Broadband GAP Analysis Report

Joplin, Missouri

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Finley Engineering
CCG Consulting

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PROJECT DESCRIPTION

Finley Engineering and CCG Consulting were hired to create an in-depth Internet/broadband GAP analysis for Joplin. The original RFP that defined the project set the following goals:

> *In September of 2018, the City of Joplin began the process of assessing whether the City should adopt a Smart City approach to advance more resilient economic and community development to benefit its citizens and businesses. Internal and external stakeholders were interviewed to determine which practices and initiatives the City could undertake to begin a technological upgrade. Through evaluating the City's current state, conducting peer city research, and obtaining design inputs, the City's team created a Smart City Roadmap to help guide community leaders and City staff through the next steps of implementing the Roadmap. In September 2019, the Joplin City Council approved the Joplin Smart City Roadmap.*
>
> *Following a pause due to the COVID-19 Pandemic, a Steering Committee of key community leaders was formed in September 2020 to validate the Roadmap's findings and determine the trajectory of focus based on a handful of projects narrowed down by City staff and public comment. Internet access was at the top of the list. Consequently, Guidehouse (the City's disaster recovery and Roadmap consultant) was hired to seek proposals to perform the needed analysis.*

The Scope of Work for the project included the following:

- Assess the current infrastructure landscape.
- Conduct a local broadband market assessment.
- Conduct stakeholder outreach.
- Conduct market research.
- Engage with internet service providers.
- Provide a benefits/risk analysis, a gap analysis, and a project map.
- Recommend broadband strategies
- Recommend a business model and implementation approach
- Develop a conceptual network design
- Evaluate available funding
- Recommend the next steps

We believe this report is responsive to all the requirements identified in the goals and the project scope of the RFP.

Executive Summary

Finley Engineering and CCG Consulting submit this Broadband Gap Analysis Report that provides our findings of the state of broadband in Joplin. Broadband is a generic word used to describe technologies and products that bring Internet access to residents and businesses. The project involved several areas of investigation, including a gap analysis, stakeholder outreach, and an assessment of the cost and feasibility of bringing better broadband to Joplin. We were also asked to investigate several additional topics related to broadband, such as looking at the benefits to the community for getting better broadband and current ways that broadband can be funded.

The primary Internet Service Providers (ISPs) in Joplin are Sparklight which covers most of the city, Mediacom, which serves some of the edge neighborhoods in the city, and AT&T, which announced in 2020 that it will no longer sell DSL broadband. There are several ISPs providing fiber broadband to a small number of businesses. There are wireless ISPs that claim to cover the city, but we didn't find evidence of more than minor use of these carriers.

Our analysis identified several broadband gaps in the city today.

- Joplin has a broadband adoption gap. The statistically valid survey showed that only 71% of households in the city have a home broadband connection. This is significantly below the national average broadband penetration rate of 87%. There is also an affordability gap, and 13% of all households in the city reported not having broadband because they could not afford a monthly broadband subscription or a computer.
- We identified a broadband speed gap, specifically, inadequate upload speeds. 36% of households with a family member who works from home said that their broadband is not adequate. 57% of homes with students said that their broadband was not adequate for schooling from home.
- Joplin suffers from a lack of broadband competition. AT&T stopped offering broadband on DSL in 2020 and most residents and businesses can only buy broadband from one of the cable companies. Almost every business not served by fiber told us that they felt like they have no options other than the current ISP.
- Finally, we identified what we call a future broadband gap. Statistics gathered by companies like Cisco and OpenVault show that the amount of broadband used by homes and businesses continues to double about every three years – as it has done since the early 1980s. This kind of sustained growth will stress the existing broadband networks in the city, and broadband performance will worsen in coming years unless the cable companies make significant investments to stay ahead of the broadband demand curve or if the City can attract a new fiber broadband competitor.

We conducted community outreach that included a statistically valid residential telephone survey, online surveys for homes and businesses, interviews with key stakeholders in the city, and speed tests that were open to everybody.

- The telephone survey highlighted an overwhelming desire for better broadband. 67% of households said that they support the idea of the City trying to find better broadband. Another 14% said they might support the idea but needed more information. Even stronger support for better broadband came when the survey showed that 79% of all respondents said they would consider buying broadband from a new fiber network.
- The business surveys and interviews provided evidence of the broadband gaps. Fiber is only available in limited parts of the City, and businesses served by fiber are satisfied with broadband

speeds, but most noted that fiber broadband is expensive. Almost every business not served by fiber told us they feel they have no broadband options. Businesses report regular short outages that disrupt business operations. Businesses that aren't served by fiber all have a wish list of broadband improvements they could undertake if they had faster broadband, such as using more cloud software or converting to voice-over-IP.

- During the study, we collected speed tests from broadband customers in the city and also reviewed speed test results gathered by the National Telecommunications & Information Agency (NTIA). The speed tests showed that businesses served by fiber are seeing fast, symmetrical broadband speeds. The NTIA gathered speed tests by Census tract and show that average broadband speeds across the city vary by neighborhood from a low of 38/10 Mbps to a high of 87/10 Mbps. This wide variance in speeds might be evidence of performance problems with the Sparklight network and is worth additional investigation.

These conclusions led us to the next area of our investigation. The RFP asked us to quantify the cost of bringing better broadband to Joplin. We examined the most commonly used wireless technologies, and none of them will work well in Joplin due to housing density and the heavy tree cover.

Since wireless did not seem like a reasonable technology option for Joplin, we focused on estimating the cost to bring fiber to all parts of the city. The cost of a fiber network varies depending upon the number of customers added to the network. Finley Engineering estimated that the total capital cost of building fiber everywhere in Joplin would vary between $69.9 million (45% penetration) and $72.6 million (55% penetration). Finley designed the fiber network to be 100% buried to avoid a repeat of the problems experienced with the 2011 EF-5 tornado.

The primary purpose for quantifying the cost of building fiber was to understand the feasibility of attracting a commercial ISP to invest in the city. To complete the analysis, we created financial business projections to determine if an ISP could build a new fiber network and be profitable. We show that a commercial ISP could be marginally profitable – but that the returns would be lower than what most commercial ISPs expect to earn. This tells us that Joplin is not likely to get fiber if you wait for somebody to make the needed investment.

We then looked at other business operating models to see if there are other ways to reasonably get a fiber network built in the city. For example, we looked at various types of public-private partnerships between the City and an ISP. Our analysis shows a higher likelihood of finding an ISP partner if the City helps to finance the fiber network.

We also investigated the likelihood of finding grant funding to help pay for fiber. The City has funding from the American Rescue Plan Act that could be used to fund some fiber – but the use must be somehow related to problems caused by the pandemic. The State will be administering grants of $196.7 million from the ARPA Capital Projects Fund, but the State has been directed to use these funds to solve rural broadband gaps before using any of this money for cities like Joplin. There is a possibility of larger future grant funding if Congress passes the infrastructure – but this funding will also be heavily focused on rural broadband gaps, but there might be creative ways to get some grant funding for issues like smart grid and smart city. The report recommends that all of the stakeholders in the city that are eligible for grants should collaborate to get the most overall benefit for broadband.

The RFP asked for our opinion if current broadband is adequate to meet the City's vision expressed in Joplin's Smart City Roadmap. We conclude after considering all the aspects of current broadband that the broadband networks in the city today will not meet your goals for the following reasons:

- Smart Joplin will need ubiquitous, fast, and affordable broadband everywhere if you want everybody to participate in a Smart Joplin. That's only going to come from attracting an additional competitor to the market, which would result in faster broadband speeds and price competition.
- Only a few businesses in the city have fiber broadband today, and it is expensive. None of the current fiber carriers have plans to extend fiber to all, or even most of Joplin.
- The cable companies could upgrade broadband networks over time to meet the Smart City goals. This is worth discussing with the cable companies, but we see several reasons why this might never happen.
    - The copper networks are old and will soon be nearing the end of life. There is already reason to believe that the networks underperform in some neighborhoods.
    - With AT&T leaving the market for new customers, the cable companies are effectively monopolies and have no economic incentive to do better or to spend money on upgrades. The upgrades needed to get faster upload speeds are going to be expensive.
    - Upload speeds on the cable networks are too slow to meet Smart Joplin goals. Speed tests show the average upload speeds in various neighborhoods are between 8 and 16 Mbps. We saw ample evidence during the pandemic that speeds in this range are already inadequate today.
    - Meeting the Smart Joplin goals doesn't just mean meeting today's broadband demand. Broadband volumes that must be handled by the ISPs are likely to be ten times higher in ten years and one hundred times higher in twenty years – those are the target broadband needs that must be considered.
    - All the big cable companies in the U.S. seem to be pursuing a path to reach and exceed $100 residential broadband. High prices will not support your Smart Joplin goals because higher prices mean even more households won't be able to afford a broadband connection.

The report concludes with a list of specific recommendations on the next steps to consider after digesting this report. The City must decide if the broadband gaps are significant enough to warrant pursuing a broadband solution. This is not an easy question to answer. The one finding in our study that would indicate that the City should keep moving forward with the broadband question is the fact that 79% of households said they would consider buying broadband from a new and faster network – that's evidence of big public demand for better broadband.

One of our primary conclusions from the study is that the best chance for getting fiber broadband will be by finding an ISP partner. While it's always possible to talk an ISP into making the needed investment, our analysis shows that the likely returns for a commercial ISP making such an investment look slim. However, the likelihood of getting fiber should be better if the City is open to forming a public-private partnership and is willing to commit/pursue funding towards achieving the goal.

FINDINGS

This section of the report functions as a more detailed summary of the study than is included in the Executive Summary above.

Existing Providers and Market Rates. The incumbent telephone provider is AT&T. The city is divided between two cable companies, with Sparklight (Cable One) covering most of the city, but with portions covered by Mediacom. There are several IPSs that provide fixed wireless broadband (Aire Communications, Lost Creek Wireless, Rise Broadband, and Wisper, Inc.). There are two companies providing high-orbit satellite broadband - Viasat and HughesNet. Residents can also satisfy broadband needs using only cellphone data plans.

We looked at the key products and prices currently offered by the existing broadband providers. Residential broadband prices in Joplin seem to be high. The two residential surveys done during this study showed the average cost of residential broadband to be between $82 and $86. In a few dozen similar surveys that we've done over the last two years in other markets, the average prices have been reported to be between $72 and $76.

Broadband Gaps. One of the primary purposes of the study was to identify any broadband gaps in Joplin. Our analysis identified several broadband gaps in the city today.

- Broadband Adoption Gap. The statistically valid survey showed that only 71% of households in the city have a home broadband connection. This is significantly below the national average broadband penetration rate of 87%. We view this as a gap because Joplin can't meet your Smart Joplin goals if a lot of the public isn't connected to the Internet.
- Affordability Gap. 13% of all households in the city reported not having broadband because they could not afford a monthly broadband subscription or a computer. Another 10% of all households only connect to broadband through cell phones – a much higher percentage than we normally see, and another indication that broadband is viewed as expensive.
- Upload Speed Gap. We identified a broadband speed gap, specifically, inadequate upload speeds. 36% of households with a family member who works from home said that their broadband is not adequate. 57% of homes with students said that their broadband was not adequate for schooling from home.
- Competition Gap. Residents and businesses in the city don't feel like they have broadband options. This is probably now magnified even more since AT&T stopped offering broadband on DSL late in 2020. Almost every business not served by fiber told us that they have no options for broadband other than the current ISP. 73% of homes with broadband told us they want more competition.
- Future Broadband Gap. Perhaps the most important broadband gap is a fear that the current broadband networks in the city aren't able to meet future broadband demand. The amount of broadband used by homes and businesses has grown at a steady rate since 1980. As an example, OpenVault, which provides software for major ISPs, reports that the national average household broadband usage grew from 215 gigabytes per month in the first quarter of 2018 to 483 gigabytes at the end of the first quarter of this year. Trending that growth forward (and there are no broadband experts we know who don't think that broadband demand will continue to grow) means broadband traffic will be ten times greater than today in ten years and a hundred times greater today in twenty years. That kind of broadband growth will stress broadband networks everywhere. The cable companies will need to make large investments to try to keep up with this growth in broadband

demand. The only technology that will be able to always handle this kind of broadband growth is fiber. Cities without fiber broadband face a risk of falling behind the many parts of the country that are getting fiber.

Market Outreach

Residential Survey. We conducted a statistically valid residential survey by telephone, meaning that the survey results are 95% accurate plus or minus 5%. That means you would expect the same survey results within that range of accuracy if you were to ask the same questions to everybody in the city. Following are the key findings of that survey:

Broadband Penetration. Perhaps the most surprising result of the survey was that only 71% of residents have wireline home broadband (cable or DSL). This is significantly below the national average of 87% of homes with a wireline broadband connection.

Sparklight serves the largest number of residential broadband customers in the city (36%), followed by AT&T (26%) and Mediacom (8%). Only 1% of households are using other forms of broadband like satellite broadband and fixed wireless broadband.

45% of households are still buying a traditional cable TV product. This is significantly below the national average of 59%. 25% of households in the city claim to be cord-cutters who only watch video online. 38% of households still have a telephone landline. That's higher than the national average of around 30%.

Broadband Affordability. The primary reason that homes don't have broadband is affordability. Residents with broadband reported having monthly bills between $82 and $86, which is higher than what we normally see in surveys – most typically between $72 and $76.

13% of households in the city said they couldn't afford home broadband. Another 10% of homes rely on their cell phone for broadband, and we assume that affordability is a major driver for many of these residents. We have rarely seen more than 5% of households in a market who rely strictly on cell phone broadband.

The lower penetration rate for traditional cable TV is another indicator of affordability being an issue in the city.

Customer Satisfaction. The survey results reflect only moderate dissatisfaction with the current ISPs. 19% of residents are dissatisfied with speeds, 20% are dissatisfied with customer service, 18% are unhappy with the reliability of the broadband connection, and 35% are unhappy with the value they get for the price they pay.

There are subsets of households that are less happy with existing broadband. 35% of all households reported having somebody who was working from home at least part-time. 36% of these homes say that the home broadband was not adequate for working from home. 22% of homes reported having students who took classes from home during the pandemic. 78% of these homes say the home broadband connection was inadequate.

Interestingly, the relatively low percentage of homes that say they are unhappy with broadband contrasts with some of the most important findings of the survey. 67% of respondents support the idea of the City finding a better broadband solution. Another 14% might support better broadband but need more information. 19% of respondents do not support the idea. 78% of all households say they would consider buying broadband from a new fiber network - including 45% who say they definitely would buy. These two findings highlight the difference between unhappiness with ISPs and a desire for competition and something better – people don't have to be unhappy with an ISP to consider changing to something better.

There were a few major reasons given why households would consider changing to fiber broadband. 89% of respondents wanted more competition and choice. An overwhelming 98% hope for lower prices.

The surveys indicate that the likely penetration rate for a fiber builder might be as high as 62%. Our analysis doesn't focus on that number because customers were asked that question in a vacuum without knowing the broadband prices or the identity of the ISP. Our best guess is that the actual penetration rate for a fiber ISP would be something lower than 62%, mostly due to the high sensitivity in the market to the cost of broadband. We studied a range of scenarios that have a penetration rate as high as 60%.

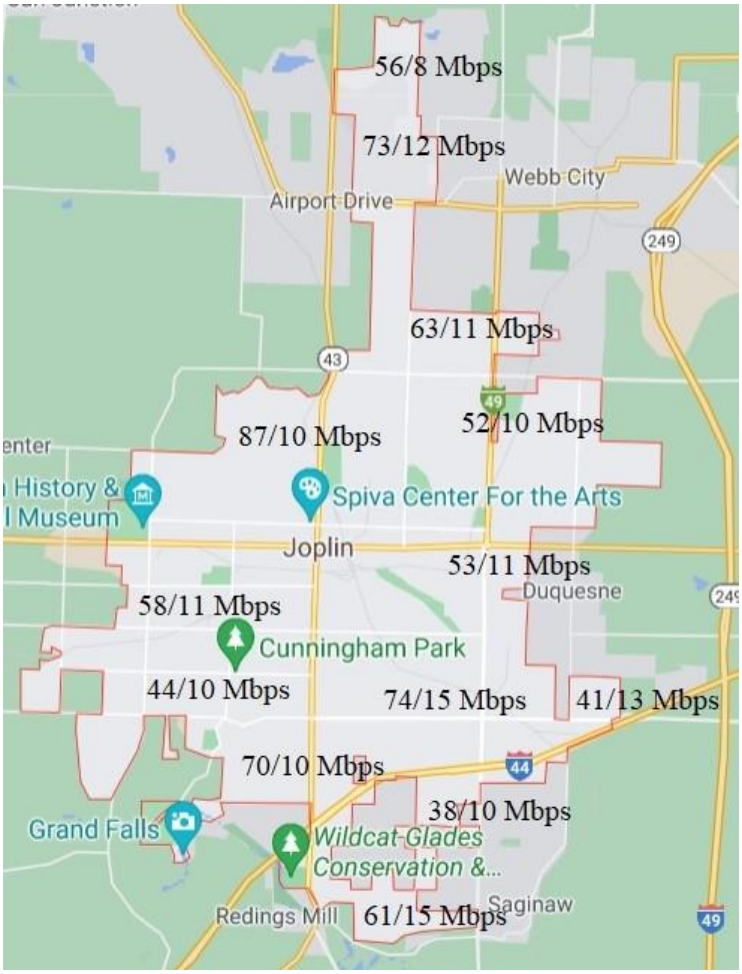
The study also included an online residential survey that had similar results. A description of the results of the surveys is shown in Section I.B. of this report. The questions and responses to both surveys are included in Exhibit I.

Business Survey and Interviews. As part of the study, we interviewed key businesses and also distributed an online business survey. We found the following:

- A small portion of the business community is served with fiber provided by Liberty Utilities, AT&T, and Sparklight. This includes large businesses, anchor institutions like the schools and the hospitals, and a few smaller businesses lucky enough to be near fiber. These businesses are all happy with their broadband, although most of the ones we talked to say that fiber broadband is expensive.
- Businesses not on fiber tell a different story. Most businesses abandoned AT&T DSL in the past for being slow and unreliable, and most use the two cable companies. Almost universally, these businesses said they don't have a broadband option other than the cable company. Businesses are generally okay with Sparklight, but the network has occasional outages, and speeds often fluctuate during the day. Some businesses reported problems with inadequate upload speeds.
- Almost every business we heard from had a wish list of business functions they would tackle if they had faster broadband. For example, with better broadband, businesses might migrate more software to the cloud or convert the telephone system to voice-over-IP.
- Sparklight doesn't reach every business in the city. One business was disconnected by AT&T, and the company was able to get service from Whisper, a wireless ISP. But wireless technology does not work well everywhere in the city, and it's likely over time that AT&T will continue to abandon customers served on copper. It's not inconceivable that a few businesses could end up with no broadband option.

- Businesses struggled with broadband during the pandemic, with the biggest problem being employees having inadequate broadband at home. It's worth noting that many of the employees with the biggest problems working from home live outside the city – however, as reported above, 36% of residents in the city reported having inadequate home broadband for working from home.
- The university, schools, libraries, and other anchor institutions have adequate broadband delivered by fiber. All told us that students and employees experienced problems with home broadband that made it a challenge to connect.

Speed Tests. During the study, we looked at speed test data as a way to have a sanity check to compare against the speeds that the ISPs report to the FCC. We were able to see the results of a lot of speed tests taken by Ookla (speedtest.net) over the last year. The Ookla data showed that the average broadband download speeds in various neighborhoods in Joplin range between 38 Mbps and 87 Mbps. The speed tests show that the average upload speeds vary from 8 Mbps to 16 Mbps.



We've usually found that big differences in speeds in different parts of a city is an indicator of local technical problems in the broadband networks. The City might be able to influence the ISPs to fix broadband issues in the worst-performing neighborhoods, but it would be nice to know more about the specific issues first. The State has access to the Ookla speed test data in more detail than was available to

us. We've recommended that the City ask the State for this detail in order to better understand the broadband performance across the city.

Fiber Network Design. Finley Engineering calculated the cost of building a fiber network to pass every home and business in the city. Per the City's preference, largely due to the past experience with the 2011 EF-5 tornado, the entire network was designed to be buried in conduit. Finley considered several fiber technologies and settled on Passive Optic Network (PON) technology as the best fit for building fiber everywhere. PON is a technology that can deliver symmetrical gigabit broadband today and can deliver symmetrical 10 Gbps speeds with relatively minor upgrades.

The network design calls for building 309 miles of fiber in the city. This is not the same as the number of miles of streets in the city because fiber sometimes follows alternate paths like alleys. The fiber design excludes the MSSU Campus since it already has its own fiber network. The fiber network was designed to go to the rest of the city, including to places that have existing commercial fiber, in order to bring price competition.

The telecom industry uses the term passing to mean any home or business in the market that can be considered as a potential customer. Finley Engineering primarily used the City's GIS database to count passings. We verified passings from external sources like the U.S. Census and Google Maps. In the study, we used the following passings in our analysis:

Passings	
Single Family, Duplexes, Small Apartments	17,636
Larger Apartments	3,297
Businesses	2,564
Total	23,497

Asset Costs. The cost of the needed assets to build a new fiber network varies according to the number of customers added to the network. Below are the ranges of costs for customer penetration rates of 45%, 50%, and 55%. In all three cases, the numbers represent the cost of the network by the end of the fifth year, by which time we've assumed the business would achieve the customer penetration rate.

	45%	50%	55%
Fiber	$52,302,616	$52,302,616	$52,302,616
Drops	$ 6,300,045	$ 6,995,450	$ 7,660,150
Electronics	$ 9,434,346	$10,068,491	$10,695,694
Huts	$ 1,255,081	$ 1,255,081	$ 1,225,081
Operational Assets	$ 652,272	$ 661,380	$ 666,795
Total	$69,944,360	$71,283,018	$72,580,336
Cost per Passing	$ 2,977	$3,034	$3,089

Our Approach to the Financial Analysis. We used the following approach in estimating the revenues and costs for operating a new fiber network for each of the three scenarios:

- A base model was created that assumes that a commercial ISP builds and operates the network.
- We considered a range of customer penetration rates between 45% and 60%.

- All financial projections cover a 20-year period. All projections include projected financing costs for borrowing the money needed to build and launch the network.
- We believe the engineering cost estimates are conservatively high.
- All forecasts include an estimate of future asset costs that are needed to connect future customers and to maintain and upgrade the network over time. We've assumed that electronics wear out and need to be replaced periodically during the studied time frame.
- The estimates of operating expenses represent our best estimate of the actual cost of operating the fiber business and are not conservative. Most operating expenses are adjusted for inflation at 2.5% per year. We are entering the first time in many years where inflation might become an issue. We have no better crystal than anybody else on the future inflation rate, and the assumption in these forecasts is that an ISP will raise rates as needed to cover inflation over our estimated level. If that happens, then bottom-line results would be the same as shown in our forecasts.
- Prices were set at what we consider to be market-based rates – the starting rate is close to the lowest-priced product from Sparklight. The forecasts assume that the broadband products don't have data caps and provide unlimited broadband usage to customers. If there were data caps, then customers that exceeded those caps would be charged more than the basic prices. Both Sparklight and Mediacom have data caps in the market today. The forecasts do not specify broadband speeds. We have shown broadband speeds by three tiers. A typical mix of products in three tiers on fiber might be something like 100 Mbps, 250 Mbps, and 1 Gbps

Residential Fiber Broadband	Price
Tier 1	$ 60.00
Tier 2	$ 75.00
Tier 3	$ 90.00
Business Fiber Broadband	
Tier 1	$ 75.00
Tier 2	$ 95.00
Tier 3	$110.00

Financial Forecast Results. One of the tasks requested by the RFP was to create financial forecasts showing the financial feasibility of various scenarios. The main reason for this analysis is to demonstrate if ISPs can be profitable in Joplin. The assumptions used in creating the various forecasts are included in Section III.C of the report. The results of the forecasts are included in Section III.D of the report. A summary of the financial results is included in Exhibit II. Following are the key financial findings of our analysis.

Key Variables. A fiber broadband business in Joplin would be sensitive to a few key variables. The most important is customer penetration rate, and it would be essential before building fiber for an ISP to better understand the number of customers likely to buy broadband. Another key variable is price, and even shifting broadband prices by a few dollars has a big impact on the bottom line. The financial performance of an ISP is also sensitive to interest rates and the length of debt financing, but not nearly to the extent of the other key variables.

Commercial ISP. It looks financially feasible for a single commercial ISP to build and operate a fiber network and be profitable in Joplin. However, in our opinion, the projected returns don't look

attractive enough to lure most commercial ISPs to fully fund and build a network. This leads us the conclusion that some sort of public-private partnership might be needed to make it feasible for an ISP to build and operate in the city – meaning the City might have to help fund the network or at least help an ISP attract broadband grants.

Breakeven Scenario. We calculated that the fiber business could maintain a positive cash flow if the customer penetration rate drops as low as 42%. That provides some safety net for an ISP if the project doesn't perform at the higher penetration rates we considered in the analysis. However, no commercial ISP would build a fiber network if the outlook was to just break even.

Municipal ISP. It looks a little more feasible to operate the business as a municipal ISP, mainly because the goal of most municipal ISPs is to break even and not make a big profit. However, there are legal and regulatory restrictions that might limit the ability of the city to do this. This is discussed in greater detail in the report. There is a State law that for years has been interpreted to mean that municipalities couldn't build and own a telecom network. However, the newest legal consensus is that the long-standing legal restriction applies only to telephone service and not to broadband. In the last few years, the City of Springfield used this newer interpretation of the law to construct a fiber network in partnership with CenturyLink and other ISPs. However, as long as the current law is effective, there is always a risk that the City could be challenged if you try to build a fiber network – that's the nature of legal gray areas of the law and the success of Springfield in skirting the law does not mean that another city couldn't be challenged. The legal issue would be the same if the City wanted to own a fiber network or provide funding for a network along with an ISP partner.

