issues of stocks, bonds, and other forms of indebtedness – 392.310

- Telecommunication companies can issue stocks, bond, and other forms of indebtedness when authorized by the PSC.
    - Funding must be used for construction, completion, extension, or facilities improvements, or the improvement or maintenance of its service within the state.

Account for Disposition of Proceeds – 392.330

- The PSC regulates telecommunication companies for the disposition of proceeds for stocks, bonds, notes, and other evidence of indebtedness.

Reorganization – 392.340

- The PSC must provide authorization for the reorganization of telecommunication companies.

Liability for Loss or Damage – 392.350

- Any telecommunication company is liable to the person or corporation affected by prohibited or forbidden/unlawful practices.

Forfeiture – 392.360

- Telecommunications companies must obey any order given by the PSC. Any company that does not obey will forfeit a max of $5,000 to the state for each offense.

Classification – 392.361 and 392.370 and 392.380

- Any telecommunications company can petition to be classified as competitive and will be subject to lesser regulations.

Minimum Requirements of Telecommunication Companies – 392.390

Carriers must:

- File annual reports with the PSC in a form and at times prescribed by the PSC. The PSC may require different forms of annual reports for different telecommunications companies.
- Comply with any subpoena issued by the PSC, any order issued by the PSC pursuant to section 386.450 and provide specific answers to any questions asked by the PSC pursuant to subsection 1 of section 392.210;
- Comply with any reasonable requirements which shall be imposed by the PSC for determining and reporting the jurisdictional nature of the telecommunications services it provides.
- Be subject to the provisions of sections 386.320 and 386.330; and
- Be subject to the provisions of subsections 2, 3, 4 and 5 of section 392.200, so far as such provisions are applicable to a telecommunications company.

Noncompetitive telecommunication services rates – 392.400

- The commission can permit, approve, investigate, or establish rates or changes for noncompetitive telecommunication services.

Certification of public convenience – 392.410

- Telecommunication companies must possess a certificate of public convenience and necessity from the PSC to provide services.
- No political subdivision of the state shall provide or offer for sale, either to the public or to a telecommunications provider, a telecommunications service or telecommunications facility used to provide a telecommunications service.
- Political subdivision must provide nondiscriminatory access to right of way structures.
- A political subdivision can provide telecommunication services or facilities for the following:
    - For its own use.
    - For 911, E-911, or other emergency services.
    - For medical or educational purposes.
    - To students by an educational institution; or
    - Internet-type services.

Call Location for Emergencies – 392.415

- Telecommunications carriers must supply location information in emergency situations.

Regulations/Modifications for Public Convenience Certification – 392.420

- The PSC can modify the certificate of public convenience.

Certificates of Local Exchange or Interexchange Service – 392.430

- The PSC will approve an application if the grant of authority is in the public interest.

Service Authority – 392.440 and 392.450

- Any telecommunications company offering or providing the resale of either local exchange or interexchange telecommunications service must first obtain a certificate of service authority.

Certification Process – 392.460

- Defines certification process for basic local telecommunications certification.

Exemption from certain rules – 392.461

- Telecommunication companies may request to be exempt from certain rules.
    - Exemptions include the requirement to file tariffs or schedule or rates, rentals, charges, privileges, facilities, rules, regulations, or forms of contract.

Conditions the Commission May Impose – 392.470

- The PSC may impose any condition or conditions that it deems reasonable and necessary upon any company providing telecommunication services.

Prohibition of Resale – 392.475

- The PSC shall prohibit the resale of a telecommunications service available at retail only to designated categories of subscribers to different categories of subscribers.

Services to be offered under Tariff – 392.480

- All telecommunication services offered or provided shall be under tariff and classified as either competitive, transitionally competitive, or noncompetitive.

Changes in Rates Competitive Telecommunication Services – 392.500

- Any change in rates or charges will be permitted after one day if the rates decrease or ten days if the rates increase for competitive telecommunication companies.

Tariffs, bands, and ranges – 392.510

- Any competitive or transitionally competitive telecommunication service may file a proposed tariff which includes a range or band describing the minimum and maximum rate for services charged.

Private Shared Tenant Services and Coin Operated Telephone Services – 392.520

- The PSC has jurisdiction over private shared tenant services and customer-owned coin telephone communication services.

Interconnected Voice Over Internet Protocol – 392.550

- Interconnected voice of internet protocol service shall be subject to appropriate exchange access charges to the same extent that telecommunication services are subject to such charges.