Open-access Doesn't Look Possible. The scenario where the City builds the fiber network and leases fiber loops to multiple retail ISPs doesn't look feasible. The losses for the City would be gigantic over time, while the ISPs would be profitable.

Partnership Options Look Possible. There are partnership scenarios that can be profitable. The primary reason these scenarios are attractive to ISPs is because the City would fund a lot of the assets. For that same reason, these three scenarios might not be attractive to the City.

- Operator for Hire. It looks feasible for the City to build and own the network and hire an ISP to operate the network. In this scenario, the network, customers, and revenues would belong to the City, and the ISP operator would be a vendor-for-hire. The key to making this work is to have a business plan that will generate enough cash to afford the operator fees.
- Leasing the Network. It looks challenging but possible for the City to finance and build a network and lease it to a commercial ISP. The big challenge to making this work would be finding an ISP willing to guarantee lease payments.
- Leasing the Network to Multiple ISPs. This scenario is similar to the arrangement between CenturyLink and Springfield, Missouri. In this scenario, the City would lease dark fiber to multiple ISPs. Each ISP would be responsible for funding and operating all network electronics. This scenario would only break even if the City could attract enough ISPs to cover the City's cost of debt. For various reasons, this looks like a huge challenge.

Funding Options. As noted directly above, there are several business models that could be used to bring fiber to the city.

Commercial Financing. For forecast purposes, we assumed that any commercial funding of fiber would be done through standard commercial bank practices that mix both ISP equity and bank debt. However, there are commercial ISPs that use other methods of financing.

Municipal Funding. If the City were to contribute towards the cost of a fiber network, we have assumed that funding would come from some mix of municipal bonds and grants. We compared the use of revenue and general obligation bonds.

Grant funding will be a challenge for Joplin because most of the broadband grant funding now in place or being contemplated is aimed at tackling the rural broadband gap. Here is a short synopsis of grant opportunities (or non-opportunities).

- ARPA Funding. The City has directly received funding from the American Recovery Plan Act (ARPA). That money can be used for broadband and other kinds of infrastructure. The funding is not intended to be used to build a second competitive network where there is a fast ISP like a cable company. However, cities are thinking about using this funding for more limited broadband builds, such as constructing a fiber network to connect City buildings or building fiber to reach underserved areas in a town like public housing. This funding could be used as part of a larger build as long as the City is careful to direct the grant funding to the parts of the project that meet the ARPA funding rules.
- Capital Projects Fund. The ARPA legislation also gives $10 billion to states to build broadband, and Missouri's share is $196.7 million. This will likely turn into a grant to be administered by the state broadband office, although the legislature has to act to make that happen. While the State will choose the specific grant winners, the grant plan must be approved by the National Telecommunications and Information Agency (NTIA). The NTIA has made it clear that states should strive to take care of needed rural areas before using the money in cities, so it's possible in Missouri that none of this money comes to cities. The grant rules are more relaxed than other federal grants, but it's all going to boil down to how the State decides to structure the broadband grants. The State must file its plans with the NTIA on how it plans to use this funding, and grants will be awarded next year.
- Smaller Grants. The ARPA money spread smaller grants to numerous federal and state agencies. For example, there are almost a dozen grants that apply only to libraries. It's possible that a creative city could corral some of these smaller grants to help fund a larger broadband plan – however, most of these grants are already in the process of being awarded.
- Future Grants. There is no guarantee that Congress will pass an infrastructure bill. If they do, then some of that money could find its way to Joplin for broadband. However, if we use the legislation already passed by the U.S. Senate as a guideline, the broadband grants will be primarily aimed at solving rural broadband gaps before considered cities. However, there may be other ways to use infrastructure funding other than broadband grants. For example, the Senate infrastructure plan includes money for smart grid technology that might be able to be repurposed for broadband. This would probably require a creative partnership between a city and the electric utility.

Alternate Tax Revenue. We showed that any scenario will be improved if some alternate form of tax revenue is used to help fund a fiber business plan. This could be a wide range of revenue streams such as

sales taxes or property taxes. There have been a few creative solutions around the country in the use of alternative revenues. The small cities in Utah that are part of the Utopia network got pledges on customers' homes that were effectively a small second lien. Ammon, Idaho got its start in the fiber business by having customers give a deposit of $3,500 to get onto the network. The City of North Kansas City pledged revenues from riverboat casinos to fund fiber.

Benefit / Risk Analysis. Section IV.B. of the report includes a lengthy analysis of the benefits to the community from having good broadband. This section of the report also discusses the risks for any ISP for launching a new fiber network. Here is a short synopsis of the benefits and risks:

Benefits of Better Broadband:

- Choice. A new network means more choices for residents and businesses. This is something that the surveys in Joplin show to be a high priority for the public.
- Lower Prices. There are dozens of examples across the country where a network with a fiber competitor will have lower prices than a nearby town without that same competition. When ISPs compete, prices are lowered.
- Improved Repairs and Maintenance. An interesting impact of a new fiber network is that the incumbents try harder to retain customers. This means faster service repairs and improved overall maintenance.
- Faster Broadband Speeds. Fiber, by definition, brings faster broadband speeds. But when a fiber provider comes to town, the incumbent providers often make upgrades to also be faster.
- Improved Telemedicine. Households need a decent and reliable upload data stream to partake in telemedicine. In a city like Joplin, telemedicine can be used for routine medical visits that don't require a live examination. It's proved to be a boon for counseling. Telemedicine allows seeing a specialist in Kansas City or other metropolitan areas.
- Improved Education. We saw during the pandemic how difficult schooling from home could be. Broadband is vital for better education even after the pandemic. 37% of all graduate degrees now include a substantial amount of online classwork. Several definitive studies show a big gulf between student performance for homes with and without broadband. The most staggering statistic from a recent study showed that 11th graders without home broadband have the same digital skills as 8th graders from homes with good broadband.
- More Efficient Businesses. There are huge opportunities for businesses to become more efficient by using cloud software and other online tools to improve operations. Most of the businesses we talked to that don't have fiber said they could not attempt these new opportunities.
- Economic Development. Many cities still swear by the traditional model of economic development where making sure businesses have the tools like broadband can be used to lure new businesses to the community or stop existing businesses from relocating. A newer concept of economic development looks at the huge positive impact of people working from home. There is as much economic benefit to a community from attracting a hundred people to work from home than from attracting a new business with a hundred employees. We also see that a lot of job creation and new businesses are originally started in the home.
- Better Cellular Networks. One benefit of fiber everywhere will be more robust 5G networks that take advantage of small cell sites.
- Expanded Public WiFi. A new fiber network could mean an opportunity for the City to expand public and outdoor WiFi.

- Smart City. One of the primary purposes of this report was to describe how broadband could help the City meet its vision for a Smart Joplin.
- Smart Government. Related to a smart city initiative is a smart government initiative that brings the same kinds of technology and software benefits to city government that is being used by commercial businesses.
- Improved Resiliency. One of the most common complaints we heard about existing broadband in Joplin is that there are many small broadband outages during the year. Any outage can be crippling to some businesses. A fiber network can bring more stability and resiliency.
- Taking Part in the Modern World. There are huge benefits to homes from faster broadband. Some of the benefits comes from improved recreational uses of broadband like gaming or watching high-quality video. But there are other important benefits like improved security systems and cameras. We're now filling our home with smart devices that want to constantly communicate with the cloud, and our computers and smartphones quietly connect to the cloud many times per day.

Risks for Not Bringing Better Broadband. The report doesn't spell out the list. It's essentially the negative mirror image of the list above. Without better broadband, those benefits don't materialize.

Risk for Launching a New ISP. There is an additional list of risks that any new ISP – commercial or municipal – should be aware of:

- Legal Hurdles for Municipal Broadband. Missouri Statute § 392.410(7) has been interpreted for years as being a prohibition against municipal broadband. However, when the FCC got out the broadband regulation business, this cascaded downward to states. The latest interpretation of this law is that it is still a prohibition against municipalities providing telephone service, but not a ban against broadband. There is a lot of support for this new view since the City of Springfield relied on this interpretation when entering into a partnership with CenturyLink and other ISPs to build a fiber network, largely funded by the City. This interpretation is further bolstered due to several unsuccessful legislative attempts to modify the old law to include broadband – legislators don't believe the existing law is a prohibition against municipal broadband.
- The Reaction of the Incumbents. Every fiber ISP worries to some extent about the reaction of the incumbents to a new fiber competitor. We haven't seen price wars in many years. However, incumbents can get aggressive with special pricing and try to lock customers into long-term contracts before a new builder completes a network.
- Financial Risks. No ISP is guaranteed to succeed. There have been failures of both commercial and municipal ISPs that botched entry into a new market. The downside to a commercial ISP that fails can be as drastic as going out of business. Cities that fail with a broadband launch might still be obligated to repay bond debt even if the ISP business doesn't make it.
- Operational Risks. Not every ISP is good at all aspects of operating a complex ISP business. This can result in poor margins and cost overruns even if the business doesn't fail.
- Local Rules and Regulations. ISPs are often surprised by unexpected local rules that make it hard to build a fiber network.
- Market Forces. Every ISP faces external threats such as a poor local economy, runaway inflation, or in today's environment the problems due to a gummed-up supply chain.
- Extra Risks for Municipal ISPs. Municipal ISPs face two risks that don't apply to commercial ISPs. One is the slow, costly process of launching a complex new business while saddled with cumbersome municipal purchasing rules. The other risk can best be described as political risks.

There have been municipal ISPs that had problems when the ISP was not shielded from decisions made by politicians – such as lowering rates in an election year.

Finding a Partner. Section IV. D. discusses the steps that other municipalities have taken to find an ISP partner.

Other Issues. Section IV.C. looks at cities of similar size that have built fiber networks.

Recommended Strategies

The RFP asked Finley Engineering and CCG Consulting to recommend broadband strategies and to recommend a business model and implementation approach. This section includes our recommendations. Note that the rest of this report is intended to be a factual assessment of the state of broadband in Joplin, but in this section, we are making observations and recommendations based upon our industry experience. We think you hired us because of our long and deep industry experience, but we will be the first to acknowledge that others might come up with different conclusions based upon the same facts. The primary purpose of our observations in this section is to help spur the conversations that must take place if you are to solve the various broadband gaps identified during our study.

Is the City Poised to Meet the Smart Joplin Roadmap?

One of the primary questions posed by the RFP is if Joplin is poised to be able to implement the vision adopted by the City for the Smart Joplin Roadmap. Before drawing a conclusion we'd like to list the goals of that Roadmap that we think rely on good broadband:

- The 2011 EF5 tornado made it clear to the City that networks and infrastructure need to be resilient, meaning that they can be quickly brought back to life after a major disaster.
- Everybody in the region should have access to fast Internet.
- There should be education programs so that Joplin residents have the skills needed to be successful in the technology and data-driven future.
- The City government should digitize internal processes to be more efficient.
- The Roadmap recommended the creation of an innovation district that embraces technology, entrepreneurship, and collaboration.

The following list is broadband factors that we think are necessary for the City to meet the Roadmap goals:

- The most resilient broadband network will largely be buried. Buried networks can survive bad storms and other disasters. Resiliency also requires creating broadband networks with a distributed core – meaning that if a building that houses the brains of the network is destroyed that a second core location can pick up the control of the network. Resiliency also means having a network distribution design that limits outages when a network sustains damage.
- Meeting the goals means having broadband networks with fast download and upload speeds so that residents and businesses can get unimpeded access to broadband services.
- Getting more households onto the Internet requires a willing ISP that embraces the idea of providing affordable broadband and which will aggressively work to get more residents connected to the Internet.
- The goal of training the public in digital skills is something that is outside the scope of a broadband network or ISP. This is something the community has to tackle on its own. This study discusses this topic to some extent, but this is something separate from making sure the community has the needed broadband.
- There is one aspect of good broadband needed for the City to meet its internal digital goals. Most cities reach this goal by connecting all key city locations on a private network. A city doesn't necessarily have to own the private network. If the network is operated by an ISP, the City needs an ISP partner that is willing to be nimble enough to meet changing city needs.

- We know other cities that have created innovation zones. From a broadband perspective, an innovation zone needs great broadband connectivity. An innovation zone also requires an ISP partner that is willing to be creative to craft unique solutions as the needs arise.

After looking at all of the facts, we reach the conclusion that the current broadband in Joplin today is not sufficient to meet the Smart Joplin Roadmap. We relied on the following support in reaching this conclusion:

- Lack of Competition. AT&T stopped selling DSL in October 2020. This has huge implications for the future of broadband in the city. New customers can't opt for AT&T, and anybody that disconnects AT&T for any reason can't go back to DSL. The long-term consequence of this change is that the cable companies are becoming broadband monopolies. We already heard from businesses and residents who don't feel like they have broadband choices. The only way to get choice is to have competition between the cable companies and somebody else. AT&T abandoned that competitive niche, and unless another ISP enters the market, the competitive choices in Joplin are shrinking and not expanding.

- Data Caps. The two cable providers in the city – Sparklight (Cable One) and Mediacom – have one broadband practice that tends to squelch broadband connectivity. Both companies have data caps and bill customers that exceed relatively low broadband usage levels each month. Customers have to consciously monitor and restrict broadband usage in order to avoid paying extra.
    - According to OpenVault, the average monthly broadband usage for residential households at the end of the first quarter of 2021 was 462 gigabytes. That's higher than the data caps on the basic broadband products from the two cable companies.
    - The monthly data cap on the Sparklight basic 100 Mbps broadband product is 300 gigabytes per month. Customers can buy unlimited data for an additional $40 per month.
    - The Mediacom data cap on the 60 Mbps product is 200 gigabytes per month. Customers can pay $20 more per month to raise the data cap to 400 gigabytes.

- Broadband Affordability. The residential broadband penetration rate for a home landline broadband connection is 71% in Joplin. This is far below the national average of 87% and far lower than what Joplin needs to meet the Roadmap. We think one of the primary reasons for the low home broadband adoption is the cost of broadband. 13% of all households said they didn't have a broadband connection due to the cost. The average residential price for broadband was reported by the two surveys to be between $82 and $86. This is higher than what we have seen in other broadband surveys that show prices between $72 and $76. Part of the reason for the higher rates is probably the data caps, which add a cost to the broadband bill for many households. Another 10% of households only use cellphone data as the home broadband connection – that's another indicator to use that affordability is an issue.

  Performance of Existing Networks. This is an area that probably needs more research, but we got feedback from the public that the existing broadband networks don't meet existing broadband needs. Consider the following:
    - 36% of households with somebody who works from home told us in the survey that home broadband isn't adequate to meet their needs.

- 78% of homes that had students working from home during the pandemic told us that the broadband connection was not adequate.

- Businesses gave us the same feedback. Almost every business had problems connecting with employees working from home during the pandemic. Businesses without fiber almost all told us that they had problems using functions that require upload bandwidth, like working with cloud software.

- We heard from both residents and businesses that AT&T and the cable companies routinely have short broadband outages in the city. These were described as outages that lasted from a few minutes to a few hours. We heard that major all-day outages are rare.

- The speed test data gathered by Ookla showed evidence to support what the public told us. We saw Ookla speed test data by Census tract, which gave us a peek at average broadband performance in 13 different parts of the city. Average download speeds varied from 38 Mbps to 87 Mbps across the various neighborhoods. Average upload speeds vary from 8 Mbps to 16 Mbps across the city.

  Average download speeds that vary that widely generally indicate that some parts of the ISP networks are underperforming for some reason. There are numerous issues that can cause networks to underperform. The State has access to details of the Ookla data that are not available to us. We've recommended that the City ask the State for more detailed records so that you can better understand if there are broadband performance issues between neighborhoods.

- CCG has done similar broadband studies in over a dozen cities since the start of the pandemic, and the upload speeds in Joplin are typical of what we see elsewhere. In all of these other cities we also heard from the public that upload speeds were inadequate for a lot of households.

- The existing broadband networks in the city are getting old. The cable networks were likely built in the 1970s, and the expected economic life of coaxial copper networks has historically been estimated to be about forty years. This means the coaxial copper portions of the network are at the expected end of economic life. This could explain some of the differences in broadband speeds experienced in different neighborhoods – copper networks don't age uniformly. The AT&T copper networks were likely built in the 1960s and also have a forty-year expected life. This is the primary reason that AT&T is backing out of the DSL business nationwide since the company understands that performance degrades year after year on old networks.

- We also have evidence in Joplin that converting to fiber makes a big difference. Many of the larger businesses and anchor institutions in the city are served by fiber provided by Liberty, AT&T, and Sparklight. Every business we talked to with fiber is happy with the broadband performance. Almost every business we talked to that doesn't have fiber told us that current broadband performance restricts them in some manner. For example,

businesses said that they would put more functions in the cloud if they had faster broadband.

- Future Demand. We can't judge the adequacy of the existing broadband in the city solely on the current performance of the ISPs. We know that the demand for broadband has been growing at a steady rate since 1980, and the end of that growth is not in sight. At the end of 2018, the average home in the U.S. used a combined amount of upload and download broadband of 215 gigabytes per month. At the end of the first quarter of 2021, the average household usage had grown to 462 gigabytes per month.

  There was a slight upward blip in broadband demand in the early months of the pandemic, but over time we're still seeing broadband usage doubling about every three years (as it has been doing for decades). It's always hard for the mind to fully grasp this kind of geometric growth. If broadband continues to grow at the historical long-term growth rate, then the broadband networks in Joplin must be ready to carry ten times more traffic than today in ten years and one hundred times more traffic than today in twenty years.

  We know the cable companies will have to make huge investments in the network to keep up with the expected future broadband demand. Many Wall Street analysts believe that sometime during the next two decades that the big cable companies will ditch the coaxial copper networks and make the leap to fiber. We've already seen one large cable company, Altice, make the decision to convert to fiber, and the company has already converted a substantial portion of its coaxial networks.

These findings, along with many other observations we made in working on this report, lead us to the conclusion that the broadband networks in Joplin today are not fully meeting the current demand for broadband. Without substantial upgrades, the current networks will be even more unable to meet future broadband demands. That means that the current networks are not positioned to meet the Joplin Smart Roadmap.

What is Needed to Meet the Smart Joplin Goals?

We're going to answer that question by referring back to the Smart Joplin Roadmap goals listed at the beginning of this discussion.

Resiliency

There are three network characteristics that will best meet the resiliency goal. The first is to bury as much of the communications network as possible to protect against storm damage. The second is to create multiple network hubs so that the loss of one hub doesn't cripple the network. The final resiliency technique is to route communications cables in a way that either can be self-healing if communications wires are cut or that are designed to be easy to repair and restore service after storms.

The current broadband networks don't meet these resiliency standards, which is why there were major communication problems after the 2011 tornado. For example, we have never heard of a cable company that builds multiple hubs in small cities. This would even be rare in major NFL

cities. Much of the original cable company and telephone company networks were placed on poles because that was the least expensive construction method.

In this study, the Finley engineers considered a network plan for a new fiber network that would meet all three of these goals. First, the network is designed to have two fully redundant hubs that each could be used to control the network in the case of major damage to one of the hubs. Second, the neighborhood fiber nodes and the two redundant hubs would be placed on a self-healing fiber ring. This means that the network would not lose any service from a single fiber cut along the main fiber routes. Finally, the entire network has been designed to be buried, which would have avoided the vast majority of the damages suffered in the 2011 tornado. This design is not only prepared to protect against a repeat of major storm damage, but a more resilient network means there will be far fewer smaller outages.

Access To Good Broadband For Everyone

There are several aspects of good broadband that are needed to meet the Smart Joplin Roadmap:

- Good download speeds
- Good upload speeds
- Reliable and always functional
- Available to everybody
- Affordable

These are not all technical parameters, which means that it not only matters if the networks are adequate, but it matters who is the ISP. Let's look at each of these issues in the context of the existing networks and of the fiber network proposed by Finley Engineering.

Good download speeds. We heard very few complaints about the current download speeds provided by the cable companies. There are customers unhappy with the AT&T download speeds, but the vast majority of customers in the market have the option to use a cable company instead of AT&T.

The cable companies will have a challenge to deliver good speeds in the future without making some upgrades and network improvements. For example, both cable companies tell us that the networks have been upgraded to the DOCSIS 3.1 standard. That means the networks are capable of delivering gigabit download speeds. However, something that cable companies don't talk about is that their networks can bog down if too many customers in a neighborhood are using fast speeds at the same time.

There are future upgrades on the drawing board at CableLabs that will enable the cable companies to improve download speeds if the companies are willing to invest in the expensive upgrades.

Fiber technology is already capable of delivering symmetrical gigabit broadband to every home and business in the city. Further, with a relatively minor upgrade, a fiber ISP can offer symmetrical 10-gigabit broadband.

Good upload speeds. This is the Achilles heel of every cable company. The DOCSIS standard places a cap on upload speed performance, which was designed into the standard in order to maximize download speeds. The performance of Sparklight in Joplin is typical of what we see in most other cable companies – most neighborhoods have relatively slow upload speeds in the range of 10 Mbps. To make matters worse, the DOCSIS technology places the upload data stream in the noisiest part of the cable TV spectrum band. What this means in layman's terms is that there can be significant interference from the outside world that can degrade the upload performance.

There is a new standard called DOCSIS 4.0 that is going to drastically improve upload speeds on cable networks. This upgrade probably won't be commercially available for four or five years. The biggest dilemma facing the cable companies is that this upgrade is going to be expensive. Several Wall Street analysts have speculated that the cable companies will delay this upgrade as long as possible, but after the big public relations problems unearthed by upload speeds during the pandemic, the cable companies might not be able to put this off.

Fiber networks have a vigorous upload data path and can provide symmetrical gigabit speeds today with ease.

Is reliable and always functional. A good broadband network will deliver fast broadband speeds at all times of the day. Cable companies have had the historical reputation of putting too many customers on a neighborhood node which resulted in performance bogging down during the peak primetime evening hours. The cable companies have fixed this problem in most cases by reducing the number of customers on a cable node.

During the pandemic, we saw a new phenomenon, where the cable networks bogged down on upload speeds during the day when people were working and schooling from home. Since the upload data path on a cable network is much smaller than the download path, it's much easier for the upload network to get overwhelmed.

The other issue associated with reliability is outages. We heard from both businesses and residents that AT&T and the cable companies suffer small but regular small network outages that might last from minutes to hours. Some businesses are so reliant on broadband that even short network outages shut them down. If a business relies on software in the cloud, then the business stops functioning when it can't reach the cloud. Short outages are also becoming an issue for homes. Outages drop remote workers from connections to office servers or access to cloud software. Residents also use upload broadband for important functions. In another study we did this year, we heard a story of a student taking a nursing certification exam from home. When the broadband failed for a few minutes in the middle of the test, she wasn't allowed back into the exam and had to wait six months to become certified.

All broadband networks have outages. For example, while a buried fiber network is largely immune to storm damage, fiber can be cut by somebody with a backhoe that isn't following protocols for locating fiber before digging. But a buried fiber network with redundant hubs on a fiber ring should have a lot fewer outages and network problems than an older network that still has parts of the network on poles.

Available to everybody. The cable networks are available to almost all businesses and residents in the city, but we know there are exceptions since we talked to one business that is not near to the Sparklight network. When cable networks were first constructed, the networks were built to reach residential neighborhoods – who were the purchasers of cable TV. Since broadband was introduced on cable networks around 2000, most cable companies have built to reach most, but usually not all businesses. It wouldn't be unusual if there were some apartment buildings or small side streets in the city that were never connected by the cable companies.

If the City is involved somehow in building or attracting a fiber network, you'll have the same situation. There are always places that won't let a fiber network onto a property. Apartment owners have to right to bar ISPs from their properties, as do places like trailer parks. Sometimes streets that are privately owned won't let a fiber builder undertake any construction.

Affordable. Our study showed that broadband prices are a key factor in homes deciding to buy broadband. We were surprised to see 13% of residents saying that they didn't buy broadband because it is unaffordable.

Providing affordable broadband is a policy choice for an ISP and not a technical issue. It is fairly obvious in looking at the low 71% broadband penetration rate that none of the existing ISPs have made any push to get low-income residents onto the network. Even when an ISP has a low-income product, it doesn't mean that it will aggressively market the product and strive to get homes connected.

Low-income broadband has not been a priority for the ISPs in Joplin, which is probably one reason why the penetration rate of landline broadband is so low. AT&T historically participated in the FCC's Lifeline program that provided a discount of $9.25 per month that can be applied to either telephone service or broadband. However, after the State deregulated AT&T for telephone service, the company withdrew from the Lifeline program in Missouri.

Before the pandemic, Sparklight had no low-income program – which is a bit unusual for a major cable company. During the pandemic, the company offered a temporary discount, but that special promotion has ended. Sparklight is participating in the FCC's EBB program that offers a discount of up to $50 per month to qualifying low-income homes. We have no way of knowing if the company is aggressively advertising the plan – and with its history of not having a low-income plan, it would not be surprising if it is not. Mediacom has a decent low-income program, but it only covers a small part of the city. We also have no idea if Mediacom aggressively markets the low-income program.

There is also no guarantee that a new fiber provider will offer a low-income plan. For example, many cities have partnered with Google Fiber, and the company has never offered a discount from its basic $70 price.

If the City is to reach its goals, you'll have to find ways to get more people connected to broadband. It's possible to put pressure on Sparklight to do better, but this might fall on deaf ears since the decision to not have a low-income program before the pandemic is a corporate decision – and big cable companies rarely stray from corporate policies in any given market.

If the City somehow attracts a fiber ISP, it could make sure that serving low-income homes is part of the promises made by the ISP – but such promises still won't assure that a new ISP will be diligent and aggressive.

This is dilemma faced by cities all over the country, and probably the only way to try to get broadband into every home would be for the City to have a role in operating the ISP.

Broadband Education and Training

We agree with the Smart Joplin Roadmap that broadband training is a key element for getting broadband to everybody. We don't know of any examples where major broadband training initiatives that have been successful. However, there is a good chance that this is going to change.

When residential broadband was a new phenomenon in the late 1990s, many local governments sponsored broadband training. It seems like governments now assume that people have figured out how to use the Internet, and broadband training programs largely disappeared. It turns out that was a badly mistaken assumption. Let me provide an anecdote to show how wrong this was.

A few years ago, I talked to Deb Socia who is the CEO of the Enterprise Center in Chattanooga, Tennessee. This is a non-profit with the goal of leveraging the City's fiber network to benefit the whole community. Even though Chattanooga has operated a citywide fiber network for well over a decade, it had the same problems being seen in Joplin, where a lot of homes are not connected to broadband. The city-owned ISP took the first step to help close the digital divide by offering a low-cost broadband product at half the price of a normal broadband connection. The lower price helped to connect many homes to broadband, but not nearly enough.

The Enterprise Center developed a curriculum of free computer training courses to cover basic computer skills like writing emails, connecting to social media, and downloading and using common apps. The response of the community was overwhelming, and classes were massively oversubscribed. It turns out that a lot of people without broadband are not comfortable with using computers and navigating the Internet but are not willing to admit it. This is likely true in Joplin also, and many of the folks who told us they can't afford broadband or who said they aren't interested in broadband might instead not be comfortable using computers.

The reason this might be changing is that some of the federal ARPA grant funding is being directed at grants for digital literacy training. Communities and community activists became acutely aware of the lack of digital literacy during the pandemic, and hopefully, the new funding will spur training programs across the country.

It is beyond the scope of this report to suggest how the City tackles this issue. This is a relatively new discussion in most communities, but from the few places that we see this solution being discussed, it looks like having a non-profit address the issue is a common solution. However, this is something that the City or the schools could also address.

Smart Government

This is also beyond the scope of this report, and in fact, is a topic that requires assistance from somebody who knows the best and latest specialized software systems that can help cities to modernize and improve the IT functions and interfaces with citizens.

We know that one of the keys to fully implementing a smart city solution is to be able to get all city locations integrated onto the same broadband network. This can be accomplished by building fiber between city locations or by leasing such a network from others. However, in the future, pursuing a smart city initiative will mean adding more locations to the City's network if the City tackles things like smart streetlights, smart parking, or any of a number of smart applications under consideration.

Innovation District

Every city I've talked with that is contemplating an innovation district has a different definition of what that entails. That's not surprising since the main purpose of an innovation district is to solve perceived local problems – and every city has a different list of problems and goals for an innovation district.

Consider the innovation district that has been created in Chattanooga, Tennessee. The City owns a citywide fiber network which gives it great tool when considering creative broadband solutions. The Chattanooga innovation district has some specific goals. The section of town selected for the innovation district was run-down, so one goal was to use the effort to bring life back to the neighborhood. The City is using the district to promote new business start-ups. Emphasis is being made to create collaboration between creative thinkers, entrepreneurs, the local University community, and technology gurus. There is also an infrastructure aspect of the innovation district that includes building a high-tech business incubator and co-working center.

The Chattanooga innovative district is also being used to develop the City's smart city efforts. The municipal ISP has made a 1.5-mile section in the innovation district into a testbed for smart city applications and has attracted institutions like the Oak Ridge National Laboratory, the National Science Foundation, U.S. Ignite, and the University of Southern California, along with numerous vendors and entrepreneurs. The goal of this collaboration is to test new smart city ideas in a field environment that is wired with gigabit fiber. The long-term goal is to spread the best smart city applications to the rest of Chattanooga.

It's unlikely that an innovation district in Joplin would look the same as the one in Chattanooga – and there is no reason it should. For example, an innovation district in Joplin might focus on some of the issues identified in this report, such as the low overall broadband penetration rates in the city.

But the basic infrastructure needed for an innovation district would be the same. An innovation district needs great broadband, available both inside buildings and outside as needed to allow for whatever innovations are to be tackled. This could be a fiber network owned by the City or

provided through a partnership with a willing ISP. An innovation district also needs an ISP willing to think outside the box and willing to provide broadband connections that might not make money.

The Big Picture

Our research shows that there are already some significant broadband gaps in Joplin today. The City is to be commended for asking the right questions. The Joplin Smart City Roadmap was a great first step towards the future. That Roadmap outlines specific goals that the City believes are needed for your economic well-being. Not surprisingly, many of the recommendations of the Roadmap require good broadband.

Undertaking this report was a great next step, and the most important output of this report is to identify the existing broadband gaps in the city that are impediments to meeting your Smart City goals. The City can't solve broadband gaps until you fully understand them.

Broadband in Joplin is not horrible – to see horrible broadband, you only have to drive into the rural areas around Joplin to see the impact of having almost no working broadband. But the existing broadband infrastructure in Joplin is already failing some homes and businesses – broadband prices are high, broadband penetration rates are low, and both businesses and residents have clearly said they want broadband competition and choice. The coaxial networks in the city are near the end of economic life, and it will be harder each year for the cable companies to coax the needed performance from the networks. The pandemic uncovered the upload speed gap, which makes it difficult to work or school from home.

The current broadband gaps are only going to worsen over time if nothing is done to improve the broadband infrastructure in the city. The demand for broadband continues to grow, and the current networks will be severely impacted as broadband demand grows by ten times over the next decade and by one hundred times over the next twenty years. This is not a problem unique to Joplin, and any city that gets broadband primarily from cable companies faces this same future.

The next section of the report discusses the immediate next steps that we think should be considered following this study. But it's important to first look at the bigger picture. The primary finding of this report is that the broadband infrastructure in the city will need to be improved over time if you want to achieve your Smart City goals.

Technologies. There are only a few technologies that can meet your Smart City goals:

Fiber. For various reasons, fiber is the best technology solution for meeting all of your goals. The best feature of fiber is that it is almost infinitely upgradable to faster speeds. If networks need to be ten, a hundred, or a thousand times faster over the next decades, then fiber can reach that through faster lasers and upgraded electronics. The fiber technology discussed in this report is already capable today of delivering broadband speeds at a symmetrical 10 Gbps. That is one hundred times faster than the basic 100 Mbps broadband product offered today by the cable companies. And that's not the end game for fiber. The next generation of fiber-to-the-home in the labs is delivering 40 Gbps. A month before this report was written, Zayo implemented an 800 Gbps fiber route between New York City and New Jersey.

Hybrid Fiber Coaxial Networks. This is the technology used in the city by the two cable companies. This technology today has a realistic download speed capability of around 1.2 Gbps. The Achilles heel of this technology today is the poor upload speeds, which in Joplin are mostly between 10 Mbps and 15 Mbps.

However, there are upgrades to the technology that have been developed by CableLabs. Within four or five years, the cable companies will have the option to upgrade to the DOCSIS 4.0 standard. That's going to increase download speeds to multiple gigabits (the maximum speed will differ according to local conditions). The biggest improvement will be the capability for gigabit upload speeds. If this upgrade is made in the city, these speeds would be sufficient to meet the Smart City goals for the next decade or two, and maybe longer.

The biggest downside to the technology is that the copper wires in Joplin were built in the 1970s and are near to the end of economic life. We see some evidence of this when seeing that speed test results vary in different parts of the city. The problems associated with aging copper will slowly worsen each year, and those problems could negate many of the benefits of layering on faster technology.

Fiber-to-the-Curb. This is a technology that brings fiber along each street and delivers broadband from the pole to the home using a wireless link. The only company doing this in any serious way today is Verizon.

We didn't spend much time on this technology in this study for several reasons. First, the technology currently is delivering download speeds of around 300 Mbps, but Verizon says they will be able to boost that to gigabit over time. However, it doesn't look like there is a future upgrade path for going much faster than a gigabit. The technology is currently more expensive to build than fiber-to-the-home. The technology is also going to be best suited to carriers that have bought the rights to licensed spectrum from the FCC. Most ISPs and cities can't afford the spectrum. There are two more reasons why we didn't consider this technology in Joplin. This technology is best delivered from poles, and that does not align with the City's resiliency goals – a bad storm could rip out a lot of this network. More importantly, the wireless delivery doesn't do well with trees and bushes, which isn't a good match for Joplin.

Business Models. There are four business models that can be used to improve broadband. One of the primary purposes of the next steps section below is to help the City choose between these options. The broadband networks needed for the future can come in the following ways:

Attract a Fiber Overbuilder

One of the best possible outcomes would be for the City to convince an ISP to fund and build fiber. That would solve some of the major issues identified by this study. A new fiber network would provide faster speeds, and customers that need faster upload speeds would have an alternative. A new network would likely spur competition with Sparklight, which might mean improved performance and lower prices.

But a fiber overbuilder might not satisfy all of the City's needs. First, many fiber overbuilders don't want to build to every part of a market and might only build to the neighborhoods they find to be the most attractive. That would create a new broadband gap in the city between neighborhoods with and without fiber broadband. There is no guarantee that a new fiber provider will have affordable rates or that it will want to bring a low-income solution.

A fiber overbuilder might not want to do anything extra that would help you meet your Smart Joplin needs. For example, a commercial ISP might not be interested in working with an innovation district.

Finley Engineering talked to several regional ISPs that provide fiber-to-the-home in other nearby parts of Missouri. None of these ISPs is willing to go on the record as being interested in bringing fiber to Joplin, but we know that several of them are interested, and we'll introduce them to the City when you are ready for those discussions.

The bottom line of these observations is that better technology doesn't automatically solve broadband issues. It also requires an ISP that is willing to tackle the broadband gaps.

Partner with Sparklight

It would be possible to meet the Smart City goals by working in conjunction with Sparklight. A local representative of Sparklight told us that the company would be interested in working with the City to meet your smart city goals. However, there are a lot of current issues with the company that would have to be solved for them to meet your goals:

- Commitment to Improving Upload Speeds. The Sparklight network failed many homes and businesses during the pandemic. There are probably steps the company could take to goose upload speeds a little higher today, but the only real solution to upload speeds will require a commitment from the company to upgrade to DOCSIS 4.0 when it becomes available in a few years.
- Affordability. We think that Sparklight policies are likely a major factor for the low broadband penetration rates in Joplin. We learned in this study that 13% of households don't have broadband because it's too expensive. Sparklight historically had no affordable options for low-income households, although the company is currently participating in the FCC's Emergency Broadband Benefit program. However, there is a huge difference between mere participation in a low-income plan and aggressively courting low-income homes to get onto the network. The City needs a partner that shares the goal of getting broadband into the greatest number of homes.

  Sparklight also has some of the most aggressive data caps in the industry. Its basic 100 Mbps broadband product has a 300-gigabyte cap on monthly broadband usage, and customers exceeding that cap must pay extra. Homes where price is an issue must choose between paying more to get the broadband they need or curtailing broadband usage to save money. That is not in line with the Smart City goals.
- Old Network Infrastructure. Perhaps the biggest problem for Sparklight is that its coaxial cable network is near the end of its economic life. The company may goose the network

and keep using it for many more years, but problems caused by the deterioration of the cables will mean that more and more local problems will arise each year into the future.

At some future time, Sparklight and other cable companies will have to upgrade to fiber. The question each is wrestling with is if they tackle this in the next five years or take steps to prolong the life of the coaxial networks for a few more decades.

- Corporate Bureaucracy. Cable companies operate in many markets, and they know that if they make improvements in one market that they will be expected to do the same in other markets. It's possible for big ISPs to break out of this kind of thinking, and we've recently seen some unique one-market deals between communities and big ISPs – like the partnership between CenturyLink and Springfield. But such partnerships are still a rarity, and an ISP like Sparklight will have a hard time pulling off a partnership with a city like Joplin, even if its intentions are good – because doing so would mean having to do the same thing in many other markets.

Create a Public-Private Partnership to Build Fiber

Another alternative is to create a partnership with an ISP. This would likely involve the City putting some money into a fiber network. If the City was to help fund a network, you'd also be able to influence the ISP to deal with issues like affordability or supporting an innovation district.

But even partnerships are no guarantee of solving all of the broadband gap issues. We know that a lot of the ISPs that are building fiber today have a business plan to flip the business in 7 to 10 years to realize the market appreciation. If you partner with an ISP with that business model (which is something they might never reveal), the City could find itself in seven years with a different ISP partner that might not be interested in the City's needs.

This report discusses the most common types of partnership. The big difference between various partnership models is the amount of funding that comes from the City versus from an ISP partner. The more money the City is willing to invest, the more say you would have over making sure the new business addresses the broadband gaps.

Build Fiber Yourself

The ultimate control that the City can have to solve the broadband gaps and to fully embrace the Smart Joplin Roadmap would be for the City to build and operate a fiber ISP business. There are not many cities that don't already operate an electric utility that have tackled this idea because operating a big network and a competitive business is a highly complex undertaking.

We see more cities contemplating this option today, but most of them have first tried the alternatives discussed just above of looking for a partner. If a city decides that it needs fiber badly enough, and if the incumbents or regional ISPs are not willing to bring a solution, then doing this yourself might be the only eventual alternative.

We are not recommending that Joplin become an ISP. We think the City needs to first explore the other alternatives of working with an incumbent, attracting a fiber overbuilder, or partnering with

an ISP are all feasible ideas that need to be fully explored. Our analysis shows that it can be at least somewhat profitable for a fiber ISP to operate in the market, and we think Joplin has a good story to tell to ISPs.

Consider Incremental Broadband Projects

We are starting to see cities thinking about ways to use the American Rescue Plan Act (ARPA) money. Probably the most important aspect for any City that wants to use ARPA money for broadband is that the legislation says that any such use of the funds must fix a specific issue that was created as a result of the pandemic. The U.S. Department of Treasury was tasked with translating the law into practical principles, and it's clear that Treasury doesn't think the funds can be used to simply overbuild fiber to compete with an existing cable company. It's easy under the Treasury rules to use ARPA money in rural areas. But this restriction means that any city that wants to use ARPA funds for broadband will have to be creative.

There are numerous ideas that we've heard about for using the ARPA funds for broadband – but note that none of these have yet been implemented.

- Better Broadband to Public Housing. The lowest-income parts of Joplin are likely the places that have been most neglected by the incumbents. That's particularly the case in Joplin, where the incumbents have not had a plan for helping low-income households. We know a few cities that are thinking of building fiber to public housing to provide low-cost or even free broadband. These ideas are likely in conjunction with providing computers and digital literacy training. One of the biggest decisions in implementing this idea is who will act as the ISP – somebody has to route broadband traffic, protect traffic from malicious software, and take care of the things that ISPs handle for customers.
- Build Broadband to Business Districts. The businesses we heard from that don't have fiber have all said they want faster broadband and more choice. Cities have been tackling this issue for years, and there are dozens of cities that have built fiber to business districts. This concept requires an ISP partner unless the city is willing to tackle the ISP functions – which are more complex for businesses than with something like public housing mentioned above.
- Build a City Network. A lot of cities are thinking of using the ARPA money to build a fiber network to connect city locations. This would connect all city locations on a single network and would eliminate external fees paid to ISPs to connect city locations. Many cities have tackled this task in the past as a money-saving idea, although it is made even easier to ARPA funding.
- Tackle the Innovation District. Fiber is only one component of an innovation district, but it's an important one. The ARPA money could be a big first step towards fulfilling this goal if the innovation district can be somehow tied to solving pandemic-related problems.
- Outdoor WiFi. The pandemic showed that every city needs more places where people can access the Internet. The ARPA funding language almost invites this kind of application.
- Tackle Smart City Applications. The ARPA money can probably be used to tackle smart city applications that benefit the public. This might be smart traffic, smart lighting, or some of the other ideas that are on your wish list. This is not as easy as some other ideas to justify with ARPA money, but it probably could be done if the right picture is painted of the community benefits.
- Economic Development Projects. It might be possible to use ARPA money to help fund a larger economic development initiative. This might have to be justified as a project that helps the wider community and doesn't benefit commercial entities.

We are not in a position to specifically recommend any of these ideas for Joplin for several reasons. First, implementing any of these ideas involves a lot more than just building fiber. As an example, bringing cheaper broadband to public housing means that somebody still has to the ISP. Is this a role the City would be willing to permanently take on, or would you find a partner – and who might that partner be? There are also political ramifications of each of these ideas. For example, if the City brings affordable broadband to public housing, how do you respond to other poor neighborhoods that would benefit from the same thing? We've always cautioned cities about build broadband to even one resident - because the rest of the community might expect the same thing.

Some of these ideas might also conflict with finding a larger broadband solution. For example, if the City builds fiber to the business districts, that might make the market less attractive if you are also trying to lure an ISP to serve the city. Almost none of the ideas above exist in a vacuum and could have an impact on other broadband solutions you are considering.

But all of these ideas have merit and are worth being considered if the City is willing to divert some of the ARPA money towards broadband.

RECOMMENDED NEXT STEPS

This section of the report discusses the next immediate steps you should consider after receiving this report.

We don't recommend any specific process for tackling the recommendations made below. We've learned that every city routinely deals with big issues, and we see a wide variety of ways that communities tackle big questions. We assume you'll tackle the broadband questions in the same way that the City has tackled other big questions in the past.

There are several kinds of recommendations below – process, strategic, and tactical. The process questions ask how to digest this report and move forward to be able to address the strategic and tactical questions. The strategic questions were discussed in the preceding section of the report and ask the big questions that the City needs to contemplate. These tactical next steps are aimed at doing more legwork and investigation to answer questions raised by this report.

The Process Questions

Digest This Report

The City asked a lot of questions in the RFP that prompted this study, and this report discusses a wide variety of topics related to broadband. Somebody at the City needs to go through the various findings and recommendations in this report and somehow create an actionable and prioritized approach to tackling the next steps.

We've always found that one person or group in a city must be given this specific responsibility, or else much of the ideas in the study never make it into the public debate.

Identify Staffing Resources

If Joplin is going to pursue the next steps discussed below, you'll need staff resources to tackle many of the tasks. Finding a broadband solution takes a focused and persistent effort, so it's important to identify the needed staffing. We've seen many efforts to get broadband fizzle when nobody was dedicated to the early tasks. We've seen the following ways that cities have done this well.

- Dedicate Staff. The communities that have done this the best have dedicated at least one staff person to concentrate on moving the process forward. The biggest challenge in doing this is usually finding the funding. This is not a permanent position, but rather somebody dedicated to this effort for some fixed time. This is also not always a 9 to 5 job if some of the effort includes community engagement.

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

staff position.

- Volunteers. Volunteers can be an important part of this effort. In the example given above of the Minnesota county, the one staffer assembled a group of active volunteers who helped with the effort to engage the public. These folks created email lists, went canvassing door-to-door talking about the need for broadband, and showed up at every government meeting to stress that they wanted a broadband solution. It's important that any volunteer effort has some structure and is working with a staff person to make sure the effort is focused. The City needs to be prepared to fund efforts that the volunteers think are needed.

- Broadband Task Force. A more formal solution is to use a committee of citizens who are willing to work to get better broadband. A Broadband Task Force generally is composed of citizen volunteers and a few elected officials. These groups meet regularly and work towards finding a broadband solution. It's normal that such a group would report back regularly to the city government about their progress. Such a group can collectively take on the needed community engagement tasks, and we've seen effective committees do this well. It's not unusual for a Broadband Task Force to solicit additional help from volunteers.

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

  The City already has two groups that might play some or all of this role. You have a Steering Committee made up of key CEOs from the community. There is also a Broadband Working Group. The roles being suggested for a Task Force are probably different than what these two groups do today. In the short run, you need a Task Force willing to tackle specific assignments and deliver results. For example, a Broadband Task Force might be given a specific assignment such as organizing community workshops or similar hands-on tasks.

Educating Staff, Elected Officials, and the Public

This report digs deeply into a lot of issues that are going to be foreign to both staff and elected officials. You will need to think about ways to condense the key findings from this report in a way to get everybody on the same page. Finley Engineering and CCG Consulting will help with the first step of this process when we prepare a PowerPoint summary for presenting the results of the study.

Many cities decide to engage the public as part of making any decision about moving forward with a broadband initiative. We already know from the survey results that a majority of the public wants better broadband choices, so we have to think there are many in the public who will be interested in the topic and will want to know what the City is thinking on broadband issues. If the City wants feedback from the community, then one important step to take is to begin the process of providing information to the public about broadband. Most communities do this in two ways. They first provide basic information that

explains broadband in ways the public can understand. They also generally provide some kind of outline or timeline explaining the progress towards finding a broadband solution.

We've seen communities tackle public education in some of the following ways.

- Publish This Feasibility Report. While not a lot of people will wade the whole way through a report of this size, it has been written for the layperson. The report is in three sections. There is a short Executive Summary, a longer section of our Findings – which is largely the same as the Executive Summary with many of the details from our research added. Finally, the body of the report goes into great detail on the various topics.
- Hold Public Meetings / Workshops. Meetings can be held to explain the results of this study, or meetings could be more generic to explain broadband issues. City Councils often decide to hold workshops to focus on broadband. It's worthwhile to have elected officials at public meetings so they can directly hear the kinds of issues that households have due to lack of broadband.
- Broadband Website. Many communities that are looking for broadband solutions create a broadband web page. Such a page can be used to educate as well as to inform. For example, a common educational feature is to have a lengthy section with responses to "Frequently Asked Questions." It's important that if you create a broadband website that you keep it current. You want the public to think of this site as a resource. Following is an example of a typical community broadband website from Falmouth, Massachusetts.[1]
- Gather a List of Broadband Proponents. One of the most beneficial steps we've seen cities make is to create a database of local broadband proponents – citizens who say they support better broadband. Having a list of emails, home addresses, and phone numbers can be useful when you want to ask for public support for specific tasks or want to notify people of upcoming meetings.
- Broadband Newsletter. Cities often create a newsletter dedicated to broadband. These newsletters are aimed at educating the public on topics related to broadband and to keep the public informed on the progress of the effort to get better broadband.
- Outreach Meetings. One of the most successful ways to reach the public is what CCG calls outreach. This means sending a spokesperson to meetings of local organizations to talk about better broadband. This can be a wide range of community organizations – PTAs, church groups, service organizations, youth groups, etc. Most organizations will allow time for a short presentation. It's vital to have a prepared presentation to get across whatever message you want the public to know. These outreach meetings are best done by those who are strong broadband proponents – this could be City staff, somebody from a Broadband Task Force, or even willing volunteers. The one caution of using non-staff is to make sure any presenters adhere to the City's intended message.

Tackling the Strategic Questions

The City already started the ball rolling when you approved the Smart Joplin Roadmap and authorized this study. The strategic questions represent the big policy decisions that will shape any final direction the City might take in relation to broadband. Following is a short list of the big strategic questions the City should consider debating:

[1] https://falmouthnet.org/

Do You Agree With the Findings of the Study?

This study attempted to identify existing broadband gaps. We're sure that some of these gaps were already well understood by the City and that some of our findings are new. We reached the overall conclusion that existing broadband in the city is not sufficient today to support the Smart Joplin Roadmap. We think that the broadband gaps will widen as broadband demand continues to grow. The big question that needs to be answered is if the findings from this study justify an effort to keep moving forward.

Is the City Willing to Invest in Broadband?

Another key question to tackle is if the City is willing to invest in a broadband solution. The options for moving forward are significantly different depending upon your willingness to fund or not fund some broadband infrastructure.

At this early stage, the City doesn't need to commit to funding infrastructure. What is needed at this early stage is to understand if the City is willing to make any investment in broadband.

It's not mandatory that the City fund infrastructure to get better broadband, and there are cities that have found broadband solutions without contributing towards the cost of a new network. The main purpose of tackling this question early is to avoid wasting time considering scenarios that require the City to pay for infrastructure if that is not a realistic option.

What Business Structures Should be Considered?

The study looks at several distinct business and operational structures. This includes 1) a commercial ISP will fund, build, and operate the network, 2) the City will fund and operate the network, 3) the City will fund a network but hire an ISP to operate the network, or 4) the City will partner with a commercial ISP to jointly fund the network, with the ISP operating the network.

If the City already knows that any of these scenarios are not likely to happen, you should eliminate such scenarios from future discussions and investigations to avoid wasting time thinking about unrealistic scenarios.

Are There Any Partners You Don't Want to Consider?

There is an interesting range of ISPs to consider if the City is open to the ideas of a partnership. This includes Sparklight, AT&T, several regional independent telephone companies, and possibly larger ISPs that have been building fiber in multiple cities.

Most of CCG's clients decide before reaching out to ISPs if there are any partners they would not partner with. Finding a partner would not involve municipal purchasing rules, and a city is not obligated to waste time talking to every potential partner in the world. We think it's a fair question to look at each option and decide if an ISP meets your criteria before reaching out to discuss the idea of partnership. For example, you might not trust one of the current incumbents. You might feel that some of the regional ISPs are too small. The process of discussing potential partnerships

is time-consuming, so it's in your best interest to have a frank examination of potential partners before starting the process of meeting with ISPs.

Tackling the Tactical Questions

The rest of the next steps are tactical. These steps are tasks that help the City decide how and if you should move forward.

Reach out to Potential ISP Partners

If the City decides that having an ISP partner is worth exploring, the next step is to reach out to ISPs to open a dialog. Section IV. D. if this report includes specific ideas on how to reach out to ISPs. This can range from holding one-on-one private discussions to issuing an RFP looking for a partner.

One easy first step is to share the results of this study with ISPs since they should be interested in much of the research we've done. For example, ISPs might be interested in the survey results and in the estimated cost of building fiber in Joplin. These are facts that any ISP needs to be able to consider serving in Joplin. ISPs should also be interested in the financial analysis that shows the potential for profitability if working in the city. Every ISP would tailor the financial results to match their own specific costs, but we know from experience that our estimated costs are reasonable and are a good starting place for any ISP to understand the potential of serving the market.

Consider the Funding

Several of the operating models considered in this study require the City to make a substantial investment in fiber infrastructure. Before going too far with any of these ideas, the City should meet with your bond/financial advisors to see if borrowings of the sizes estimated in this study are feasible and if this fits within your overall long-term bonding strategy.