Local Exchange Telecommunication Companies to decrease certain rates for three years – 392.605

- Incumbent local exchange telecommunications companies shall decrease its composite intrastate switched exchange access rates annually by 6% of the difference between its composite interstate switched exchanged access rates and its composite intrastate access rates.

Inapplicability of Laws and Rules – 392.611

- Broadband and other internet protocol enabled services shall not be subject to regulation under chapter 386 or chapter 392 except Voice over Internet Protocol.
- Other Internet Protocol Enabled Services are any services offered over the open internet regardless of whether it's voice, data, or video.

Missouri Legislative Review

2021 Legislature

HB 321 (Referred to Utilities Committee)

The bill establishes the "Electrical Corporation Broadband Authorization Act." The bill authorizes electrical corporations to do the following:

- To own, construct, install, maintain, repair, and replace broadband infrastructure.
- Operate the corporation's broadband infrastructure for or in connection with providing electrical service.
- Engage in broadband operation or permit broadband affiliates to engage in broadband operations using the corporation's infrastructure.
- Provide broadband services or permit broadband affiliates to provide broadband services using the corporation's infrastructure.
- Enter into contracts, leases, licenses, or other agreements concerning broadband operations.

HB 580 (Reported Do Pass (H) has not been sent to Senate yet)

The bill requires the Department of Elementary and Secondary Education to submit an annual report to indicate the number of elementary and secondary students with limited or no access to the internet at home.

HB 735 (Referred to Utilities Committee)

The bill authorizes two or more political subdivisions to form a broadband infrastructure improvement district to provide broadband services to their residents upon a vote of eligible voters.

- The district has the power to contract with a broadband service provider or to provide broadband service.
- The district may finance the provision or expansion through grants, loans, bonds, or user fees.
- The bill outlines the composition and operation of the District Governing Board.
- The Board authorizes the admission of additional political subdivisions and withdrawal through an application request.

HB 774 (Referred to Economic Development Committee)

The bill requires the Department of Economic Development to increase high-speed internet access in underserved areas of the state as quickly as possible. Preference is given to areas with no internet access. The Department can provide high-speed internet access itself or contract with an entity to do so.

HB 1160 (Referred to Utilities Committee)

The bill establishes the "21st Century Missouri Broadband Deployment Task Force." The task force members include 3 members of the House of Representatives, 3 members of the Senate, and 18 members representing various interested parties. The duties of the task force are as follows:

- Evaluate the status of broadband deployment in the state.
- Evaluate the deployment process.
- Make recommendations about how to best increase broadband internet deployment to certain residents.
- The Task Force will make recommendations for legislation and provide annual reports to the General Assembly.

HB 1378 (Referred to Utilities Committee)

The bill authorizes two or more political subdivisions to form a broadband infrastructure improvement district to provide broadband services to their residents upon a vote of eligible voters.

- The district has the power to contract with a broadband service provider or to provide broadband service.
- The district may finance the provision or expansion through grants, loans, bonds, or user fees.
- The bill outlines the composition and operation of the District Governing Board.
- The Board authorizes the admission of additional political subdivisions and withdrawal through an application request.

If partnering entities include a municipal utility, electric cooperative, or public utility, the entities may enter into a broadband infrastructure partnership.

- Partnerships may provide broadband service within the corporate limits or service territories of any partner and within a two-mile radius of the corporate limits or service territory if 70% of the area does not have broadband service.
- A partnership may finance the expansion through grants, loans, bonds, user fees, or other methods that do not negatively impact the cost of service provided to its customers.

HB 1384 (Referred to Utilities Committee)

The bill establishes the "Broadband Enhancement Council." The Council consists of 30 members, including members from certain state agencies, members of the general public, and two members each from the Senate and House of Representatives. The duties of the Council are as follows:

- Explore ways to expand access to broadband services.
- Explore the potential for increased use of broadband for education, career readiness, workforce preparation, and alternative career training.
- Explore ways to encourage state and municipal agencies to expand service to better serve the public through the use of streaming, voice over internet protocol, teleconferencing, and wireless networking.
- To make recommendations to the General Assembly regarding strategies to make broadband available to certain communities and statutory changes needed to enhance broadband access in the state.
- The Council will submit annual reports to the General Assembly.
- The Council must establish a mapping of broadband services in the state based on analysis of data, demand, and other relevant information and publish an interactive public map that providers certain information based on information received by the Council from specified data sources.
- The Council must receive the location, type, and extent of the infrastructure from any entity that is awarded state or federal funds to install infrastructure for broadband services in the state.

SB 108 (Passed Senate and Referred to Utilities Committee by House of Representatives)

Under the act, the state or any political subdivision shall not impose any new tax, license, or fee in the addition to any tax, license, or fee already authorized on or before August 28, 2021, upon the provision of satellite or streaming video service.