If the City is willing to consider making investments in infrastructure, we also recommend that you begin the discussions early of what such funding might look like. The report discusses a wide variety of ways that cities fund broadband infrastructure, and we've seen that this is often one of the most important aspects of deciding if a city can fund something.

In the preceding section preceding the report discusses the idea of using American Rescue Plan Act (ARPA) funding to help pay for broadband. Our warning on that is that any use of the money must be justified under the federal guidelines that came with the funding. Broadband is clearly an authorized use of the funding, but we think a community would have a hard time justifying using the money to build a citywide network to compete against existing incumbents. However, the funding can be directed at specific projects that meet the ARPA guidelines that might become part of a greater effort. We caution about making sure the use of these funds satisfies the ARPA law and U.S. Treasury guidelines.

The report looks at a few alternate ways to fund part of a network, such as increasing sales or property taxes, but few communities have elected these alternate forms of financing. Most municipally funded fiber has been financed from municipal bonds.

Consider a Collaborative Effort to Get Better Broadband

With the wide range of current and future grant funding coming available, we strongly recommend a collaborative effort of the major stakeholders in the community to work together towards a broadband solution. Our past tradition in the country has been that every stakeholder in the community chased grant funding for its own use, and it's been rare that fiber built for one purpose that was shared with the rest of the community. The best example of this is in the hundreds of communities that have gotten transportation grants in the past to support traffic light networks - in most cities, this fiber has not been shared with other stakeholders.

If the wave of federal and state broadband grant funding continues, then the smart community is going to pool the resources of all stakeholders to build infrastructure intelligently. There is no reason that a fiber built to connect two schools should not be used to benefit other stakeholders at the same time. Consider the following entities in the city that might have access to grant funding that could be at least partially directed towards broadband.

- The City has funding from the American Rescue Plan Act that can be used to provide broadband. This money probably can't be used to fully overbuild the cable companies, but it creatively can be used for a number of broadband purposes that were discussed in the previous section of the report.
- The State will be receiving $196.7 million from the ARPA Capital Projects Fund. This will likely turn into a grant to be administered by the state broadband office, although the Legislature has to act to make that happen. While the state will choose the specific grant winners, the grant plan must be approved by the National Telecommunications and Information Agency (NTIA). The NTIA has made it clear that states should strive to take care of needy rural areas before using the money in cities, so there no guarantee that any of this money will be available for Joplin – but it could.
- The schools in the city receive E-Rate funding from the FCC's Universal Service Fund. This money can now be directed to pay for some infrastructure or for paying for long-term leases of fiber – in the past, this could only go to ISPs to pay for transport.
- The libraries might get some funding that could be used to connect the libraries to better broadband.
- The infrastructure bill that has been passed by the U.S. Senate includes substantial funding for electric smart grid. It would make sense to collaborate with the electric utility to get some of this funding if fiber is also being built for other purposes.
- That same infrastructure bill will provide transportation funding that might help to fund some fiber.
- A federal infrastructure bill might include some funding for smart city applications and for functions like connecting alternate power sources to fiber.
- There has routinely been funding available for public safety that might benefit a collaborative effort.

The funding opportunities for the next several years are unprecedented and offer a once-in-a-lifetime opportunity to collaborate and get the biggest bang for every buck of grant funding. It's not easy to form such a coalition because stakeholders are not used to thinking of the bigger community picture beyond their own needs and own funding sources.

Review City / Town Policies Related to Fiber Construction.

We recommend a review of city and city policies and ordinances that might add to the cost of building broadband in the city. ISPs will be concerned that there might be local rules, ordinances, and processes that will slow down the construction process and add cost to the fiber construction process.

The Ccity should coordinate a review of the following types of policies to see if there are ways to be friendlier to ISPs. Changing these processes might require new ordinances or new internal procedures. Note that any changes made to accommodate a new ISP would also apply to the incumbent ISPs, and even to other utilities. Some of the areas that should be investigated include:

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

Regardless of who might bring a broadband solution, it's going to be easier and less costly if there are no unneeded hindrances caused by rules that were created in past years to solve past problems.

Finally, if there will be any major construction or rebuilding projects in the city in the next several years, it's important to connect those projects with the bigger effort to find a fiber solution.

Seek More Evidence of Uneven Broadband Performance.

The speed test data available to us showed that different neighborhoods in the city have significantly different download speeds that varied averages between 38/10 Mbps and 87/10 Mbps. The City can't address this issue effectively with the cable companies without more facts.

There are two ways to get more evidence of broadband performance. One would be to gather a large number of speed tests from residents. An easier solution is to ask the State to share the data from Ookla speed tests. The State has access to the data in far greater detail than was available to us. We recently completed a broadband feasibility analysis in Wisconsin where the State was willing to share speed test results by ISP and by Census tract. Since the Ookla speed test is the most popular nationwide speed test, we think this evidence would be of interest and value to the City.

Consider an Economic Benefits Study

This report quantifies the financial viability of an ISP that builds fiber in Joplin. However, we know that most of the benefits of a citywide fiber network accrue to the wider community and not to the fiber owner or the City directly.

There was an economist report generated in 2020 for the City of Chattanooga, Tennessee, that quantified the ten-year benefit of broadband for the whole community.[2] Economist studies look at costs that are difficult to normally quantify. For example, what is the benefit to the City if fiber raises property values and increases property tax revenues? What's the dollar benefit to the community if 10% of the workforce finds a better job by working from home? What's the dollar benefit to the entire community from improved telemedicine? We suggest that you look at the Chattanooga study cited in the footnote and consider if such a study would be beneficial for Joplin. There is no question that the benefits cited in the Chattanooga study are real – but these kinds of benefits are a challenge to quantify.

Tackle the Other Broadband Gaps

The following ideas are steps to consider in tackling some of the broadband gaps identified in this report. Specifically, this looks at issues of broadband affordability, the lack of computers in homes, and the lack of digital literacy for a lot of citizens. Since the City has a goal of becoming a smart city, one of the key building blocks of that plan is to improve broadband availability for those that can't afford or don't know how to use broadband effectively.

We recognize that the following ideas sound somewhat generic. There are several reasons for this. Communities have struggled with these issues for decades, and we aren't aware of any city of the size of Joplin or larger that has come close to solving any of these issues. That makes it nearly impossible to point to highly successful programs elsewhere.

However, there is a ray of hope that these kinds of issues might finally be tackled because, for the first time, there is federal money available for programs like buying computers or establishing digital training programs. The pandemic has also raised awareness of the problems created by homes that don't have computers, don't have broadband, and don't have the skills needed to use technology even if it is available. The time might finally be ripe for communities to successfully tackle these issues.

Solving any of these problems is going to require a lot of ingenuity and local collaboration. For the first time in my career, we are now seeing communities having serious discussions about tackling these issues. This is such a new movement that we don't have a lot of specific examples to cite, but it's likely that stories will begin to emerge over the next year or two.

Tackle the Affordability Gap

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

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

Inform the Public About the Low-Income Broadband Subsidies

Mediacom offers a low-income program called Connect 2 Compete that provides 25 Mbps broadband for $9.95 to qualifying households. Both cable companies are participating in the FCC's Emergency Broadband Benefit (EBB) program that offers up to a $50 discount on broadband.

The City should consider increasing awareness of these programs as a way to get more households connected to broadband. That requires understanding the rules for household eligibility and advertising to make sure the public knows about the programs.

Find Broadband Solutions for Public Housing

Many communities have found ways to bring broadband to public housing. A common model is to buy one high-speed connection to the public housing complex and then use WiFi to distribute broadband to individual living units. Such connections often include low-cost or even free connections from local ISPs as a public service.

There is one national non-profit that concentrates on this effort. ConnectHomeU.S.A[3] has helped communities find broadband solutions for public housing across the country. This organization is currently helping communities in and around St. Louis and Kansas City, and their stated aim is to help communities everywhere. They work with another non-profit, EveryoneOn, to implement the solutions.

Support Local Affordability Efforts

There are non-profit organizations around the country that are tackling the affordability issue. One of the more ambitious such efforts is being made by Mobile Beacon.[4] This is a non-profit that works nationwide to bring low-cost mobile broadband to non-profits organizations around the country, and through those local non-profits brings low-cost broadband to low-income people.

There are numerous solutions being used by the non-profits working with Mobile Beacon. One common effort was discussed above, which is to provide portable WiFi hotspots that are distributed from libraries. Mobile Beacon has also negotiated a deal with Sprint (now T-Mobile) to provide low-cost cellular broadband to students and others that is priced as low as $10 per month for an uncapped cellular broadband connection. The Joplin Library was able to obtain 100 hotspots to lend out during the pandemic. The library did a survey and found that 61% of borrowers used the hotspots for school and education, and 38% used the hotspots for working from home. However, with 29% of the households in the city without home broadband, a much greater effort is likely needed if this is chosen as a way to tackle the digital divide.

[3] https://connecthomeusa.org/

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

An interesting study[5] was done looking at the impact of bringing broadband to low-income homes for the first time in the Twin Cities in Minnesota through the Mobile Beacon effort.

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

Bridging the Broadband Skills Gap

Even if better broadband becomes available, there are many residents of the city that don't possess the basic computer skills needed to take part in the modern digital world. The City should consider finding ways to provide more computer training. There is currently a lot of federal and state grant money available to establish and fund digital training efforts. This can be done in a wide variety of ways:

Allow the Schools to be Used After-Hours for Training Adults. A number of communities use computer training centers that already exist in schools to hold after-hours training for adults.

Develop Training Course in the Libraries. A number of communities have developed computer training programs through their libraries.

Find Solutions for the Homework Gap and Computer Gap

The survey showed that 29% of the homes in Joplin don't have home broadband, and that has to mean there is a homework gap – homes with students without good broadband or homes without computers. The city and local non-profits did a lot during the pandemic to solve the home-schooling problem, but that is not a permanent solution that will keep these homes connected after the end of the pandemic. There will always be new homes each year with students that don't have the needed broadband., Possible solutions might include:

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

Lending Mobile Hot Spots. The Joplin Library has a program to lend mobile hot spots to citizens through the libraries much the same way they lend books. A person can check out a hot spot for

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

some period like a week or ten days, which will provide broadband that can be used with computers or tablets.

The current Joplin program is far too small to satisfy the needs of the huge number of homes that don't have home broadband – but it's a start. A longer-term program means buying a lot more mobile hot spots and finding a way to finance the hot spot broadband fees into the future. That probably means partnering with one of the big cellular companies to provide free or inexpensive bulk cellular data to power the hot spots.

Get Computers into all Homes that Need Them. Many communities are working with local non-profits that are tackling the computer issue. Most home and business computers last 3-5 years, and non-profits have found that older computers can be upgraded fairly inexpensively and placed in homes that need them. Such an effort can be a lot of work, but communities have found groups willing to tackle the issue. We can't know specifically how many homes in Joplin don't have computers, but it's not a bad assumption to think that most of the 29% without a home broadband connection and 10% of the homes that only use cellphone data don't have computers.

One such program is the non-profit E2D[6] (End the Digital Divide) in Charlotte, North Carolina. The organization refurbishes laptops contributed by businesses in the Charlotte area and gives them to students. The organization has taken a several-prong approach to make this happen:

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

Another organization that works nationwide to fund computers is Minneapolis-based non-profit PCs for People[7]. They provide PCs to households that need them and work with other entities, including Mobile Beacon and E2D.

The City of Joplin or some local non-profit could connect with PCs for People to find ways to get computers into the hands of the neediest households in the city. A local non-profit could also mirror what's been done elsewhere.

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

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

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

A more aggressive plan would be to create public hotspots in each neighborhood around the city - the places where citizens need it the most. However, it might be a challenge to find the bandwidth needed to support such hot spots. Doing this the right way would require partnering with an ISP or cellular carrier.

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

I. MARKET ANALYSIS

A. Providers, Products, and Price Research

AT&T is the incumbent telephone company in the city and offers DSL. Mediacom and Cable One are the incumbent cable providers, and each serves part of the city. Aire Communications, Current, Lost Creek Wireless, Rise Broadband, and Wisper ISP are wireless carriers that claim to cover some or all of the city. Homes and businesses can buy satellite broadband from Viasat and HughesNet. Homes and businesses can buy cable TV from DirecTV or Dish Networks.

Following is an analysis of the prices being charged in Joplin today. We know from experience that prices vary widely by customer for many ISPs. Over the years, customers have purchased bundles or participated in promotional pricing and might be charged differently than their neighbors. The wide variance in rates charged in the community means there is no longer anything that can be considered as a standard price in the market. Nevertheless, we wanted to understand the average price being charged today for broadband and the other products.

Incumbent Telephone Companies

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

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

AT&T recently announced an even bigger deal and sold off WarnerMedia to Discovery Inc. The sale nets $43 billion in cash to AT&T to pay down debt. The newly formed company will become the second-largest Media company and will combine HBO, Warner Bros. Studios, TNT, TBS, and CNN with Discovery, Oprah Winfrey's OWN, HGTV, The Food Network, Animal Planet, and others. The new company will have a huge sports presence between TNT and TBS and Discovery's worldwide sports coverage. The sale represents another big loss for AT&T. The company paid $85 billion for Time Warner and will lose $42 billion after only five years. The two sales will allow AT&T to pay down about $51 billion of its $169 billion in debt. But a lot of the remaining debt is still on the books from the original two purchases.

The company lost only 5,000 net broadband customers in 2020. However, AT&T added over 1 million customers on fiber in 2020, which offsets the loss of DSL customers. AT&T has built fiber to pass 14.5 million potential customers and is planning on passing 3 million new passings in 2021. The company says it plans to be passing 25 million homes with fiber by the end of 2025.

AT&T has upgraded cellular networks across the county, which can be seen by seeing faster cellular broadband speeds.

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

Stand-Alone Internet. AT&T has simplified its Internet pricing. Over the years, the company had a wide range of different speed offerings and prices.

DSL. There are still DSL customers with grandfathered rates and speeds from old plans. Again, the company won't sell this product to new customers.

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

DSL modems are leased at $ 10 per month. Customers must use an AT&T modem.

Fiber Broadband. Following are the prices for AT&T broadband on fiber.

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

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

Data Caps. AT&T Broadband products come with a data cap set at 1 terabyte (1,000 gigabytes). Overage charges are $ 10 for an additional 50 gigabytes of data. For $30 per month, a customer can get unlimited data. The Internet 1,000 product has no data cap and provides unlimited data.

Cable TV Prices. AT&T's cable products are hard to understand since the company is in a state of flux after the sale of the cable business. Even after the sale, the company is still selling cable TV over DSL. The following prices apply for customers that still have a traditional settop box:

	Channels	Price	Introductory Price
Entertainment	160 channels	$ 102	$ 65
Choice	185 channels	$ 122	$ 70
Ultimate	250 channels	$ 151	$ 85
Premier	330 channels	$ 206	$ 135

A customer must have at least one settop box for a monthly rate of $10 per box. The introductory prices are typically good for 12 months for a new customer.

The company started rebranding U-Verse TV in March 2020 from U-verse to AT&T TV. This is a drastically different product. The settop box is gone, and a customer instead gets a dongle or small box that connects to a TV, much like Roku or an Amazon Firestick. There is an installation charge for the service that includes paying for the dongle, but apparently, this fee is often waived. The channel line-ups are much smaller than with U-verse and are closer to what is offered on DirecTV. Following are the charges for AT&T TV.

	Channels	Price
Entertainment	65 channels	$ 70
Choice	90 channels	$ 85
Xtra	120 channels	$ 95
Ultimate	130 channels	$ 140

Cable TV Providers

Sparklight (Cable One, Inc.) provides broadband under the brand names Sparklight and Clearwave. Cable One had 880,000 broadband customers in 21 states at the end of the first quarter of 2021. Cable One had 252,000 cable customers at the end of the first quarter and has an unusual strategy for the industry by not fighting to keep cable customers.

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

Following are the prices for Sparklight broadband:

Residential Broadband

Starter 100+	100 Mbps	$ 55.00	300 GB Data Cap
Streamer & Gamer 200+	200 Mbps	$ 65.00	600 GB Data Cap
Turbo 300+	300 Mbps	$ 80.00	900 GB Data Cap
GigaOne+	1 Gbps	$125.00	1.2 TB Data Cap
Modem		$ 10.50	
Unlimited Data:		$ 40.00	

Television

Economy	20 Channels	$42.00
Standard	100 Channels	$94.50
Digital Value Add On	24 Channels	$16.00
Settop Box:		$ 7.00

DVR Box:	$15.00

Telephone

Economy	$20
Standard	$25
Long-Distance:	Price varies by location

Bundles

Elite Package	Internet/TV/Phone	100 Mbps/100 Channels	$154.00
Elite 2 Package	Internet/TV/Phone	200 Mbps/100 Channels	$164.00
Elite 3 Package	Internet/TV/Phone	300 Mbps/100 Channels	$179.00

Mediacom is a second incumbent cable TV provider that serves a small portion of Joplin. The company is a large cable company with corporate headquarters in New York City. They are an interesting company that serves some large markets like parts of the New York City metropolitan area but mostly serves smaller rural markets. At the end of the first quarter of 2021, the company had 1.45 million broadband customers and 626,000 cable customers.

Residential Broadband

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

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

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

Cable TV

Basic	$29.95
Essential TV	$69.95
Variety TV	$85.99
Local Surcharge	$20.74

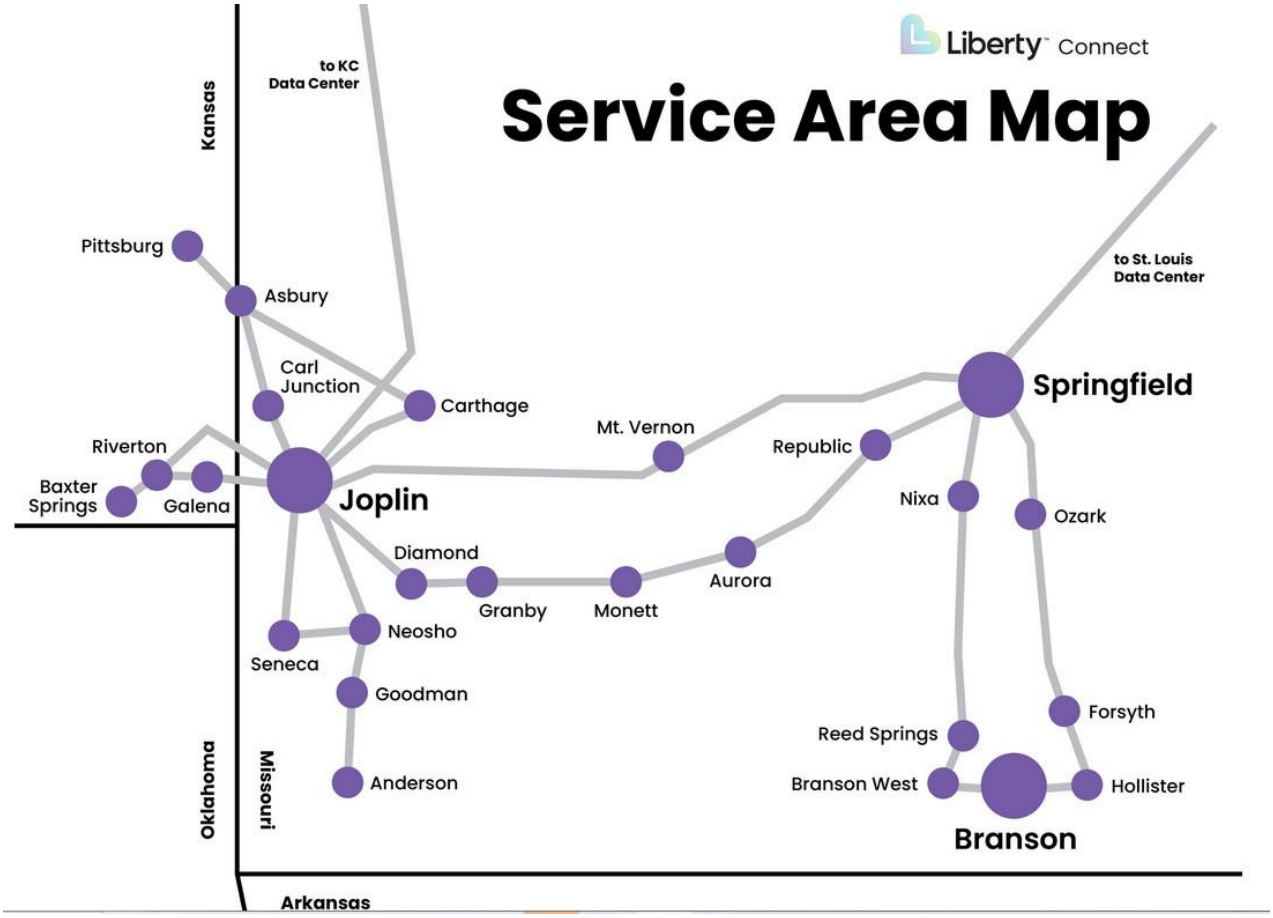
Regional Sports Surcharge $ 5.73

Fiber Overbuilder

Liberty Connect is a fiber network built and operated by Liberty Utilities, the regional commercial electric utility. The fiber network was started in 1996 by the Empire District Electric company. The network was built to support the electric and gas business, and the fiber network eventually extended to 45 towns and cities in southwest Missouri. The fiber business was acquired by Liberty Utilities in 2017 and was renamed as Liberty Connect in 2018.

The company provides fiber connectivity to some businesses in the city, with a network that is mostly downtown but also has a few spurs to reach through the city.

The company doesn't publish prices but will negotiate with businesses for fiber connectivity. In the course of our research, we talked to customers that were buying products that ranged from symmetrical 100 Mbps bandwidth to symmetrical gigabit bandwidth. For some reason, the company does not report to the FCC as a broadband provider, and so there is no official acknowledgment that gigabit fiber is available in the city. Following is a map of the whole network from the company's website. We talked to Library, and they are not willing to provide a local fiber map.



WISPs (Wireless ISPs)

Aire Communications Group, LLC is the parent company of Aire Internet, a fixed wireless provider. Aire Internet uses 4.5 LTE technology to provide service to its customers. Aire Internet is available in three states Kansas, Missouri, and Oklahoma. In 2017, Aire Communications Group, LLC purchased Aire Fiber. The company claims to be covering all of Joplin with wireless service.

Residential Internet

Aire Connect 5	Up to 5 Mbps	$50.00
Aire Connect 15	Up to 15 Mbps	$60.00
Aire Connect 25	Up to 25 Mbps	$70.00
Aire Connect 50	Up to 50 Mbps	$80.00
Installation		$99.99
Modem		$ 9.95

Lost Creek Wireless is a fixed wireless internet provider located in Seneca, MO. Its primary service area is Newton County, MO. The company claims coverage for all of Joplin. However, our engineering analysis identified the closest tower to Joplin to be about 2.75 miles south of the city limits. This makes it unlikely that the company is serving many customers in the city.

Residential Internet

The Basic	Up to 15 Mbps	$ 55.00
The Streamer	Up to 30 Mbps	$ 70.00
The Gamer	Up to 60 Mbps	$ 95.00
Installation		$100.00
Modem		$ 5.00

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

Residential Internet

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

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

Telephone

ActivePhone (Broadband phone)	$25.00

Wisper ISP, Inc was founded in 2003 and is headquartered in Mascoutah, IL. It is a fixed wireless internet service provider that focuses on rural areas in the Midwest. In addition to providing fixed internet, Wisper ISP, Inc also provides telephone services. The company claims to cover all of Joplin.

Residential Internet

ME	Up to 5 Mbps	$ 40.00
U.S.	Up to 10 Mbps	$ 55.00
Pro	Up to 15 Mbps	$ 80.00
Ultra	Up to 20 Mbps	$ 95.00
Installation		$100.00 (drops to $50 with autopay)
Home Care (modem & security)		$ 15.00

Telephone (VoIP)

Residential with Internet	$25.00
Residential without Internet	$30.00

Satellite Broadband

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

There are a few problems that customers consistently report with satellite broadband. Customers complain that satellite costs too much. Customers also hate the high latency, which can be 10 to 15 times higher than terrestrial broadband. The latency is due to the time required for the signals to go to and from the satellites parked at over 22,000 miles above earth – that adds time to every round-trip connection to the web. Most real-time web connections, such as using voice-over-IP or connecting to a school or corporate WAN, prefer latency of less than 100 ms (milliseconds). Satellite broadband has reported latency between 400 ms and 900 ms.

The other customer complaint is about the tiny data caps. As can be seen by the pricing below, monthly data caps range from 12 to 150 gigabytes. To put those data caps into perspective, OpenVault announced recently that the average U.S. home used 483 gigabytes of data per month at the end of the first quarter of 2021. The small data caps on satellite broadband make it impractical to use for schooling or to work from home.

Viasat (was formerly marketed as Exede or Wildblue) offers broadband from one older and one newer satellite. Following are the products from Viasat:

	Price	Speed	Data Cap
Liberty 12	$ 30	12 Mbps	12 GB
Liberty 25	$ 50	12 Mbps	25 GB

Liberty 50	$ 75	12 Mbps	75 GB
Unlimited Bronze 12	$ 50	12 Mbps	35 GB
Unlimited Silver 12	$100	12 Mbps	45 GB
Unlimited Gold 12	$150	12 Mbps	60 GB
Unlimited Silver 25	$ 70	25 Mbps	60 GB
Unlimited Gold 50	$100	50 Mbps	100 GB
Unlimited Platinum 100	$150	100 Mbps	150 GB

Online reviews say that speeds can be throttled as slow as 1 Mbps once a customer reaches the monthly data cap.

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

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

These packages are severely throttled after meeting the data caps.

Cellular Data

In every market, there are customers that rely on cellular broadband rather than buying home broadband. Many such customers spend time at work or elsewhere that has access to WiFi to avoid exceeding the small data caps on cellular broadband. There are three primary cellular companies in the country - AT&T, Verizon, and T-Mobile. As a result of the merger agreement between T-Mobile and Sprint, Dish Networks is in the process of becoming a fourth nationwide cellular carrier.

Following are the latest nationwide 4G cellular download data speeds for the carriers for the first quarter of 2021. These are average speeds reported by Ookla that gathered the speeds from millions of cellular speed tests. Note that these are national averages and rural customers likely get slower speeds than these averages. Note that these speeds show a major increase for all carriers. Ookla reported these same results for the first quarter of 2019, with all three carriers having speeds of between 33and 34 Mbps.

	2021
AT&T	76.6 Mbps
T-Mobile	82.4 Mbps
Verizon	67.2 Mbps

There are several reasons for the speed increases. First, most cellular networks had not been fully upgraded to 4G in the first quarter of 2019. The first fully 4G compliant cell site was completed in the winter of 2018. Since then, the carriers have implemented 4G almost everywhere. The carriers also all implemented new spectrum bands. They've labeled this new spectrum as 5G, but the new spectrum bands are all still using 4G technology. The new spectrum allowed cellular customers to spread out in busy markets, which

means that the cellular networks have stopped bogging down at busy times of the day, such as during the daily commute.

All three carriers now offer unlimited data plans. The plans for AT&T and Verizon are not actually unlimited and have monthly data caps in the range of 20 - 25 gigabytes per month of downloaded data. These plans have limits on how much data can be used for tethering from a cell phone to other devices. T-Mobile claims to offer unlimited data but begins throttling customers after 50 GB of data usage in a month.

Fixed LTE Products. The cellular companies all have fixed LTE products aimed at rural households for use as home broadband. Until recently, these plans were marketed as a hotspot product and were expensive with tiny data caps similar to cellular plans. All three carriers have recently introduced friendlier plans, although the plans are not yet available everywhere. The companies say they don't sell these plans in cities, but it's possible that a few folks in Joplin use fixed cellular plans for broadband.

Dish Network is a large satellite provider and has customers in the city. The company had a little less than 8.7 million cable customers nationwide at the end of the first quarter of 2021. Dish Network also offers an Internet-based cable product branded as Sling TV. That service offers an abbreviated channel line-up and costs less than traditional cable products.

Dish Network has the same pricing nationwide. Following are the standard prices as well as the current web specials that were in effect at the time of writing this report. Special prices require a 2-year contract.

	Standard	Special
190 Channels	$ 99.99	$ 64.99
190 Channels +	$ 104.99	$ 79.99
240 Channels +	$ 114.99	$ 89.99
290 Channels +	$ 124.99	$ 99.99

DirecTV is one of the largest cable providers in the U.S. The company has been owned by AT&T until recently spun off to a new owner along with other AT&T cable TV customers. The customers of DirecTV are not reported separately and are combined with all AT&T cable customers – at the end of the first quarter of 2021, that was just under 15.9 million. DirecTV also offers an online version of its programming that was called DirecTV Now, but which was recently renamed as AT&T TV.

Current prices without promotional discounts are:

160 Channels - Entertainment	$ 102.00
185 Channels - Choice	$ 122.00
250 Channels - Ultimate	$ 151.00
330 Channels - Premier	$ 206.00

Existing Fiber Infrastructure

The RFP asked us to identify existing fiber infrastructure in the community. As part of this effort, Finley Engineering reached out to all of the existing ISPs in the community to ask about fiber infrastructure. A

few were willing to discuss the issue generically, but none were willing to provide any maps of existing fiber. This is not unusual, and ISPs are even more cautious today than there were in the past after the bombing in Nashville Tennessee that was aimed at destroying a fiber hub. Most ISPs don't want maps that might show the general public the location of fiber. These ISPs are always willing to discuss fiber availability with a business or government customer – just not willing to share the fiber maps.

But we found out somethings that the City should find of interest. For example, both Sparklight and Liberty say they are willing to talk privately to the City about fiber and that they are also willing to support City initiatives that require fiber. That's a fairly normal thing for an ISP to say, but it opens the door for private conversations between the City and the existing fiber providers.

Finley Engineering also talked to several regional ISPs that provide fiber-to-the-home in other nearby parts of Missouri. None of these ISPs is willing to go on the record as being interested in bringing fiber to Joplin, but several of them are interested and we'll introduce them to the City when you are ready for those discussions.

Long-Haul Fiber Map

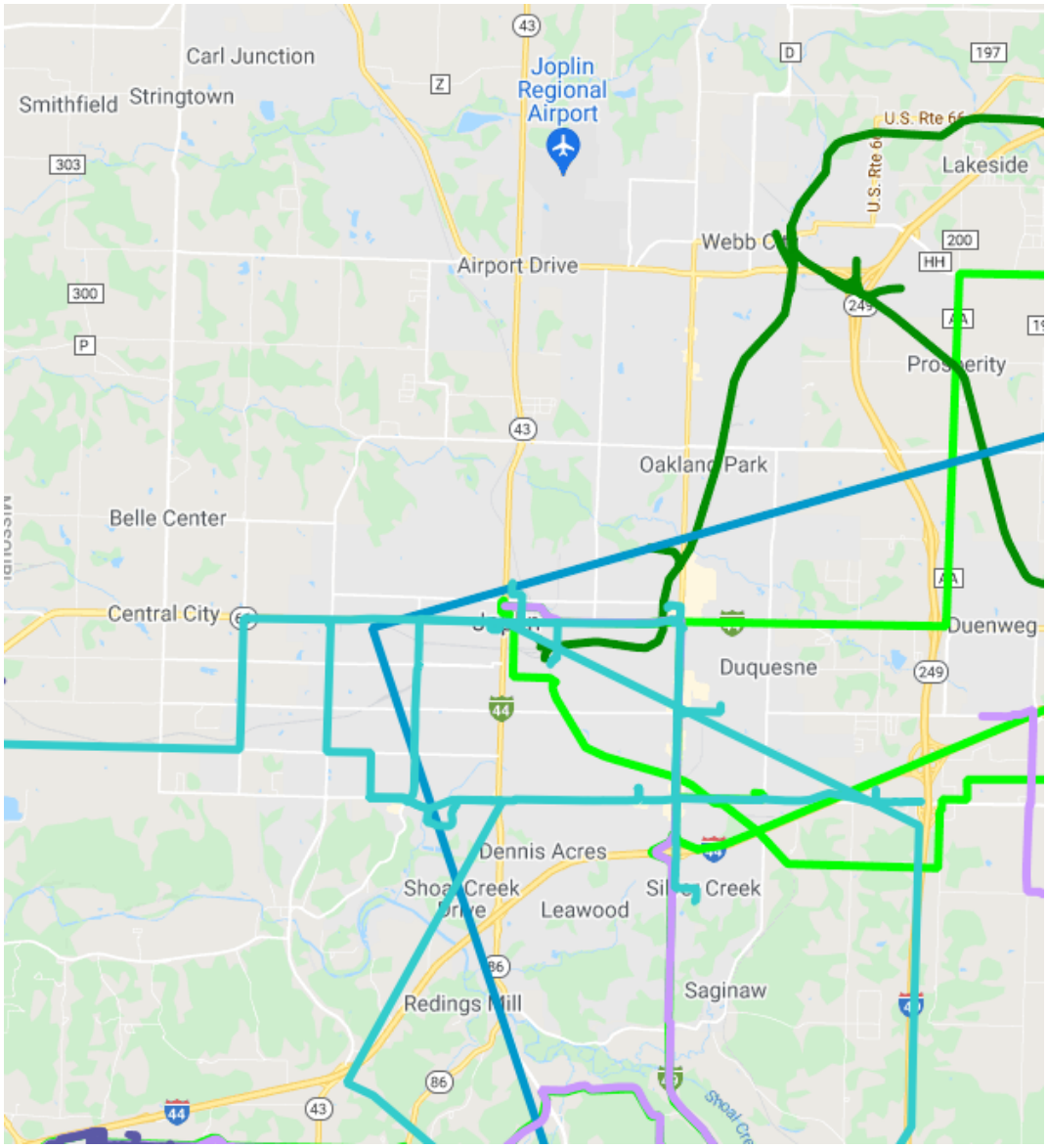
Finley Engineering has access to a database and mapping system that shows the location of long-haul fiber routes. These are routes that connect major cities. It turns out that Joplin is on a major fiber route that extends from Kansas City to Tulsa. Oklahoma. That means that fiber passes through Joplin along that path.

Long-haul fiber is almost never made-available for local purposes, so a long-haul fiber that passes along a street in Joplin would not be made available for any broadband efforts in the City. However, the presence of these routes means that any ISP located in Joplin has multiple options for buying connectivity to the Internet to both the north and the south. This report talked a lot about local resiliency, but it's also vital to have resilience in connections to the open Internet – and ISPs in Joplin have these options, while ISPs in many cities don't.

The following map shows fiber routes in Joplin that are owned by major ISPs or long-haul fiber providers. The different colors represent different fiber owners, but Finely is under NDA to not disclose the names of the fiber owners (for many of the same reasons that the local fiber owners won't tell us).

Not all of these routes are for long-haul only. A few of these routes likely are used to serve cell towers or a few of the larger businesses in the City. Not all of the fiber owners are on this map (they have to pay a fee to get on the map since this mapping system is a way for ISPs to market where they have fiber). For example, this map doesn't include fiber owned by Liberty or Sparklight.

Map of Major Carrier Fiber in the Joplin Area

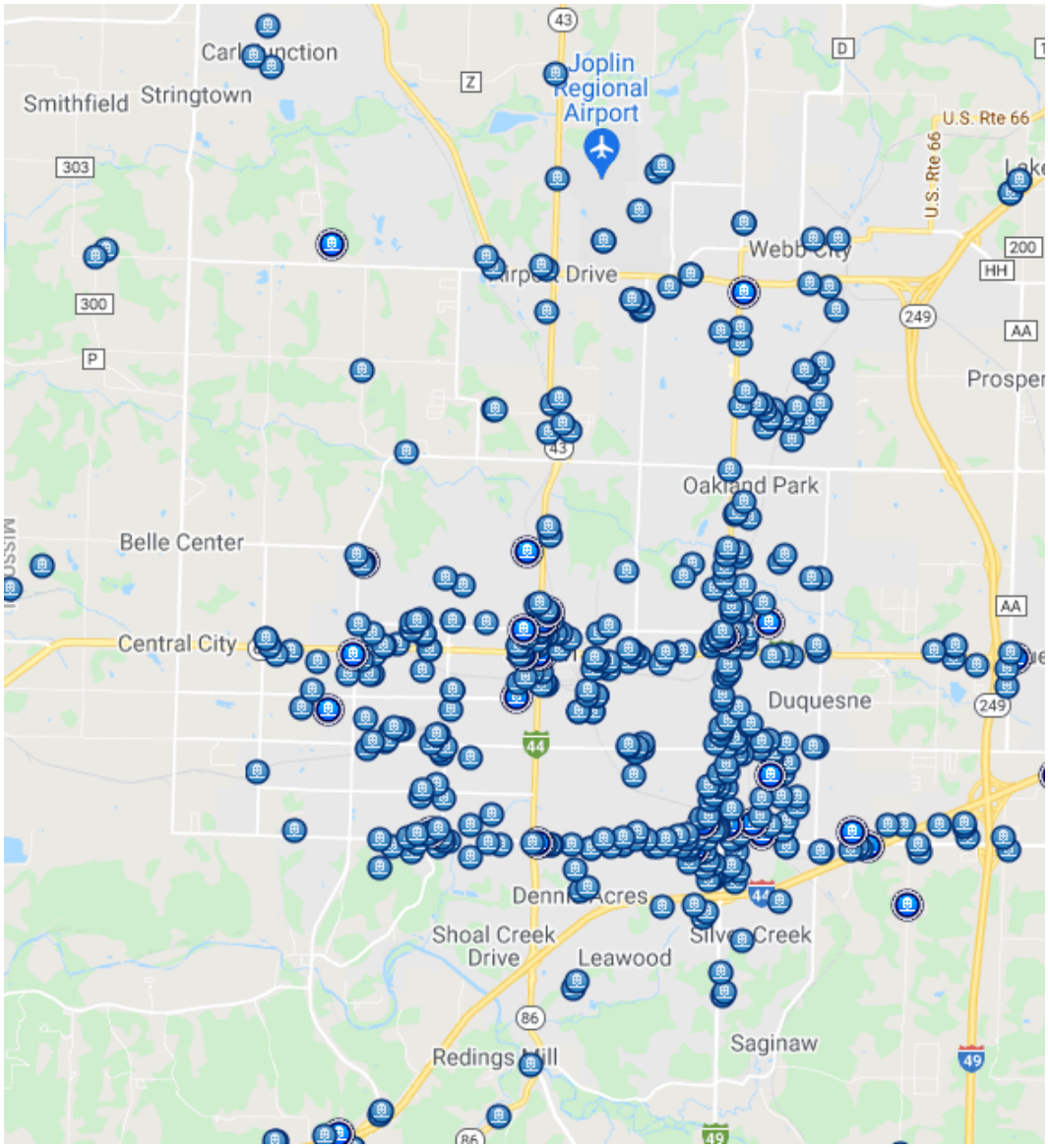


Lit Fiber Buildings

The following map is from the same database and shows all of the buildings in Joplin that are lit with fiber from the ISPs that have paid to be in the database. Many big ISPs like CenturyLink measure tout lit buildings as a way to demonstrate the reach of their fiber networks.

However, this map must be taken with a grain of sale, because what it really represents are fiber splice points where somebody could connect to a fiber ISP. While some of the points on the map are customers that have purchased fiber broadband, many of the dots on the map represent other locations like cell towers, fiber field huts, and even manholes or handholes where an ISP is willing to connect to a customer.

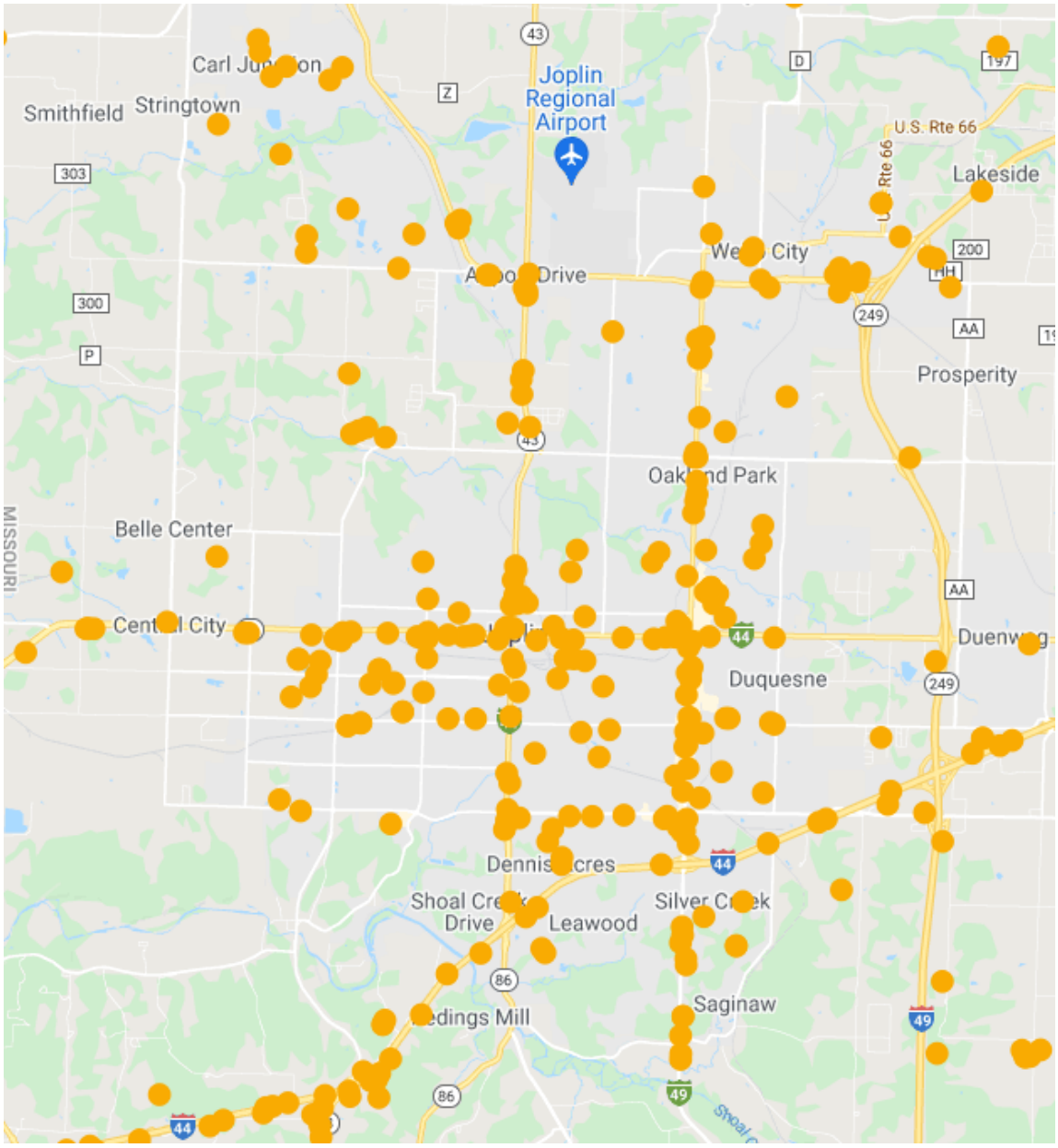
Map of Fiber Lit "Buildings"



Cellular Towers

Modern cellular towers are all connected to fiber, and the following map shows the location that the cellular carriers claim as cell sites. Historically, cell sites were mounted on giant poles that were impossible to miss in the landscape. However, modern cellular technology now includes small cell sites, which are cellular transmitters mounted on poles instead of towers. When we see the number of dots on the map, we have to assume this map includes small cell sites. Note that many of the dots on this map are likely also dots on the lit buildings map above. The definition of cellular towers gets even more confusing because cellular companies claim large cellular repeaters as cell towers. For example, a cellular company may place a cellular transmitter on the roof of a commercial structure like a hospital complex and aimed the cellular signal downward to provide good coverage inside of the building.

Map of Cellular Towers



B. Surveys / Interviews

This study included several surveys: a statistically valid residential telephone survey, an online residential survey, an online business survey, and online speed tests for residents and businesses. Additionally, we interviewed some key businesses in the city.

Statistically Valid Residential Telephone Survey Results

The survey covers the city limits of Joplin. The survey was conducted by telephone in June 2021. The city wanted this survey to represent households across the socioeconomic and age range, and the easiest way to get that broader mix is to include cell phones in the survey.

The survey was conducted by telephone. We wanted the survey to represent households across the socioeconomic and age range, and the only way to achieve that mix of residents is to include cell phones in the survey. Some of the largest survey companies that undertake nationwide surveys have reported that households with landlines tend to be older and more conservative than the average household in a community. It has become obvious that giving surveys only to landline households will skew the results. We were able to buy a list of landline telephone and cellular numbers for the city.

A statistically valid survey must be conducted randomly, meaning that the calling shouldn't be clustered around any one particular portion of the study universe. For example, the survey would not be considered to be valid if all of the calls were placed only to one portion of the city. Our method of using the list of numbers was to call every tenth phone number on the list. We cycled through the calling list until we got the desired number of completed surveys.

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

CCG uses an online survey tool to determine the number of surveys needed to achieve the desired accuracy. The tool is provided by Creative Research Systems and is found online at https://www.surveysystem.com/sscalc.htm. We've used this tool for many years and have manually done the mathematical calculations that demonstrate that the tool is accurate. This tool indicated that we needed 377 completed surveys to achieve the desired accuracy of 95%, plus or minus 5%, and we completed 377 surveys.

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

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

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

Broadband Customers

71% of survey respondents have some form of home broadband. 36% of respondents use Sparklight (Cable One), 8% use Mediacom, 26% use AT&T, and 1% use satellite broadband. Nationwide, the big cable companies typically have more than twice as many broadband customers as the big telephone companies. In Joplin, the cable companies have only 44% of the market share, which is slightly below the average nationwide market share. The corollary of this is that the city has a higher proportion of DSL compared to cable broadband than in many cities. We don't know the reasons for this – it could be due to lower prices for DSL broadband, or because of dissatisfaction with the cable companies.

An additional 10% of the residents in the market use their cell phones as the only source of home broadband. It's likely that many of these respondents have access to landline broadband at work or some other place outside the home.

Taken together, this means that 29% of respondents don't have a home broadband connection. The FCC reports that almost 87% of homes nationwide now have a home broadband connection. However, the FCC nationwide numbers are skewed because the numbers don't account for the roughly 14 million rural homes in the country that have no option to buy broadband. If the FCC statistics are adjusted for those homes, then the nationwide average broadband penetration everywhere except those rural areas is over 90%. Joplin at 71% is significantly below the national average for home broadband penetration.

We asked the 19% of the respondents why they don't have a home broadband connection. 20% of those without home broadband said that broadband is too expensive. 6% use broadband outside the home (work or library), and 7% said they can't afford a computer. 67% of those without home broadband said they aren't interested in using the Internet. This is a significantly higher number than we usually see in most other communities.

Cable TV Penetration

Only 45% of survey respondents report the purchase of traditional cable TV, meaning TV from a cable company, telco, or satellite provider. That is significantly lower than the nationwide average, which dipped below 60% by the end of the first quarter of this year. In Joplin, 12% of households use AT&T, 7% use Sparklight (Cable One), 4% use Mediacom, and 22% use satellite.

The number of households using satellite TV (22%) is significantly higher as we normally see in cities, where we rarely see even 10% of homes that still have a satellite dish.

25% of the survey respondents claim to be cord-cutters that watch all content online. There is not yet any reliable count of the nationwide market share of cord-cutters, but most estimates put it at around 20% of households. The percentage of cord-cutters is growing rapidly, so it is expected that the number of homes with traditional cable in the city will continue to drop over time.

Telephone Penetration

39% of homes still report having a landline telephone. The nationwide landline penetration has dropped below 30%. 27% of residents buy telephone service from AT&T, 9% from Sparklight (Cable One), and 3% from Mediacom.

This is the one statistic from the survey that we can't fully trust. This statistic could be driven by the percentage of landlines that were included in the list of telephone numbers we used. We have no way of understanding the mix of cellular and landline telephone numbers provided to us since telephone numbers can be easily transferred to and from landlines and cellphones today. It's possible that this is an accurate statistic and that the city has a larger-than-average number of homes that still use landlines.

Customer Bills

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

Customers buying a bundle of service	$150
Customers buying standalone broadband	$ 82
Customers buying standalone cable TV	$103
Customers buying standalone telephone	$ 33

We note that the $150 average for bundles is pretty typical of what we see in other communities. The average price for standalone broadband is higher than what we see in other communities – we usually see an average between $70 and $80. Telephone and cable rates are typical of what we see in other communities.

Uses of Broadband

35% 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 (13%), those that work several days per week (14%), and those that work from home occasionally (8%). 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. Before the pandemic, it was fairly rare to find somebody pursuing schoolwork from home, with most of the people doing so pursuing an online college degree.

36% of the homes with somebody working from home said the broadband was not adequate. The most common complaints from this group were slow connections, connections that get dropped, the inability to connect to video calls like Zoom, and family members having to take turns using broadband.

22% of respondents report having somebody in the home using broadband for schoolwork. 88% of these were K-12 students, with the rest being college or trade school students. 57% of households with students said the broadband was not adequate for their needs. This group also complained about slow connections, connections that get dropped, and the inability to connect to video calls like Zoom.

We've learned during the last year that most of the problems encountered when working and schooling from home come from inadequate upload speeds. This is something that many people don't yet understand, and they often assume that the entire broadband connection is inadequate.

Satisfaction with Existing Broadband

19% of respondents say they are unhappy with their Internet download speeds at home, while 47% are satisfied.

20% of respondents are not happy with the customer service from their ISP, while 42% are satisfied.

18% of homes are not satisfied with the reliability of their broadband connection, while 44% are satisfied.

35% of respondents say that they are unhappy with the value they get from their ISP compared to the price they pay, while 35% are satisfied.

These results show more satisfaction than dissatisfaction.

Support for a Fiber Network

One of the key questions asked in the survey is if respondents support the idea of the City of Joplin trying to get better Internet access. 67% of households support the concept. Another 14% said they might support the idea but need more information. Only 19% of households said they do not support the city pursuing a better broadband solution.

We asked the reasons why respondents support bringing a new network to the city. An overwhelming 98% said they hope for lower prices. 89% of households hope for more competition. 61% are hoping for better customer service. 57% of respondents hope for more reliable service.

We asked the reasoning for the 19% of respondents who don't support a new fiber network. The largest group of respondents don't care about broadband (77%). 18% are happy with the current providers, 4% worried that taxes would increase, and 1% said that government should not get involved in a commercial business.

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 fiber network. 45% said they would definitely buy. Another 18% said they probably would buy service, and 15% said they might buy service. Only 22% said they were unlikely to consider buying service.

We next asked if respondents would change to an ISP that doesn't offer cable TV. 43% said definitely yes, and another 15% said probably. Another 18% said they might buy. Only 24% said they were unlikely to switch due to the availability of cable TV.

When asked if they would buy a landline telephone, only 17% of the respondents said yes, with another 3% saying probably and 12% said they might buy. However, 68% said they were unlikely to buy a landline.

Interpreting the Results of the Survey

It's always a challenge to interpret survey results. It's easy to interpret a broadband survey in a rural community that has poor broadband, and we have done surveys where 80% to 90% of citizens support a new fiber network. It's much more of a challenge to understand what the responses are telling us in an area like Joplin. Proponents of fiber will see plenty of support in the survey responses, but opponents of fiber can probably say the same thing.