This act allows two or more municipalities to form a broadband infrastructure improvement district to deliver broadband internet service to the residents of such municipalities. The district created will have the power to partner with any telecommunications company or broadband service provider to construct or improve telecommunications facilities. A district may finance the provision or expansion of broadband internet service through grants, loans, bonds, user fees, or sales tax (not to exceed 1%).

SB 184 (Bill placed on Informal Calendar S Bills for Perfection w/SCS)

The act creates the Electrical Corporation Broadband Authorization Act. The act is outlined below:

- Broadband service provides to utilize certain electrical corporation broadband infrastructure to provide broadband services.
- It modifies the definition of "electric plant" to include broadband infrastructure operated, controlled, owned, used, or to be used for or in connection with or to facilitate the provision of electric service, broadband operations, or broadband services.
- An electrical corporation shall not provide broadband services to end-users.
- An electrical corporation's investment in such broadband infrastructure shall be included in the rate base used to set the revenue requirement upon which the electrical corporation's base rates are set.

- The Public Service Commission shall not have jurisdiction over the terms, conditions, charges, contracts, leases, licenses, or other agreements of an electrical corporation for the corporations' broadband operations or provision of broadband services through a broadband services provider.
- The rates and charges that an electrical corporation assesses upon a broadband services provider shall be standardized for all such providers.
- An electrical corporation is allowed to condemn land for the purpose of constructing broadband infrastructure.

SB 570 (Referred to Commerce, Consumer Protection, Energy, and the Environment Committee)

The Act allows two or more partnering entities to form a broadband infrastructure improvement district or partnership for the delivery of broadband internet service to the residents of such municipalities or service area. If the partnership is wholly composed of municipalities, it may finance the provision or expansion of broadband internet service through grants, loans, bonds, user fees, or sales tax (not to exceed 1%). The Act also sets forth the composition and operation of the district governing board.

SB 611 (Referred to Commerce, Consumer Protection, Energy, and the Environment Committee)

The Act repeals the current law, which states that broadband and other internet protocol-enabled services are exempt from rules and regulations of the Public Service Commission. The Act requires the commission to promulgate rules for the regulation of broadband and internet protocol-enabled services and to submit an annual report to the General Assembly on the progress of broadband development across the state.

2022 Legislature

SB 848 (Referred to Commerce, Consumer Protection, Energy, and the Environment Committee)

The act creates the Electrical Corporation Broadband Authorization Act. The Act allows an electrical corporation to use its broadband infrastructure to provide certain broadband infrastructure services.

- The Act modifies the definition of "electric plant" to include broadband infrastructure operated, controlled, owned, used or to be used for, or in connection with, or to facilitate the generation, transmission, or distribution of electricity or broadband infrastructure services.
- An electrical corporation's investment in such broadband infrastructure shall be included in the electrical corporation's rate base used to set the revenue requirement upon which the electrical corporation's base rates are set.
- The Public Service Commission shall not have jurisdiction over the terms, conditions, charges, contracts, leases, licenses, or other agreements of an electric corporation for the corporation's broadband operations or provision of broadband services through a broadband service provider.
- The Act allows an electrical corporation to condemn land for the purpose of broadband infrastructure services.

SB 981 (Referred to Commerce, Consumer Protection, Energy, and the Environment Committee)

Modifies provisions relating to grants to expand broadband internet access in unserved and underserved areas

- The Act adds a definition for "project" and modifies the definition of "underserved area."

    - Underserved areas are areas without fixed wireline or wireless broadband internet service of speeds of the higher of 100/20 Mbps or the minimum speed established by the FCC of 25/3 Mbps.
- The Act adds a definition for unserved areas.
    - Unserved areas are areas without fixed wireline or wireless broadband internet service that do not meet the FCC minimum definition of 25/3 Mbps.
- Grants awarded under the program shall prioritize projects provides speeds of the higher 100/20 Mbps that is scalable to higher speeds or the minimum acceptable speeds by the FCC.

SB 990 (Referred to Commerce, Consumer Protection, Energy, and the Environment Committee)

The act creates provisions relating to pole replacements for certain broadband facilities and establishes the Missouri Broadband Pole Replacement Program.

- Under the program, the Department of Economic Development shall award pole reimbursements using funds available in the Broadband Pole Replacement Fund created in the Act.
- A pole owner or a provider of qualifying broadband service who pays or incurs the costs of removing and replacing an existing pole in an unserved area for the purpose of accommodating the attachment of an eligible broadband facility may apply to the Department for a reimbursement award.
- The Department shall issue a pole reimbursement for up to 50% of the eligible pole replacement costs incurred or $4,000 whichever is less and 100% of the documented reasonable administrative expenses incurred by the applicant, not to exceed 5% of the eligible pole replacements in the application.
- One year after the pole reimbursement funds are exhausted, the Director of the Department shall identify, examine, and report on the deployment of broadband infrastructure and technology facilitated by the pole reimbursements the Department has awarded.

SB 1074 (Referred to the Commerce, Consumer Protection, Energy, and the Environment Committee)

Prohibits political subdivisions from using federal funds for the construction of retail broadband internet infrastructure in certain circumstances

- Under the Act, no federal funds received by the State or a political subdivision shall be expended for the construction of broadband internet unless the project to be constructed is located in an “unserved” or “underserved” area.
- The Office of Broadband must certify a project and will notify each ISP operating in the area.
    - ISPs can submit a written challenge within 45 days of the application.
    - If the challenge is considered valid by the Department of Economic Development, the area shall not be considered “unserved” or “underserved.”

SB 1081 (Referred to the Commerce, Consumer Protection, Energy, and the Environment Committee)

Modifies provision relating to applicants for grants to expand broadband internet access in unserved and underserved areas.

- Any applicant to receive grant monies from the Broadband Internet Grant, shall provide the Department of Economic Development with data about the deployment of broadband internet service in the state.

SB 1199 (Referred to the Commerce, Consumer Protection, Energy, and the Environment Committee)

The Act provides that the Missouri Highways and Transportation Commission may enter into a public-private partnership with private broadband internet service providers to expand and develop the Department of Transportation's fiber network.

HB 1488 (Referred to Utilities Committee)

The Bill provides that the Department of Economic Development shall not award any grant funding when funds have already been awarded by the Connect America Fund and the Rural Digital Opportunity Funds.

The Bill provides that federal funds received by the State or political subdivision through the American Recovery Plan or other federal COVID-19 Relief legislation appropriated specifically for the construction of broadband internet infrastructure shall be in or otherwise serve an "unserved" or "underserved" area.

HB 1518

Establishes provisions for Net Neutrality. The Bill provides that broadband services providers shall publicly disclose information regarding network management practices, performance, and the commercial terms of its broadband Internet access.

Broadband service provides shall:

- Not block any broadband internet access
- Impair broadband internet access
- Engage in paid prioritization or
- Unreasonably disadvantage an end user's ability to select internet content or an edge provider's ability to provide internet content to end users.

The Public Service Commission may only sanction paid prioritization if it will provide significant public interest benefit, and not impede the open access of the internet.

The Bill also authorizes the Attorney General to enforce the provisions of the Bill, with resulting proceedings including a penalty of up to $5,000 for each violation, not to exceed $25,000 per day.

HB 2016 (Public Hearing Completed)

The Bill allows any political subdivision of the state to form a broadband infrastructure improvement district. In addition, the board of a district may allow the inclusion of a private entity. The board must specify certain terms and conditions if it grants inclusion of a private entity in the district. A private entity may finance the expansion of internet service if the financing method does not negatively impact the cost of service for residents, customers, or rate-payers.

HB 2052 (Passed the House)

The Bill establishes the "21st Century Missouri Broadband Deployment Task Force".

Membership of the Task Force Includes:

- Three members of the House of Representatives with two members appointed by the Speaker of the House of Representatives and one appointed by the Minority Leader
- Three members of the Senate with two appointed by the President Pro Tem of the Senate and one appointed by the Minority Leader,
- And 18 representing various interested parties

The duties of the Task Force are to evaluate the status of broadband deployment in the state, evaluate the deployment process, and make recommendations about how to best increase broadband internet deployment to certain residents. The Task Force will make recommendations for legislation and will submit a report outlining the summary of Task Force activities to the General Assembly before September 30, 2023.

HB 2298

The Bill authorizes the Department of Economic Development to purchase and store fiber optic cable and other broadband equipment to aid in broadband development across the state. The Department will store the cable and other broadband equipment and sell it at cost to broadband providers.

HB 2353 (Public Hearing Completed)

The Bill authorizes two or more political subdivisions, upon a vote of eligible voters, to form a broadband infrastructure improvement district for the delivery of broadband internet service to their residents. A district has the power to contract with a broadband internet service provider to provide broadband internet service to the residents of the district.

A district can finance the provision or expansion of broadband internet service through grants, loans, bonds, or user fees.

Additional political subdivisions may join a district upon application to the Governing Board. A political subdivision may withdraw from a district in the same manner.