This was one of the most interesting sets of survey results that we've seen in a while since there was no one predominant theme in the survey results. We often find communities that care mostly about prices or mostly about faster broadband speeds. But in Joplin, there isn't any single broadband issue that is a key issue for a majority of households.

Following are my observations of what your survey tells us:

Dissatisfaction with the Incumbents. The surveys do not show a lot of dissatisfaction with the current providers. Only 19% of respondents were unhappy with download speeds, 20% are unhappy with customer service, and 18% are unhappy with reliability. The highest level of dissatisfaction, of 35%, was related to getting overall value for the price paid for broadband.

If this had been a short survey that only asked about satisfaction with existing providers, we would think that there is not a lot of support for the idea of launching a new broadband network. However, the responses to other questions show significant interest in having another choice for broadband.

Support for a New Network. After seeing the low-level dissatisfaction with Sparklight, Mediacom, and AT&T, the number of respondents who support a new fiber network is surprisingly high. 67% of residents support the idea of building a fiber network in the city, with another 14% might support the idea if they had more information. This is overwhelmingly positive support, with only 19% who actively dislike the idea. Most of the 19% of respondents that dislike the idea of a new network are folks who have an interest in using the Internet.

The high support is easier to understand when looking at the reasons for the support. The predominant reason for support (98%) was based on a hope for lower prices. 89% of those that support the idea of a fiber network are hoping for more competition. Much smaller numbers care about customer service or reliability.

Customer Service. Poor customer service is not a major driving factor in Joplin. Nationwide surveys document that the big cable and telephone companies are dreadful at customer service.

But this survey shows that only 20% of respondents are unhappy with customer service. Even so, 61% of respondents hoped for better customer service with a new ISP option.

Competition. One sentiment did come through strongly – the desire for more competition. However, it's not so clear what respondents mean by that. In other cities, a strong desire for competition is often coupled with a desire for lower prices or faster broadband speeds. It's impossible to draw that link from these survey results.

Price Sensitivity. We got a mixed message concerning broadband prices. While most people would love lower prices, this does not seem to be a major issue for many households. Consider the following:

- When asked why they support the idea of a new network, 98% of respondents said they would hope for lower prices. That's almost everybody, and this might make it seem like prices are a major issue with residents.
- When we look at what residents say they are spending today, we don't see a lot of households that flock to the lowest price broadband products. In communities where the price is a major issue, we see many residents buying the lowest priced options available. That's not the case in Joplin.
- 5% of total respondents say they don't have home broadband today because they can't afford a computer or can't afford the monthly broadband fee. While that is a substantial portion of the community, that is smaller than what we see in many other communities where 10% or more of residents say they can't afford broadband.
- There is one interesting fact that is a bit of a puzzle. The percentage of people that still use AT&T DSL is larger than what we see in most communities. This could be due to price, but it also could be due to people not liking the cable incumbents. We tend to think it's the latter because Joplin also has a much larger percentage of residents than what we normally see who buy cable TV from the satellite companies instead of the cable companies.
- We find it likely that the 98% of residents that say they would hope for lower prices from a new network is mostly wishful thinking and not a plea for lower prices. We just don't see enough evidence throughout the survey that speeds are a driving factor for the community at large.

Speed Sensitivity. We got a similarly mixed response to questions about broadband speeds. Consider the following:

- Only 19% of homes said they are dissatisfied with download speed.
- Yet 63% said they would change to a new network that offered faster speeds at a rate similar to what homes pay today.

Potential Customers on a New Network. The primary purpose for the statistically valid survey was to estimate the customer penetration rate if the city of Joplin were to build a fiber network. Following is how we interpret the responses about buying service from a new network:

- Our experience is that statistically valid surveys provide a reasonable prediction of how a new ISP will do within the first five years after market launch. We've been able to track client performance compared to pre-launch surveys like this one.
- Customers who say they will definitely buy probably will. Every city has some core of customers that don't like the incumbent providers. The customers who say they will

definitely buy are dissatisfied with the current providers and really like the idea of having fiber. We typically see between 20% and 30% of customers saying they will definitely change to a new network. Your survey comes in far higher than that range, with 45% of the respondents ready to immediately change to a fiber network.

- We've always found that around 2/3rds of those that say they will 'probably' change will also do so. Some won't take the initiative make the change, and some will be lured with low-priced packages aimed to keep them on the current provider. But overall, these respondents have indicated a decent interest in changing providers. In your case, 18% of respondents said they would probably change to a new fiber network.
- The 'maybe' respondents are just that. We've always seen that about one-third of these customers can be gained as customers – but at a cost. This is the part of the market that requires the marketing budget. These customers can be won if you try to explain the benefits of your network and if you have products and prices the public finds attractive. In your case, 15% said they might buy broadband.
- In summary, I think the survey indicates a 5-year target penetration of broadband of 62%. Of course, that prediction assumes that the new network provider does a good job of meeting expectations. There are plenty of opportunities for a new network to make mistakes and underperform.
- CCG has done hundreds of surveys for communities, and the 62% result is near the top end of the range of results that we've seen for communities of your size. Surveys in cities of your size more typically predict penetration rates between 45% and 55%. The highest result I remember ever seeing was 65% of respondents who were likely to buy from a new network. In my opinion, this one survey result is highly promising and provides you with a good reason to continue to investigate bringing fiber to the city.
- To summarize the opportunity that is predicted by the survey:
    - A realistic 5-year goal for broadband penetration is 62%.
    - The goal for cable TV is much lower, probably not higher than 20%. We've seen with today's cord-cutting that a significant number of homes elect to cut cable TV when given the easy option while changing ISPs. Further, the amount of cord-cutting nationwide continues to grow each year (at least up until the pandemic).
    - The 5-year market penetration for residential landline telephone is probably not more than 5%. However, as an ISP you'd likely still offer telephone as a product to satisfy the business market.
    - It's worth noting that a service provider could perform better than these predicted penetration rates with a concentrated marketing effort. A marketing plan is aimed at the 'probably' and 'maybe' customers to convince such customers to buy service.

Online Residential Survey

We also conducted an online residential survey. The results of online surveys are not statistically valid, meaning that the survey cannot be relied upon to answer numerical questions like the percentage of homes that will buy broadband from a new provider. This is due to the fact that the survey is not conducted randomly and does not reach many homes that don't have home broadband. With that said, an online survey is useful for measuring sentiment. For instance, we can learn something useful from responses that talk about how residents feel about current broadband and existing ISPs.

In our many years of conducting both online and residential surveys, we've come to understand that an online survey tends to attract members of the public that care more about broadband than the average citizen. Since taking the online survey is voluntary, only those that care about the topic are willing to take the time to answer the questions. But that's not always the case – this survey had a significant number of respondents that don't have home broadband.

The survey was conducted online using Survey Monkey in July and August 2021. The survey was posted on Joplin's website and was advertised on social media. The survey was well-received by the public and we got 295 responses to the survey.

Survey Results

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

Broadband Customers

91% of all respondents said that they have a home broadband connection today – with 9% saying they don't have home broadband. The responses show another 5% of respondents who only use their cellphone for broadband, meaning the percentage of respondents with a wired home connection is 86%.

The respondents who say they have a home broadband connection used the various ISPs in the city as follows: 70% use Cable One (Sparklight), 13% use AT&T, 5% use Mediacom, 2% use Wisper ISP, 2% use satellite broadband, and 3% use somebody else.

We asked why respondents with no home broadband don't have a home broadband connection. 83% said that broadband is too expensive – the number one reason nationwide why residents don't buy home broadband.

Cable TV Penetration

Only 32% of survey respondents report the purchase of traditional cable TV, meaning TV from a cable company, telco, or satellite provider. That is significantly lower than the nationwide average, which dipped below 60% by the end of the first quarter of this year. In the survey, 2% of households use AT&T, 10% use Cable One (Sparklight), 1% use Mediacom, and 18% use satellite.

Telephone Penetration

16% of respondents reported still having a landline telephone. The nationwide landline penetration has dropped below 30%. 10% of residents buy telephone service from AT&T, 3% from Cable One (Sparklight), 1% from Mediacom, and 2% use VOIP (Voice Over Internet Protocol).

Customer Bills

The survey asked customers what they pay each month for the triple-play services (Internet access, cable TV, and telephone). We've found that this question always has to be taken with a grain of salt because

what people say they pay is often different than what they actually pay. For example, a household might cite a $100 special price they are paying without realizing that they actually pay more due to hidden fees and additives. It's especially easy these days for customers that pay automatically with credit cards or bank debits and do not know how much they pay. With that said, here is what customers say they are spending:

Customers buying a bundle of service	$166
Customers buying standalone broadband	$ 86
Customers buying standalone cable TV	$105
Customers buying standalone telephone	$ 67

We note that the $165 average for bundles is pretty typical of what we see in other communities. The average price for standalone broadband is higher than what we see in other communities – we usually see an average between $70 and $80. The telephone price is higher than what we see in other communities – perhaps there are still homes with significant long-distance bills. Cable rates are typical of what we see in other communities.

Uses of Broadband

74% 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 (16%), those that work several days per week (29%), those that work a few times a month (15%), and those that work from home occasionally (14%). The number of people working from home across the country has increased significantly during the pandemic – before the pandemic, we rarely saw more than 10% of homes with somebody working from home. 35% of respondents with somebody working from home said they would work from home more often if they had faster Internet.

35% of respondents report having somebody in the home using broadband for schoolwork. 41% of these households said that the broadband was not good enough to support online schoolwork.

We've learned during the last year that most of the problems encountered when working and schooling from home come from inadequate upload speeds. This is something that many people don't yet understand, and they often assume that the entire broadband connection is inadequate.

Satisfaction with Existing Broadband

21% of respondents say they are unhappy with their Internet download speeds at home, while 48% are satisfied.

31% of respondents are not happy with the customer service from their ISP, while 39% are satisfied.

47% of respondents say that they are unhappy with the value they get from their ISP compared to the price they pay, while 29% are satisfied.

These are mixed results. There is more satisfaction than dissatisfaction for broadband speeds and customer service, but there was significant dissatisfaction with the overall value of the broadband being provided.

Support for a Fiber Network

One of the key questions asked in the survey is if respondents support the idea of Joplin trying to get better Internet access. 62% of respondents support the concept. Another 35% said they might support the idea but need more information. Only 3% of households said they do not support the city pursuing a better broadband solution.

We asked the reasons why respondents support bringing a new network to the city. 87% said they hope for faster speeds. 94% of households hope for more competition. 81% hope for lower prices, and 44% are hoping for better customer service.

We asked the reasoning for the 3% of respondents who don't support a new fiber network. 50% are happy with the current providers. 50% said that government should not get involved in a commercial business.

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 fiber network. 46% said they would definitely buy. Another 26% said they probably would buy service, and 21% said they might buy service. Only 7% said they were unlikely to consider buying service.

We also asked what factors would lead a respondent to move service to a new network. 70% said faster Internet, 78% said lower prices, 21% said better customer service, 2% said competition, and 2% said availability

When asked if they would buy a landline telephone, only 5% of the respondents said yes, with another 4% saying probably and 12% said they might buy. However, 79% said they were unlikely to buy a landline.

Interpreting the Results of the Survey

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

This was one of the most interesting sets of survey results that we've seen in a while since there was no one predominant theme in the survey results. We often find communities that care mostly about prices or mostly about faster broadband speeds. But in Joplin, there isn't any single broadband issue that is a key issue for a majority of households.

Following are my observations of what your survey tells us:

> Dissatisfaction with the Incumbents. The surveys do not show a lot of dissatisfaction with the current providers. Only 21% of respondents were unhappy with download speeds, and 31% are

unhappy with customer service. The highest level of dissatisfaction of 47% was related to getting overall value for the price paid for broadband.

Support for a New Network. After seeing the low level of dissatisfaction with Sparklight, Mediacom, and AT&T, the number of respondents who support a new fiber network is surprisingly high. 62% of residents support the idea of building a fiber network in the city, and another 35% might support the idea if they had more information. This is overwhelmingly positive support, with only 3% who actively dislike the idea.

The high support is easier to understand when looking at the reasons for the support. The predominant reason for support (94%) was based on a hope for more competition. 87% of those that support the idea of a fiber network are hoping for faster speeds. 81% of respondents hope for lower prices. 44% of respondents hope for better customer service.

Customer Service. Poor customer service is not a major driving factor in Joplin. Nationwide surveys document that the big cable and telephone companies are dreadful at customer service. But this survey shows that only 31% of respondents are unhappy with customer service. Even so, 44% of respondents hoped for better customer service with a new ISP option.

Competition. One sentiment did come through strongly – the desire for more competition. However, it's not so clear what respondents mean by that. In other cities, a strong desire for competition is often coupled with a desire for lower prices or faster broadband speeds. It's impossible to draw that link from these survey results.

Price Sensitivity. We got a mixed message concerning broadband prices. It's tempting to assume that everybody would like lower prices, but this doesn't seem to be a major issue for many households. Consider the following:

- When asked why they support the idea of a new network, 81% of respondents said they would hope for lower prices. That's a large percentage of the population, and this might make it seem like prices are a major issue with residents.
- When we look at what residents say they are spending today, we don't see a lot of households that flock to the lowest price broadband products. In communities where the price is a major issue, we see many residents buying the lowest priced options available. That's not the case in Joplin.
- 8% of total respondents say they don't have home broadband today because they can't afford a computer or can't afford the monthly broadband fee. While that is a substantial portion of the community, that is smaller than what we see in many other communities where 10% or more of residents say they can't afford broadband.
- We find it likely that the 81% of residents that say they would hope for lower prices from a new network is mostly wishful thinking, and not a plea for lower prices. We just don't see enough evidence throughout the survey that price is a driving factor for the community at large.

Speed Sensitivity. We got a similarly mixed response to questions about broadband speeds. Consider the following:

- Only 21% of homes said they are dissatisfied with download speed.

- Yet 70% said they would change to a new network that offered faster speeds at a rate similar to what homes pay today.

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

46% of all respondents said they would definitely buy from a new network. Another 26% said they would probably buy, and 21% said they might buy. We interpret these results as follow:

- Customers who say they will definitely buy probably will. Every city has some core of customers that don't like the incumbent providers. The customers who say they will definitely buy are dissatisfied with the current providers and really like the idea of having fiber. We typically see between 20% and 30% of customers saying they will definitely change to a new network. Your survey comes in far higher than that range, with 46% of the respondents ready to immediately change to a fiber network.
- We've always found that around two-thirds of those that say they will 'probably' change will also do so. Some won't take the initiative to make the change, and some will be lured with low-priced packages aimed to keep them on the current provider. But overall, these respondents have indicated a decent interest in changing providers. In your case, 26% of respondents said they would probably change to a new fiber network.
- The 'maybe' respondents are just that. We've always seen that about one-third of these customers can be gained as customers – but at a cost. This is the part of the market that requires the marketing budget. These customers can be won if you try to explain the benefits of your network and if you have products and prices the public finds attractive. In your case, 21% said they might buy broadband.

Unfortunately, we can't use the results of an online survey to predict a penetration rate. With that said, we've almost never seen 46% of respondents to a survey say they would absolutely buy broadband. We interpret these results to mean that there is a higher-than-average demand for better broadband.

Comparing to the Telephone Survey

There are a few interesting comparisons that can be made between the statistically valid telephone survey and the online survey. It's often not easy to understand the reasons for the difference. A statistically valid survey is done randomly throughout the community and should provide the composite opinions of the community as a whole. Online surveys tend to attract those who care about broadband, and any results have to be interpreted through that lens.

With that difference noted, there were a few interesting differences between the two surveys:

- The only survey included a lot more respondents (75%) who get broadband from the cable company than the telephone survey (44%).
- 47% of respondents in the online survey are cord-cutters while only 20% in the telephone survey made that claim. This would help to validate that the online survey represents households that use broadband more than average.

- Probably the most important difference is that only 3% of respondents to the online survey didn't support the idea of bringing a fiber network to the city, compared to 19% of respondents in the telephone survey. This clearly shows that the online survey respondents are more invested in broadband than the average Joplin resident.
- This carried through when respondents said why they favored getting a fiber network. There were more respondents in the online survey that hoped for better prices (98% compared to 81%), more competition (94% compared to 89%).
- The most intriguing result was that the percentage of respondents who said they would definitely buy broadband was nearly identical in the two surveys (45% and 46%).

Business Online Survey / Interviews

In the course of the study, we interviewed key businesses in the city and also heard from businesses through an online survey. We summarize what we found as follows:

- There are a few lucky businesses that can buy symmetrical broadband on fiber from Liberty Connect. This is a fiber network owned by Liberty Utilities, the local power utility. We encountered businesses that are buying symmetrical bandwidth with speeds between 100 Mbps and gigabit. Businesses served by fiber are satisfied with the broadband. The only complaint we heard was from a business that couldn't buy fiber at a different location in the city that is not close to the fiber.
- We also encountered fiber broadband provided by AT&T at the library and a few other businesses. We also talked to one business that has a fiber connection from Sparklight.
- All other businesses told us that they didn't feel that they have broadband options. Most have long ago rejected AT&T DSL as too slow and unreliable, and so businesses have no other choice but to buy from the cable company, which is Sparklight in most of the city.
- Businesses all reported that Sparklight is generally okay as an ISP. The biggest problem reported to us is that the network has an outage of a few hours every few months. We also heard that broadband speeds vary throughout the day. Several businesses reported problems with uploading data. Nobody using Sparklight is happy with customer service. As an interesting anecdote, several businesses told us that every outage is blamed on a fiber cut. It seems that is a standard response to customers regardless of the real reason for an outage.
- Almost universally, we were told that businesses not on fiber have a wish list of broadband functions that would be tackled if faster broadband was available.
- Sparklight doesn't serve everywhere. We heard from a non-profit that is using AT&T because no other ISP will serve the location. This is not an unusual situation because cable systems were originally built to serve residential neighborhoods. After the cable companies started to offer broadband, the companies expanded networks to reach business neighborhoods. But in every city we've ever worked in, we've found places where the cable companies have never built. These stray businesses are forced to use DSL since there is no other option. Since AT&T won't connect new customers, a new business in these pockets has zero option for broadband. Existing businesses also face the possibility of someday having no broadband option.
- Missouri Southern University is connected to fiber through MOREnet (the Missouri Research and Education Network), which is a statewide fiber network connecting universities and schools. The University has built a fiber ring around and throughout the campus to connect to buildings. The campus offers WiFi connectivity across the campus for students and faculty, but this doesn't extend off-campus. The University provided cellular hotspots to faculty and staff to work from

home during the pandemic, but this wasn't successful everywhere since there are places in the area with poor cellular coverage, including in the city.

Here are a few other interesting things we found out from the business community:

- One hotel that is part of a large national change constructed fiber to connect to an internet point of presence downtown. This hotel does this routinely in markets where there is not fiber available from local ISPs. This hotel also has a backup fiber connection from AT&T. We heard from an IT consultant that it's fairly normal for businesses to consider paying to build fiber to get faster broadband. We were told of businesses that were quoted a one-time fee of $10,000 to get fiber connectivity – a fee that few businesses are willing to spend.
- Broadband prices vary widely in the business community, and some businesses are paying high prices. For example, we heard from one business paying $700 per month for a symmetrical 100 Mbps connection on fiber, while others are paying less. We heard from a small business that was recently quoted almost $1,000 per month for a 150 Mbps connection from Sparklight that included a few telephones. Prices always vary in the business community but the high quote from Sparklight is indicative of an ISP that isn't worried about competition. One of the biggest benefits of a new network in the city would be to bring back choice and competition to the business community. Even if the city does nothing to expand broadband it's likely that the current fiber networks in the city will expand over time. But without some event to bring competition, prices will stay high and likely go even higher.
- We heard stories of businesses that struggled when employees were sent home to work but didn't have adequate broadband. Many such employees live in rural areas around the city, but there were residents in the city that had problems maintaining a connection to the work server or holding a Zoom call.
- We heard from the medical community that there were a lot of problems connecting to telemedicine during the pandemic. A telemedicine connection can sometimes require more bandwidth from the customer end than a work or school connection.
- We talked to a manufacturer that has two fiber feeds for redundancy. The \company said that it would lose tens of thousands of dollars in revenues if it was shut down for even one hour. This is a good example of how vital that good broadband access is becoming to many businesses. This business has moved much of its brains into the cloud, but in doing so, has made good connectivity mandatory. Unfortunately, there are a lot of businesses in the city that don't have the connectivity options available to upgrade their businesses to the next level.
- We talked to a non-profit that was dropped by AT&T last year. AT&T basically looks for excuses to drop DSL customers as it tries to work itself out of the copper business. This business feels lucky to have been able to get a connection to Whisper, the wireless ISP, since it had no other broadband options. Wireless broadband won't work everywhere, and there will be businesses that lose all broadband connections if they lose DSL – it's likely that's already happened somewhere in the city.

As part of the survey and interviews, we asked the businesses in Joplin how they use broadband today. Here are the responses we received:

- Communicating with Customers. Businesses routinely have portals that make it easy for customers to place and track orders. Inadequate broadband means lower sales. The old days of calling purchasing agents are slowly passing away and most commerce between companies is becoming automated – which improves accuracy and speeds up the ordering process. Businesses that operate

busy e-commerce ordering sites need big amounts of bandwidth to make sure that all customers have a successful purchasing experience. A few businesses told us that they didn't have enough upload bandwidth to host an e-commerce website for selling goods or services.

- Communicating with Vendors. Businesses also routinely use the portals of their vendors to buy goods and services needed to operate.
- Communicating with Other Branches of the Company. Many businesses are now part of larger corporations and maintain open data connections to communicate with other branches of the company and with headquarters.
- Working in the Cloud. It's now common for companies to work in the cloud using data and software 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 that has driven the biggest need for bandwidth from many businesses. A business doesn't need to be highly sophisticated to work in the cloud. Functions like banking are routinely done in the cloud. A lot of basic software like Microsoft Office and Dropbox now operate in 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. The city knows how important that is since you recently had an episode of ransomware. Security today also means the use of video surveillance cameras that upload video streams to the cloud.
- 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. Several businesses in Joplin told us they were unable to use VoIP.
- Communicating via Video. We've finally reached the time when employees routinely communicate via video from 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. We've been told by businesses that they are having problems when multiple employees want to connect by video at the same time from the office.
- 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. A business needs a sufficiently large upstream connection to connect to multiple remote employees at the same time. Several Joplin businesses told us they had problems connecting to remote workers during the pandemic. They were not always sure if the problems came from the home or the office end of the connections.

- 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. Live data backup 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 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 that only function correctly when connected to the Internet. None of these devices use a lot of bandwidth, but collectively can add up to a lot of demand.

Speed Tests

One of the tools that is commonly used to better understand broadband performance is speed tests. A speed test can tell us about the download broadband speeds, upload broadband speeds, and latency measured in milliseconds.

One of the primary reasons that speed tests are important is that it provides a data point to test the speed reported by ISPs to the FCC. ISPs often report marketing speeds, but what matters to customers is the actual performance of their broadband. Speed tests also can allow us to get a peek into the quality of the incumbent networks. It's not unusual, for example, for a cable company to deliver different speeds in different neighborhoods due to local problems in the network. We've learned that speeds within a city can widely differ due to these local issues.

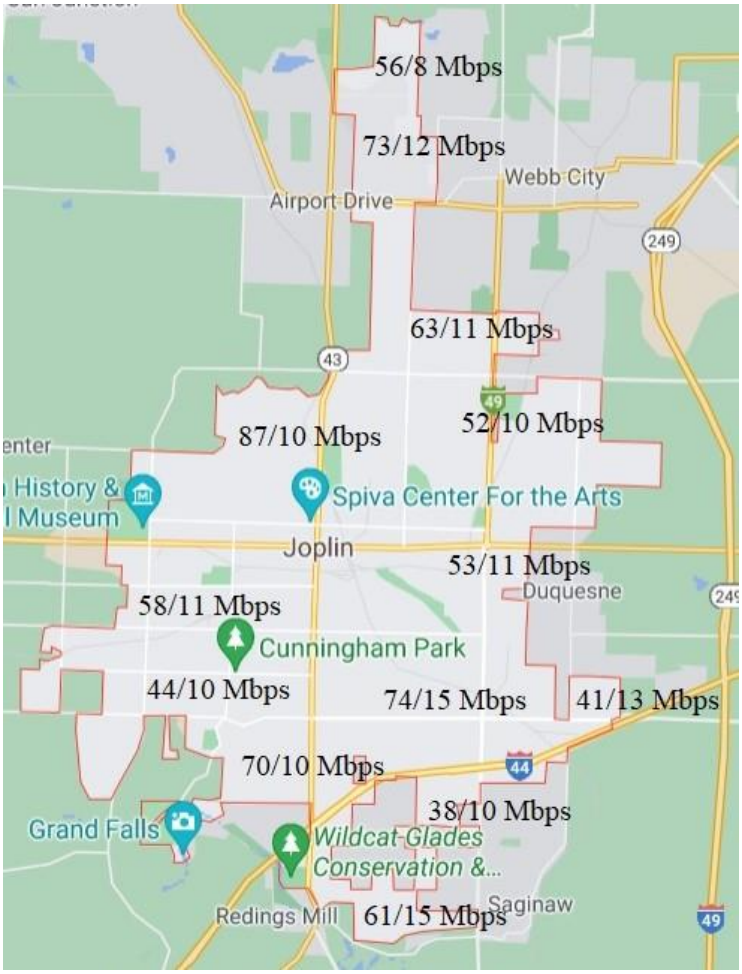
With that said, speed tests are not 100% reliable and a single speed test doesn't always deliver a true picture of the broadband being delivered to a given address. However, we've found that when speed tests are administered in mass that we can get a decent picture of the overall broadband situation in a community. Following are a few of the criticisms that can be made about an 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.
- There are several prominent speed tests used by the public, and each 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 mask what 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 the test opens multiple paths between a user and the test site and averages the results together.
- A speed test can report slow speeds due to network issues within the home, such as problems with a home WiFi router or faulty wires inside a home. A slow speed test result doesn't always mean that the ISP has a slow connection.
- Internet speeds vary throughout the day, and anybody that takes multiple speed tests on the same day will see this. Taking only one speed test might not tell the real story about a given customer.
- Some ISPs use something called "burst" technology. This provides a fast 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 time window, and the Internet

connection then slows down when the temporary burst is over. This raises an interesting question – what's the real Internet speed of a customer that gets 100 Mbps during a 2-minute burst and something slower after the burst – there is no consensus in the industry.