HB 2514

The Bill allows the Universal Service Board to use funds from the Universal Service Fund to assist low-income customers and disabled customers in obtaining broadband internet service.

HB 2560

The Bill allows the Universal Service Board to use funds from the Universal Service Fund to assist low-income customers and disabled customers to obtain broadband internet service.

HB 2563 (Public Hearing Completed)

The Bill authorizes the State broadband office within the Department of Economic Development to engage in site inspections of broadband providers that have received grants or loans for projects from the office.

HB 2588 (Public Hearing Completed)

The Bill creates the "Technology Infrastructure Reinvestment Fund," to consist of funds to be used by the Office of Broadband Development within the Department of Economic Development for the purpose of reinvestment in vertical real-estate or technology infrastructure supporting broadband on state-owned property.

HB 2609

The Bill specifies that for an applicant to receive grant money from the Broadband Internet Grant Program, the entity must provide the Department of Economic Development with data of where the applicant currently provides broadband in the state.

HB 2638 (Referred to Rules - Legislative Oversight)

The Bill establishes the "Broadband Development Council." The Council consists of 29 members.

The Broadband Development Council's duties are:

- Exploring ways to expand access to broadband services
- The potential for increased use of broadband for education
- Career readiness
- Workforce preparation and alternative career training
- Ways to encourage state and municipal agencies to expand service to better serve the public through the use of streaming, voice over Internet protocol, teleconferencing, and wireless networking.

The Council must establish a mapping of broadband services in the State based on analysis of data, demand, and other relevant information and publish an interactive public map that provides certain information based on information received by the Council from specified data sources. Any entity that receives state or federal funds to install infrastructure for broadband services must provide information to the Council concerning the location, type, and extent of infrastructure. The Council must provide a report to the General Assembly and the Governor on or before Jan 1st every year.

HB 2645 (Public Hearing Completed)

The Bill requires applicants for the broadband grant program, in addition to other required information, to provide a map showing the highest broadband speeds available within the applicant's area of service. The map must include enough detail to determine the speeds available at individual addresses.

HB 2675 (Public Hearing Completed)

The Bill modifies the provision of the grant program to expand broadband Internet access in unserved and underserved areas of the State.

The Bill adds the definition for "project" and modifies the definition of "underserved" and "unserved" areas.

- Underserved areas are defined as areas without fixed wireline or wireless broadband services of between 100/100 Mbps and the minimum FCC speed definition (25/3 Mbps).
- Unserved areas are defined as areas without fixed wireline or wireless broadband services of at least 25/3 Mbps.

Grants applicants providing speeds higher than 100/100 Mbps and are scalable are given priority.

HB 2695

Prohibits political subdivisions from using federal funds for the construction of retail broadband internet infrastructure in certain circumstances

- Under the Act, no federal funds received by the state, or a political subdivision shall be expended for the construction of broadband internet unless the project to be constructed is located in an "unserved" or "underserved" area.
- The Office of Broadband must certify a project and will notify each ISP operating in the area.
    - ISPs can submit a written challenge within 45 days of the application.
    - If the challenge is considered valid by the Department of Economic Development, the area shall not be considered "unserved" or "underserved."

HB 2726

The Bill creates the "Office of Broadband Development" within the Department of Economic Development.

- The Office will work to expand and accelerate the deployment of broadband Internet access throughout the State.
- The Office will find solutions to problems encountered by any person or entity while attempting to expand broadband Internet access in Missouri.

HB 2737 (Public Hearing Completed)

The Bill requires the Department of Economic Development to implement a program to increase high-speed Internet access in underserved areas of the state.

HB 2765 (Referred to Special Committee on Broadband and Infrastructure)

The Bill creates provisions relating to pole replacements for certain broadband facilities and establishes the Missouri Broadband Pole Replacement Program.

- Under the program, the Department of Economic Development shall award pole reimbursements using funds available in the Broadband Pole Replacement Fund created in the Act.

- A pole owner or a provider of qualifying broadband service who pays or incurs the costs of removing and replacing an existing pole in an unserved area for the purpose of accommodating the attachment of an eligible broadband facility may apply to the Department for a reimbursement award.
- The Department shall issue a pole reimbursement for up to 50% of the eligible pole replacement costs incurred or $4,000, whichever is less, and 100% of the documented reasonable administrative expenses incurred by the applicant, not to exceed 5% of the eligible pole replacements in the application.
- One year after the pole reimbursement funds are exhausted, the Director of the Department shall identify, examine, and report on the deployment of broadband infrastructure and technology facilitated by the pole reimbursements the Department has awarded.