With the above caveats in mind, the following are the results from the speed tests taken for this study. We first gathered speed tests that Ookla[8] has made available to the National Information and Telecommunications Agency (NTIA). This represents the total results of everybody in Joplin who has taken an Ookla speed test during the last year. These speed tests average together every technology, so the speed tests include AT&T DSL, cable modems from the cable companies, the handful of businesses using fiber, and the handful of households using fixed wireless broadband.

With that said, we would expect the average speed in Joplin to be relatively fast since the cable companies have most of the customers and are mostly selling broadband connections that are supposed to be faster than 100 Mbps. Ookla reported speeds to the state by Census Tracts. A Census Tract is a small statistical area assigned by the Census Bureau that averages about 4,000 residents, but that can vary from 1,200 to 8,000. Below is a map of Joplin showing the average speeds from Ookla in each of the Census Tracts.



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

It's often hard to know what the map above is telling us. However, there are a few things that pop out:

- No part of the city has average speeds of 100 Mbps. However, the speeds in the northwest average 87 Mbps download – which tells us that the broadband there is pretty decent.
- There are two other Census Tracts with overage download speeds of over 70 Mbps.
- These speeds contrast significantly with three Census Tracts in south Joplin, with average download speeds of 38 Mbps, 41 Mbps, and 44 Mbps. We get instantly suspicious when we see speeds in one part of a city that are more than twice as fast as others. In the case of Joplin, this difference is not due to a difference in technology – it's not like one part of the city has residential fiber while other places don't. It's more likely that there are issues with the cable company network in the parts of the city that have slower speeds. The only real way to know that would be to continue to gather speed tests over time to see if this difference persists.
- More of a concern is the average upload speeds indicated by the Ookla speed tests. No part of the city has an average upload speed of more than 15 Mbps, and most of the city is closer to 10 Mbps, with some even under that.
- One of the reasons this feels problematic is that the legislation that recently passed in the U.S. Senate defines any download broadband speed under 100 Mbps or any upload broadband speed under 20 Mbps to be underserved. We know that customers in Joplin can almost all buy broadband faster than 100 Mbps download. But it's not clear that Sparklight can deliver download broadband across the board that would be at least 20 Mbps.

As part of the study, we also collected additional Ookla speed test results, but not nearly enough to make a similar map. Here is what we found:

- We got several speed tests from businesses connected to fiber. The speed tests showed symmetrical speeds like what is advertised by the various fiber ISPs.
- We saw average download speeds for Sparklight in the speed tests of 167 Mbps. That average must be taken with a grain of salt because while it contained a number of download speeds in the 200 – 300 Mbps range, it also had an equal number of speeds under 50 Mbps, with some as slow as 16 Mbps. That's a wide range of speeds. Some of that can be attributed to some homes buying faster speed packages, but the homes that reported slow speeds all reported to be buying 100 Mbps broadband.
- The average upload speed in the speed tests for this study was 15 Mbps. But that ranged between 3 Mbps and 30 Mbps. Again, a wide range of results.
- AT&T speed tests for the study averaged 10/1 Mbps. That's in line with what the company reports to the FCC.

Is the Joplin Market Competitive?

The RFP asked if the city's broadband market is being driven by healthy competition to provide the best broadband services possible at a price point that provides value to the citizens. The short answer is the vast majority of the market is not competitive. Consider the following:

- There are parts of downtown and a few other areas of the city where there are large businesses that have access to fiber from AT&T, the cable companies, and a few specialty ISPs. Schools, the hospital, and selected businesses have fiber broadband and are happy with it. But fiber has not been extended to the larger market. AT&T is not reporting any residential fiber in the current FCC 477 data. That's a little surprising since it's built at least pockets of fiber in many markets.

- When AT&T stopped selling broadband in October of last year, the majority of customers lost the second choice of ISP. We've heard stories that AT&T is not even taking orders for telephone service on copper. AT&T is allowing customers to stick with DSL for now, but it's been reported that if a customer misses a payment or turns off DSL for a long vacation that they are not being allowed to reconnect. It is a reasonable assumption that at some future time that AT&T will turn off the copper network – it's already likely that there is no maintenance being done to keep it working.
- The two cable companies – Sparklight and Mediacom – are adequate ISPs, but the surveys and interviews showed a significant percentage of homes and businesses are not fully happy with them as an ISP. But in the new environment where they are the only game in town, that unhappiness is likely to grow.
- AT&T's departure from the market means the cable companies have largely become monopolies. There are several wireless ISPs that claim to cover Joplin, but we didn't find any customers of these ISPs in the surveys. The reality of the WISP fixed wireless technology is that it doesn't work well in cities, other than perhaps near the edges that are close to rural areas.
- Like most places, the pandemic showed some huge limitations on broadband when many homes were unable to work or undertake schooling from home. This issue is largely related to upload speeds, and most of the residential broadband products in the market have low, and underperforming upload speeds. This only got worse during the pandemic when everybody tried to use upload links at the same time, as the network often slowed to a crawl.
- Residential prices for broadband are perhaps a little high compared with ISP prices nationally. But both cable companies have stingy data caps, so a lot of customers routinely are spending more than the base rates due to going over the data caps. Sparklight' s basic price for standalone broadband at 100 Mbps is $55 plus $10.50 for a modem, or $65.50. But this product comes with a 300-gigabyte monthly data cap. Mediacom is higher with basic broadband at 60/10 Mbps is $69.99 plus $9.00 to $11.50 for the modem. Mediacom has a 400-gigabyte data cap. As a reminder, the national average monthly household broadband usage was 462 gigabytes at the end of the first quarter – larger than the data caps for both companies. Customers can get a larger data cap, either by spending extra to get unlimited data or by upgrading to a faster broadband product. We haven't studied any other markets recently that had such stingy data caps.
- There are no standard prices for small businesses, and like small businesses almost everywhere in the U.S., the ISPs charge a wide range of prices for the same products and there are many small businesses paying high monthly rates.

All of these factors taken together means that, in our opinion, Joplin does not have a competitive broadband environment. We think that's the reason that the city undertook this study – because you hear from a lot of citizens who are unhappy with broadband.

What Can the City Do About the State of Broadband?

The RFP asked what the city should do to improve the state of broadband. It's worth discussing what happens if you do nothing. With AT&T's withdrawal from the broadband market, the city is left with a pure monopoly situation for the vast majority of residences and businesses. We know from seeing how monopolies have operated in other markets what this means. The cable companies in Joplin have been a monopoly for less than a year, but over time you can expect the following behavior from them:

- Higher Prices. Monopolies raise rates because there is nothing to stop them from doing so. Both Sparklight and Mediacom set rates at a national level, and those rates have been rising as these smaller companies mimic the practices of Comcast and Charter, the two giant cable companies. Bother of those companies are on a path towards $100 basic broadband.

  But the price increases in a monopoly market are more subtle than the basic rates being charged. Both cable companies have offered special rates in the past to lure customers from DSL. Over time these introductory rates disappear because in a market where AT&T is the ISP, the companies know they will eventually get the rest of the customers. Both companies also have bundling discounts, and over time those discounts will shrink and disappear in Joplin. Finally, in a competitive environment, ISPs are open to negotiating with customers who threaten to leave. It's now impractical for customers in Joplin to leave the cable companies so this practice will stop. There likely is still some of all of these discount programs in the city today, but as it finally sinks in on the cable companies that they are in a monopoly position, they will pull back from giving discounts. If no other ISP ever comes to the market, in the long run, everybody in Joplin will be paying the full list prices from broadband, telephone, and cable TV.
- Degraded Maintenance. This won't happen overnight, but it's inevitable due to the way that big ISPs operate. There is always pressure from corporate for local managers to cut costs – this is the primary reason that there are problems with the cable companies today. Cable companies don't conspire to be poor ISPs at the corporate level, but they have budgetary practice and a bonus structure that rewards local employees for cutting corners and costs. One of the easiest things to eliminate in a monopoly environment is maintenance. The local managers for the cable companies likely will not eliminate jobs but rather will not fill vacant positions over time. We've seen this in practice for decades from the big telcos, which have eliminated a huger percentage of technicians over the last few decades. This is bound to happen in markets where a cable company become a monopoly.
- Little Innovation or Upgrades. Cable technology has been improving rapidly over the last decade. In Joplin, we saw both cable companies upgrade download bandwidth to the DOCSIS 3.1 standard. It doesn't look like they have upgraded the upload part of the network past the older DOCSIS 3.0 standard. Within a few years, cable companies will have the option to upgrade again to DOCSIS 4.0 – an upgrade that will allow for symmetrical gigabit broadband products to compete against fiber.

  Cable companies are not motivated to upgrade in monopoly markets. They may end up doing so over time as part of a corporate-wide effort to have the same technology everywhere, but the choice is always going to be made to upgrade competitive markets before non-competitive ones.

There is one last issue to consider in making Joplin a competitive broadband market. Today, we heard from a number of people who work in the city but live in the rural areas that the condition of rural broadband around Joplin is terrible. This is the pretty normal state of affairs for rural America, where the big telcos stopped taking care of copper networks starting a few decades ago. But there is a big change that will be sweeping through rural America. The federal government has already dedicated tens of billion in funding to improve rural broadband, and the Senate recently passed an infrastructure bill that will bring tens of billions more in funding. It's possible that the rural areas surrounding Joplin will be upgraded to fiber over the next decade. That would create an unusual situation where rural areas around cities like Joplin might have better broadband than the city. If cities don't react, this will cause big changes over

time. People who work at home will migrate to better broadband in the rural areas. Businesses that don't rely on retail traffic are likely to migrate to better broadband. Over a few decades, this could have huge implications – loss of tax base, no new homes built in the city, loss of businesses and jobs, and a host of related issues.

The strategic plan section of the report discusses steps the city should consider to remain competitive. The only solution is for at least one more ISP to compete widely in the market – otherwise, the above issues related to being a monopoly market will strengthen over time.

C. Broadband GAP Analysis

A broadband gap is where some customers have an advantage compared to others in terms of benefitting from the Internet. This report will look at the different kinds of broadband gaps as described below.

- The Gap in Broadband Speeds. How does Joplin compare with other similar communities?
- The Gap in Broadband Availability / Adoption. Every market has some homes with little or no broadband options. Even where broadband is available, there are always homes and businesses that elect not to use it.
- The Gap in Broadband Affordability. In every community, there are households that can't afford broadband.
- The Gap in Computer Ownership. There are households that don't subscribe to broadband because they can't afford a computer.
- The Gap in Broadband Skills. There are citizens who don't buy broadband because they lack the skills needed to operate in the digital age.
- Future Broadband Gaps. Even where there is adequate broadband today, we can look forward to the natural progression of technology that will create new broadband gaps that don't exist today.

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

The Gap in Broadband Speeds

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

FCC Definition of Broadband

In 2015, the FCC established the definition of broadband as 25/3 Mbps (that's 25 Mbps download and 3 Mbps upload). Prior to 2015, the definition of broadband was 4/1 Mbps, set a decade earlier. The FCC defines broadband to meet a legal requirement. Congress established a requirement for the FCC in Section 706 of the FCC governing rules that the agency must annually evaluate broadband availability in the country. Further, the FCC must act if broadband is not being deployed in a timely manner. The FCC

reports the state of broadband to Congress every year.[9] In these reports, the FCC compiles data about broadband speeds and availability and offers an opinion on the state of broadband in the country. In every report to date, the FCC has acknowledged that there are broadband gaps of various kinds, but the FCC has never determined that the problems are so bad that they need to take extraordinary measures to close any broadband gaps. Most recent FCC reports have acknowledged that there are broadband gaps but claim that the broadband situation is improving due to actions taken by the FCC. As you will see in the following report, the annual reports to Congress are largely fictional and don't describe the state of broadband in places like Joplin.

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 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 that argued 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 fill only one city block, but in a rural area it might cover a large portion of a county.
- For each Census Block, the ISP reports the fastest speed that is being marketed 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 a Census Block

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

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

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

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

All these factors taken together mean that the FCC broadband databases and maps are generally dismal. The broadband speeds in towns might be reported reasonably correctly, although the speeds reported sometimes reflect marketing "up to" speed instead of actual speeds. Speeds for areas just outside of towns and cities are routinely overstated and often show broadband coverage where there is none. Rural areas served by DSL or fixed wireless generally overstate the broadband speeds – and these are the two technologies most widely used in rural America.

FCC to Revise Maps

In January of 2020, the FCC voted to revise its data gathering and mapping system, and Congress has provided the money for this to happen. The best change in the new reporting is that ISPs must draw polygons around areas where customers either have service or where the ISP is willing to provide service within ten days of a request. This means abandoning Census blocks. This will clean up two problems. It will draw lines around areas where cable company coverage stops in towns and create a clear border. Today, reporting by Census block often shows cable coverage extending far into the rural areas surrounding towns. Second, the polygons ought to chop down on rural WISPs and telcos that claim coverage where they can't provide service.

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

The revised mapping rules also contain a two-tier challenge process – a challenge by governments or Tribes and a challenge by consumers. The government challenge is complex in that anybody that wants to challenge must draw their own versions of the polygons in an area they are challenging. It will be a huge challenge for governments to gather the huge volume of consumer data needed to make such a

challenge. A government might gather a thousand speed tests in a rural city and still be unable to draw an accurate polygon of the coverage area. I foresee governments undertaking these challenges, but the process looks heavily slanted in favor of ISPs.

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

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

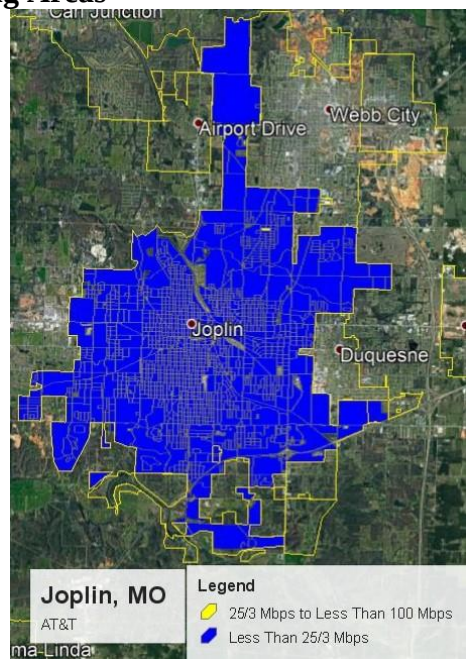
FCC Data for the ISPs in Joplin

Following is some information of what each ISP has been historically reporting to the FCC in the city.

AT&T

AT&T has historically claimed to offer DSL everywhere in the city. It's important to note that as of October 2020, AT&T will no longer install a new DSL customer. This means the map is misleading since households and businesses can no longer order DSL. AT&T claims speeds of less than 25/3 Mbps across the whole city. The company does offer speeds greater than 25/3 Mbps in areas close to the airport and outside the city. AT&T does not currently claim to have any residential fiber in the city.

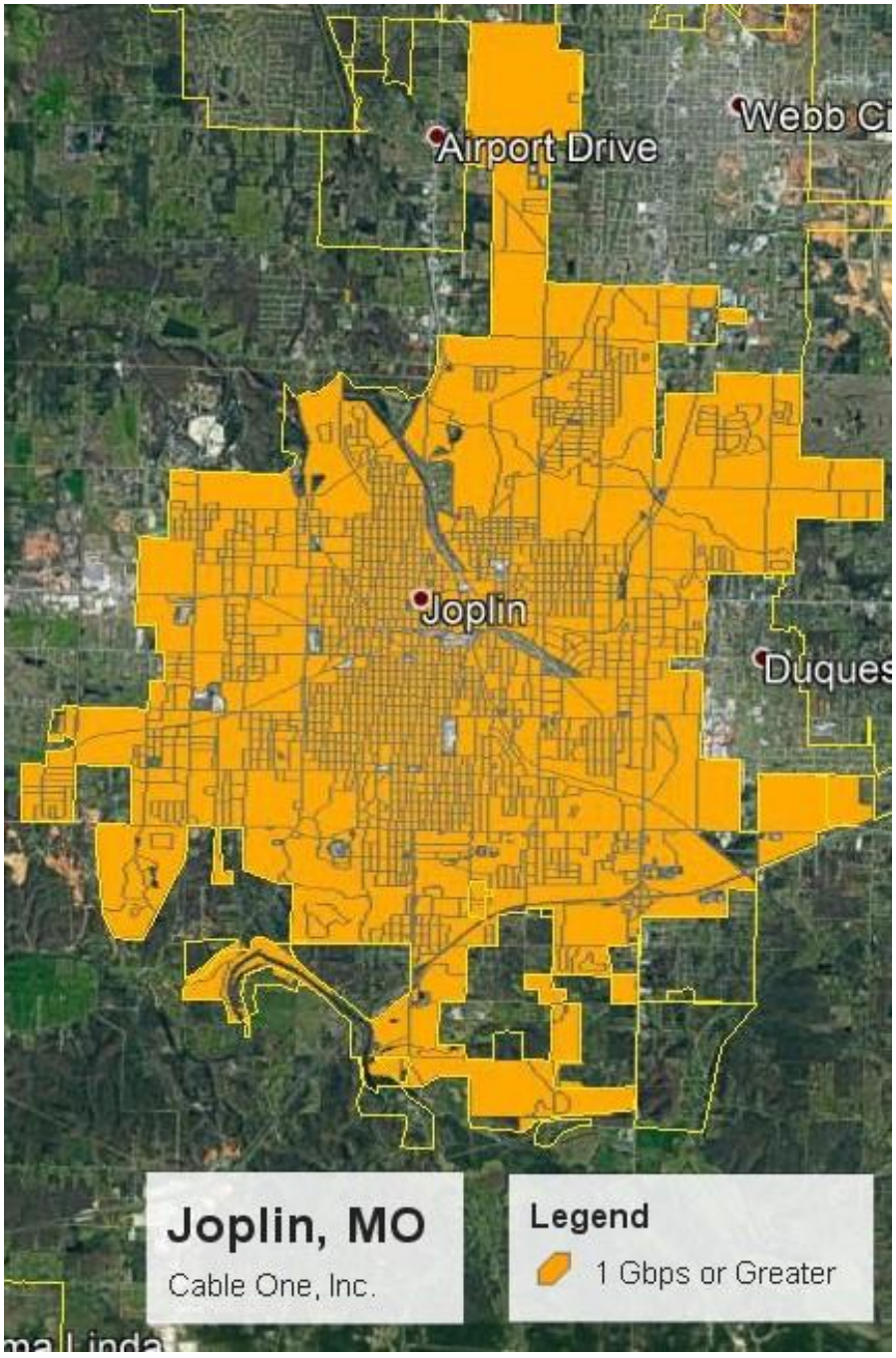
AT&T FCC Form 477 Reporting Areas



Cable One, Inc (Sparklight)

Sparklight (Cable One) reports to the FCC that it has the capacity to deliver speeds up to 1 Gbps for the whole city. Our research shows that there are parts of the city where the company doesn't achieve the gigabit speed, but it seems clear that the entire network has been upgraded to DOCSIS 3.1 for download speeds. Local conditions in neighborhoods might result in slower speeds, but this is still the fastest broadband available in the city.

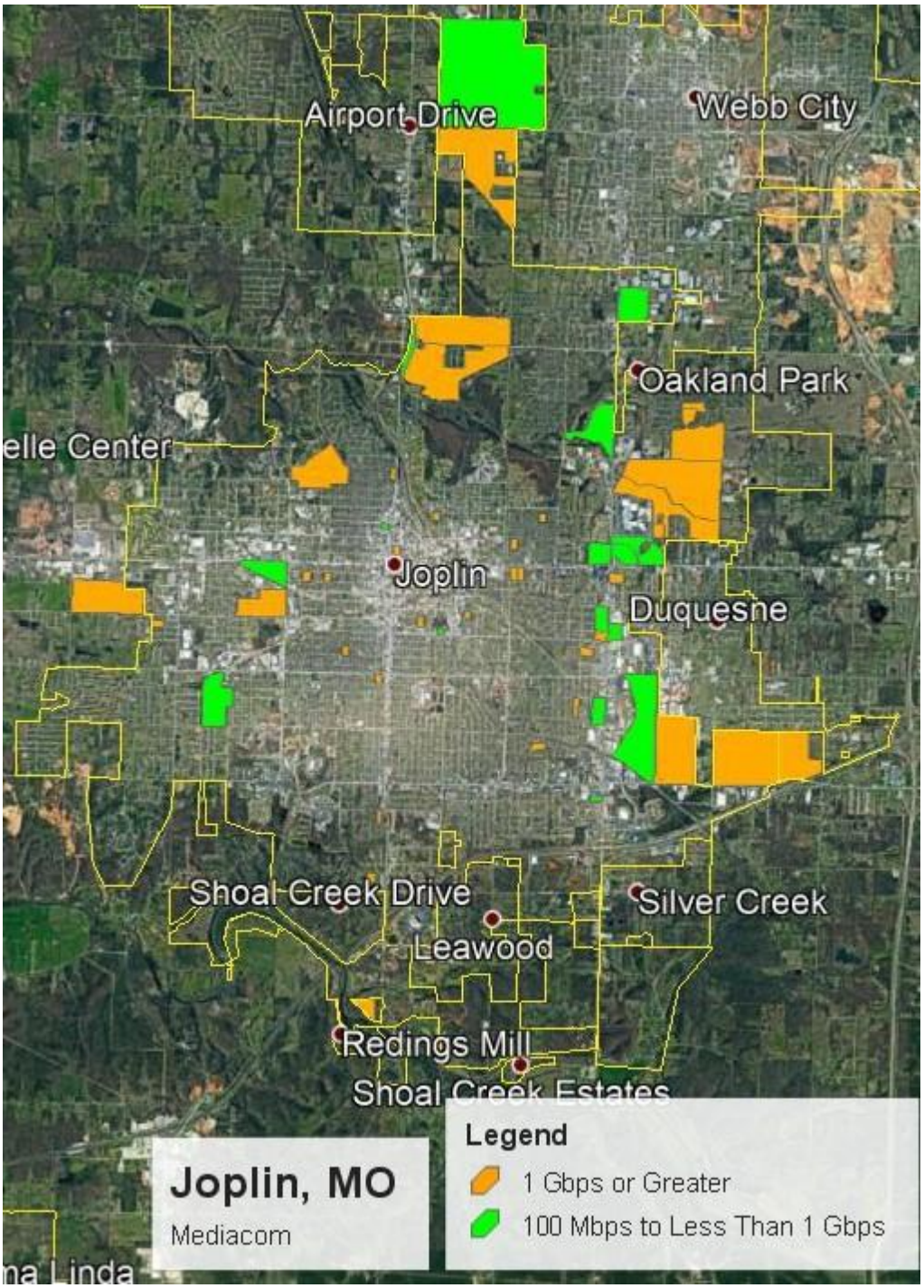
Cable One, Inc (Sparklight) FCC Form 477 Reporting Areas



Mediacom

As shown on the map, Mediacom only serves in selected parts of the city. In the areas shown in orange, the company is claiming speeds up to 1 Gbps. In the green areas, the company is claiming speeds faster than 100 Mbps, but less than a gigabit.

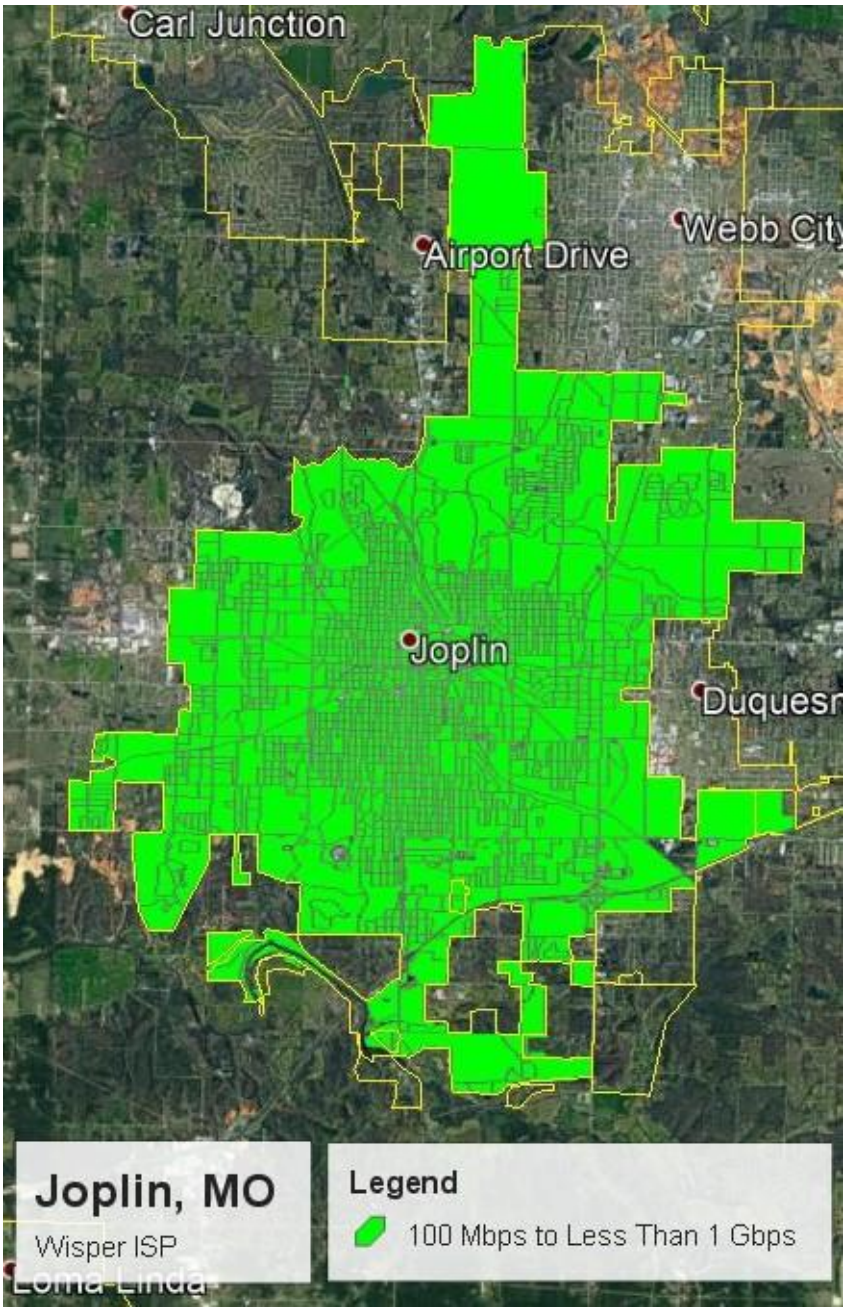
Mediacom FCC Form 477 Reporting Areas



Wisper ISP, Inc.

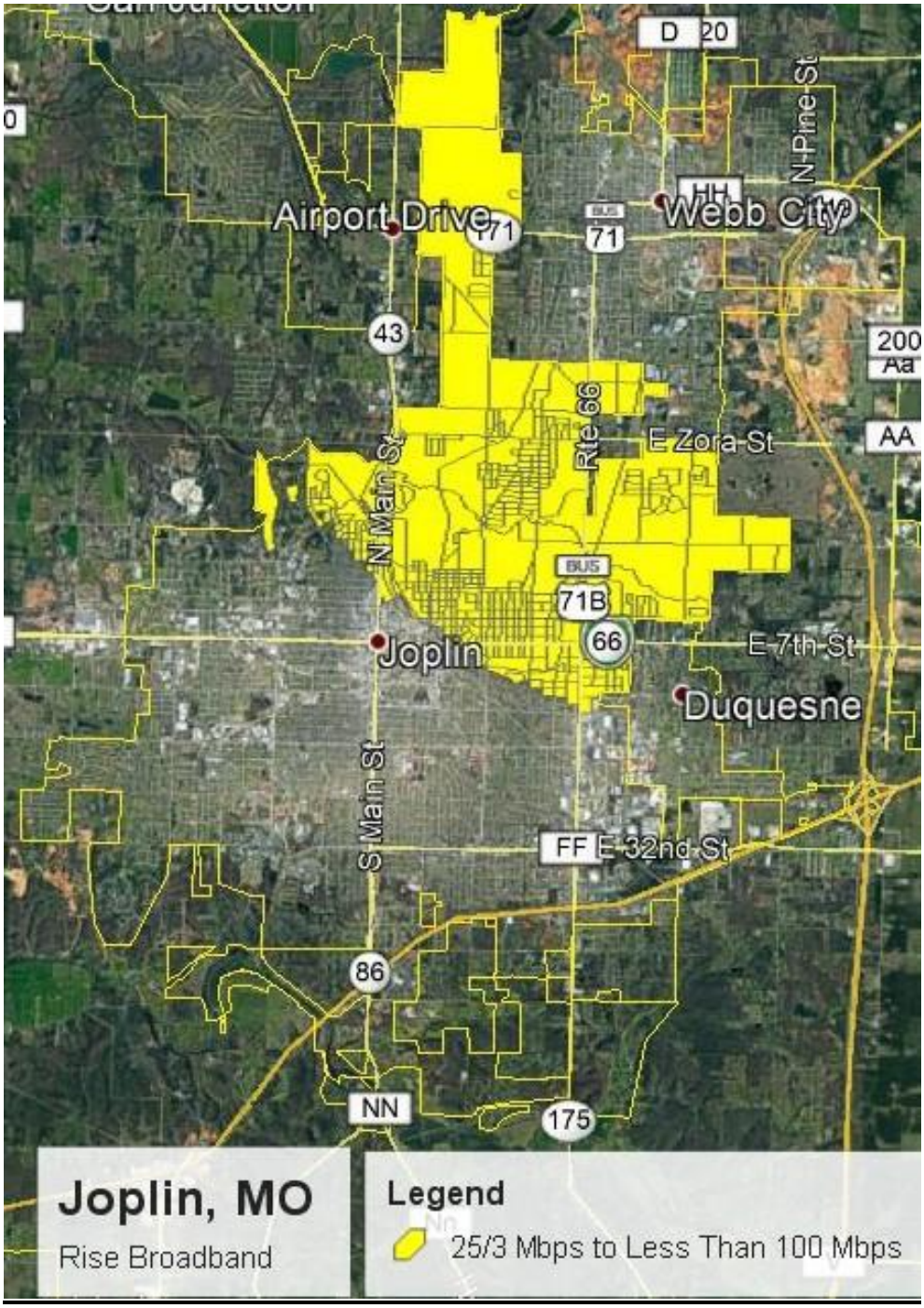
Whisper is another fixed wireless internet service provider that claims coverage over the whole city and much of the surrounding rural areas. According to the FCC 477 data, Wisper reports the availability of speeds greater than 100 Mbps everywhere. We saw Whisper customers responding to the online survey. We note that it's incredibly challenging for a fixed wireless provider to deliver 100 Mbps even in ideal conditions, so we find the company's reporting of speeds to be extremely questionable.

Wisper ISP, Inc. FCC Form 477 Reporting Areas



Rise Broadband

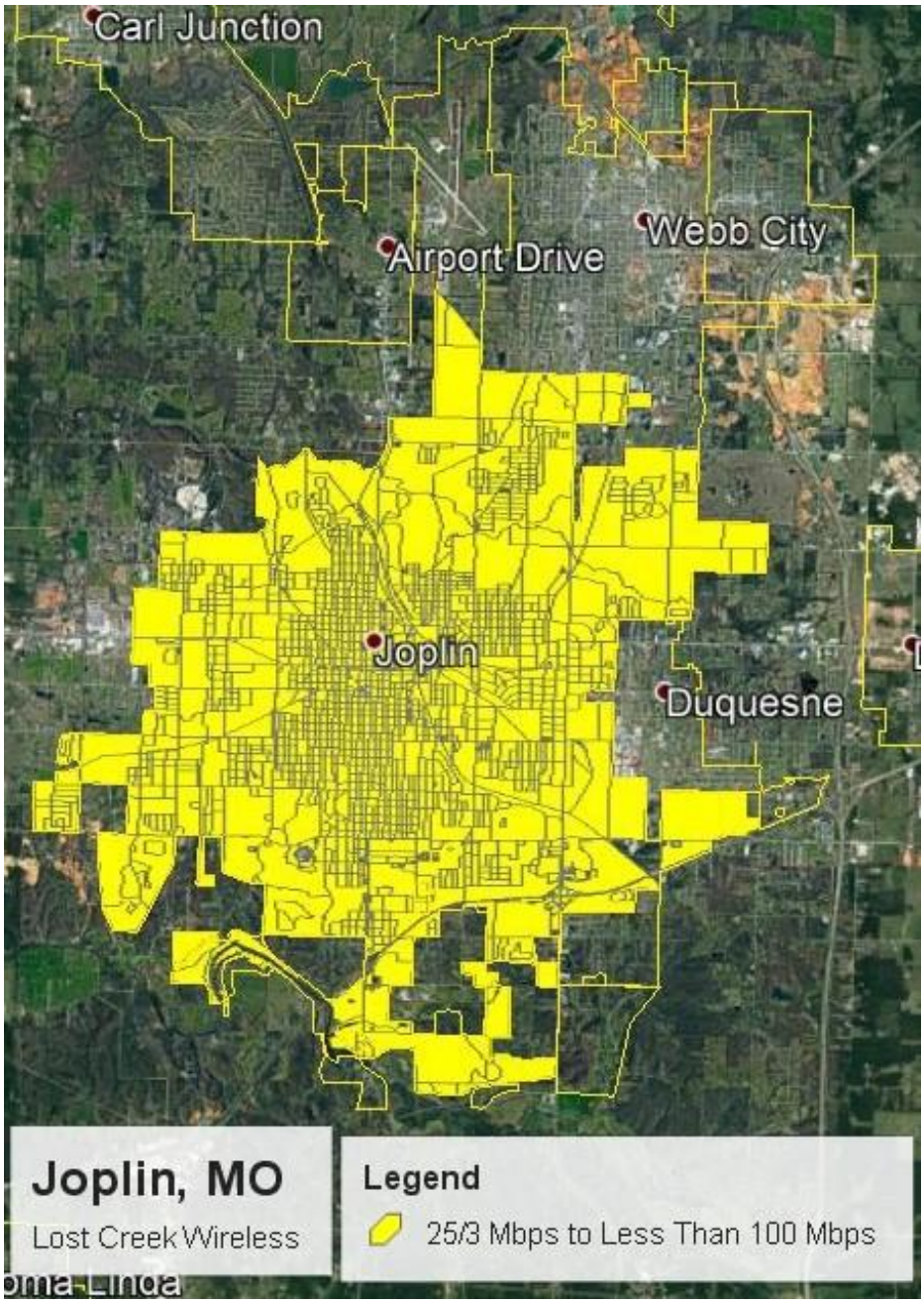
Rise Broadband is a fixed wireless internet service provider that claims coverage over the whole city and much of the surrounding rural areas. According to the FCC 477 data, Rise Broadband is reporting the availability of speeds greater than 25/3 Mbps but less than 100 Mbps everywhere. We did not run into evidence of the company serving customers in the city, although it's likely that they have some customers. We find it unlikely that the company can deliver speeds faster than 25/3 Mbps across the city – something that is technically challenging in urban areas.



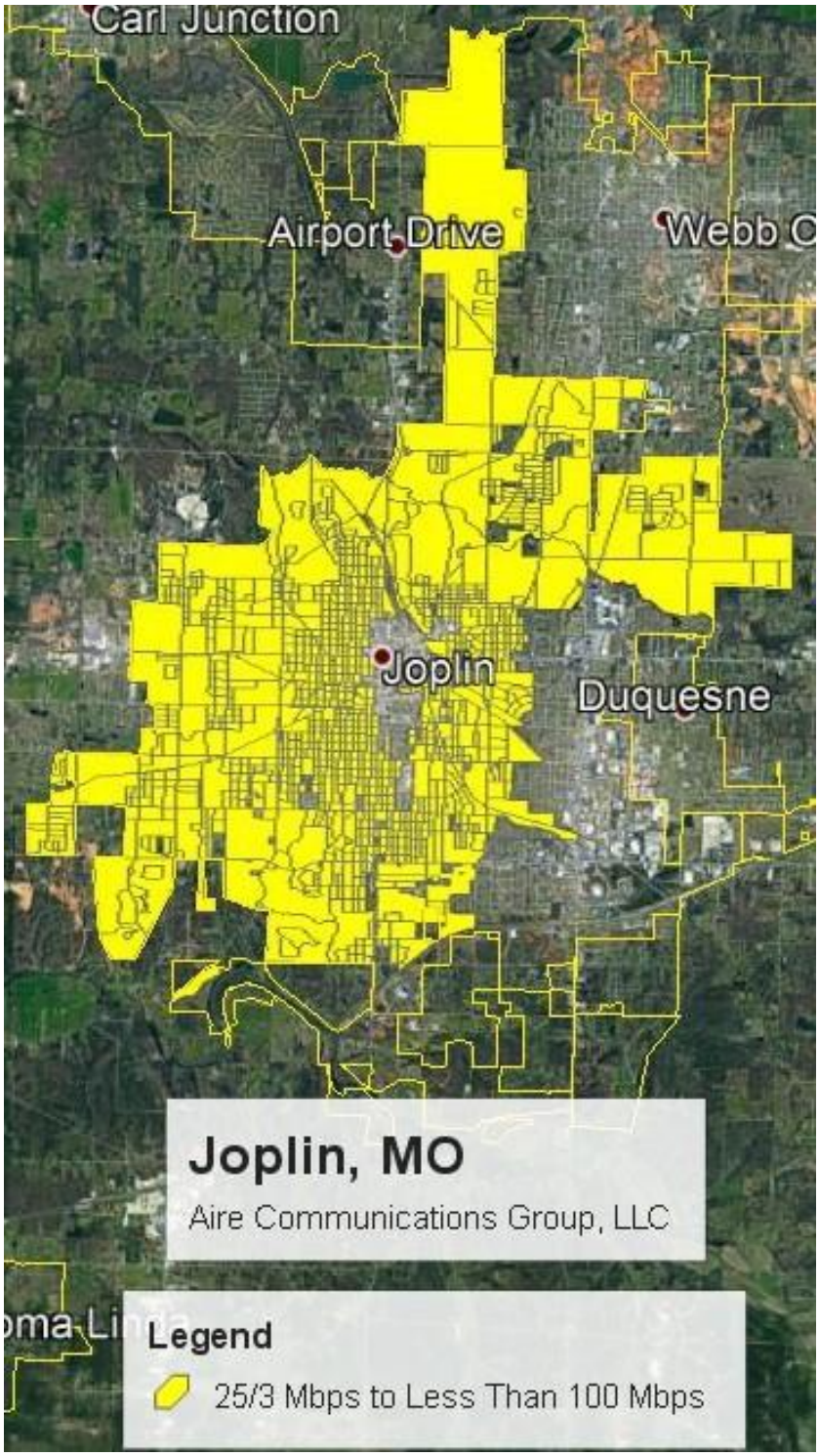
Lost Creek Wireless

Lost Creek Wireless is a fixed wireless internet service provider that claims coverage over the whole city and much of the surrounding rural areas. According to the FCC 477 data, Lost Creek Wireless is reporting the availability of speeds greater than 25/3 Mbps but less than 100 Mbps everywhere. We did not run into evidence of the company serving customers in the city, although it's likely that they have some customers. We find it unlikely that the company can deliver speeds faster than 25/3 Mbps across the city – something that is technically challenging in urban areas.

Lost Creek Wireless FCC 477 reporting areas



Aire Communications Group, LLC is the parent company of Aire Internet, a fixed wireless provider. Aire Internet uses 4.5 LTE technology to provide service to its customers. Aire Internet is available in three states Kansas, Missouri, and Oklahoma. In 2017, Aire Communications Group, LLC purchased Aire Fiber. The company claims to be covering all of Joplin with wireless service.



The Real Broadband Speeds in Joplin

We have no reason to think that Sparklight has not upgraded download broadband to the DOCSIS 3.1 standard. That means that the company can deliver speeds up to a gigabit everywhere. Our experience around the country is that there will be neighborhoods where the speeds will be less that that due to local network issues, but still fast.

There are some homes and businesses in the city that are not connected to the cable networks – an issue that is discussed below.

As can be seen throughout this study, there are still a lot of households and businesses with speeds far below the fastest speed offered by Sparklight. Everybody subscribed to AT&T DSL is seeing speeds far below that threshold, including customers that don't have speeds that meet the FCC definition of broadband. The two cable companies sell basic broadband to a lot of customers, which is 100 Mbps for Sparklight and 60 Mbps for Mediacom. And it's likely that both companies have at least some customers in the city that are grandfathered on older and slower speeds.

But except for a tiny number that can't get cable broadband, the decision to have slower speeds is voluntary since faster speeds are available – just often not affordable.

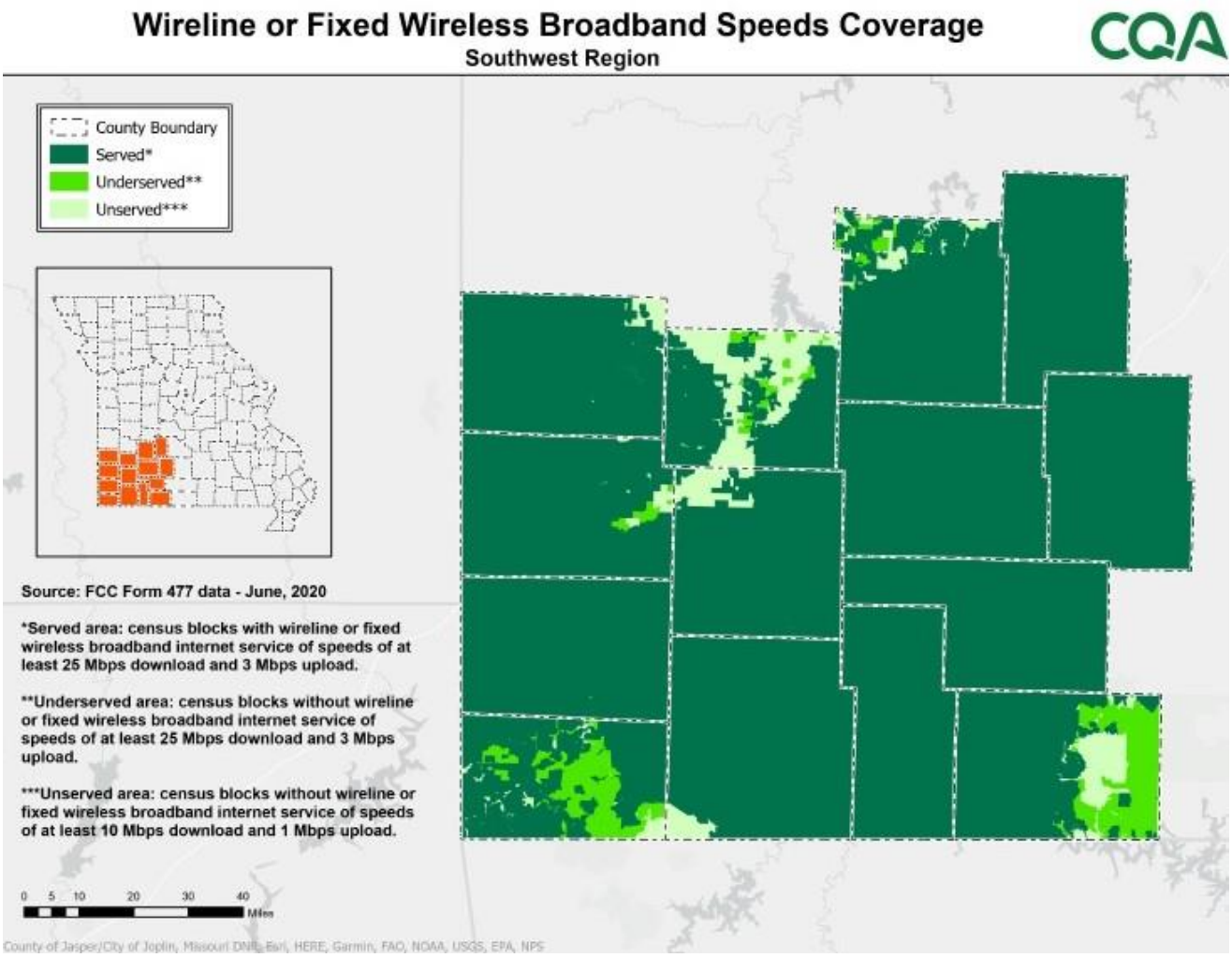
Consequences of Inaccurate FCC Maps

The FCC maps for Joplin are incorrect. This is mostly due to the wireless WISPs claiming coverage of the whole city that doesn't exist and claiming speeds greater than what can be delivered even the wireless service is available. This doesn't create any specific problems for the city since there is fast cable broadband available throughout the city.

But this creates a problem for the region. We heard from business owners and residents who work in the city but live in the rural areas outside the city. They universally told us about poor broadband, often at only a few Mbps in speeds. People living outside the city struggled and largely failed in working and schooling from home during the pandemic.

This is an issue that the city should care about because Joplin businesses employ and rely on many rural residents that have poor broadband. Overstated FCC maps have one significant consequence – areas that the FCC shows as having speeds over 25/3 Mbps are not eligible for some federal broadband grants. The most recent was the $9 billion awarded in December in the Rural Digital Opportunity Fund (RDOF) grants. Most of the areas around Joplin were excluded from receiving funds.

The following map comes from the Missouri Office of Broadband Development. This map shows in the dark green areas that the FCC considers most of southwest Missouri to have broadband speeds over 25/3 Mbps. The map shows that almost all of Jasper and Newton Counties have broadband faster than 25/3 Mbps. We know that there are many places where this is not true. These speeds are mostly due to fast speeds reported by WISPs, which in many cases are overstated.



The FCC is fully aware of the inadequacies of its mapping data, and yet they still cite the faulty data as proof that broadband isn't as bad in rural America as critics might suggest.

The Technology Gap

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

The general speeds available on various technologies is as follows:

- DSL delivered on one copper pair can deliver speeds as fast as 25 Mbps for a mile or two from the DSL transmitter, assuming the copper is in good condition and other factors are ideal. There are older and slower types of DSL deployed that might have maximum speed capability of 3 Mbps, 6 Mbps, 12 Mbps, or 16 Mbps. Copper networks are old, and almost no customer can receive ideal speeds.
- DSL delivered on two copper pairs can deliver twice the speeds. This technology is usually only deployed using the latest types of DSL and has maximum speeds of around 50 Mbps. We didn't see any evidence of AT&T having used this technology in Joplin.

- Fixed point-to-multipoint wireless is capable of speeds up to 100 Mbps, although the equipment and configuration of most networks deliver speeds significantly less than this, sometimes as slow as only a few Mbps. We don't think most of the customers in the city have the option to use the technology.
- A hybrid-fiber coaxial system (used by cable companies) can deliver fast broadband speeds. Networks using the DOCSIS 3.0 standard can deliver speeds up to around 400 Mbps. Networks upgraded to the most recent DOCSIS 3.1 standard can deliver speeds up to a gigabit. Cable companies typically sell broadband products with speeds a lot less than the theoretical fastest speeds.
- Fiber networks also deliver fast broadband. Fiber that's been built in the city uses active Ethernet technology and likely has speeds up to 1 gigabit – although the technology can easily deliver speeds up to 10 Gbps.

Every technology has some limitations in real-life networks that can produce slower broadband speeds. Consider the following factors that can affect the broadband speeds delivered over DSL. These factors explain why AT&T customers are often receiving speeds far slower than the theoretical maximum of 25 Mbps:

- The distance between the customer and the DSL transmitter (called a DSLAM). DSL speed decreases with distance.
- The size of the copper wire serving the customer matters – the larger the gauge of the copper wires, the stronger the DSL signal.
- The quality of the copper wire slowly degrades over time, particularly if the copper gets in direct contact with the elements or with longstanding water.
- The quality of the telephone wiring inside of a home can impede broadband speed.
- The type of DSL electronics used to serve a customer. There are still older DSL technologies in the field that have maximum download speeds of only a few Mbps and newer DSL that can deliver speeds as fast as 48 Mbps.
- The backhaul network that brings bandwidth to a feed the DSL network might be undersized. DSL is like most broadband technologies, and bandwidth is shared between users in each neighborhood. If the total usage demanded by the neighborhood is greater than the bandwidth supplied to the neighborhood, then everybody gets slower speeds when the network is busy.
- And finally, speeds can be impacted by how a customer gets broadband to devices. For example, an old WiFi router can cut down the speed between what is delivered to the home and what makes it to computers and other devices inside the home.

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

The Business Broadband Gap

The vast majority of businesses in the city have the same broadband options as residences. They can buy slow DSL from AT&T or faster broadband from the cable companies.

We know that a few businesses in the city can buy gigabit broadband using fiber. There appears to be fiber built through the main downtown corridor and to a few other selected large manufacturers and businesses

like the hospital. This fiber has not been extended to reach all of the businesses close to the fiber –there are many businesses downtown that have not been offered a fiber option. This is all due to deployment costs where the fiber ISPs only want to sell to premium customers willing to pay a premium price. A small retail store sitting next to a business with fiber in Joplin likely cannot get fiber (nor would it want to pay the price).

It's always been extremely hard to define a broadband gap for businesses. It's easy to define this for businesses that don't have broadband options. For example, a business in Joplin that can buy AT&T DSL but that is not connected to a cable company network would be on the wrong side of the broadband gap. It's likely that there are not a lot of businesses in this situation, but we are sure there are a few – they exist in every market. This is due to the way that the cable networks were built. Years ago, the cable networks were built to deliver only cable TV, and most cable companies didn't build to businesses since they rarely purchased cable TV. Over the last twenty years, the cable company closed this gap by building to most businesses. But there are still some businesses in the city that have never been offered broadband from the cable networks.

It's also impossible to define a business that can't get fast broadband as suffering from a broadband gap. Businesses vary widely in how they use broadband and there are still some businesses that either don't use or, or that use it for rudimentary functions like email and web surfing. Cities are often surprised when they ask around and find businesses that don't care about broadband – the companies in this category grow fewer every year – but they exist.

Microsoft Speed Data

One interesting way to understand that a lot of homes and businesses still have slow broadband comes from statistics provided by Microsoft. The company is in an interesting position when it comes to looking at broadband speeds. The vast majority of computers in the country download sizable upgrade files from Microsoft. Even many Apple computers are loaded with Microsoft Office products like Word, Excel, and PowerPoint.

Microsoft decided a few years ago to record download speeds of software upgrades. There is probably no better way to measure a broadband connection than during a big file download. Most speed tests only measure broadband speeds for perhaps 30 seconds, up to 1 minute. 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 because during a long download, such as one updating Microsoft Office, the user can see the download speeds drop 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 short 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 2019 that 100% of the people in Jasper County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reports that only 52.5% of the downloads made in the county used broadband of at least 25/3 Mbps. The FCC claimed in 2019 that 97.6% of the urban population and 80.4% of the rural population of Newton County had access to broadband of at least 25/3 Mbps. In October 2020, Microsoft reports that only 18.5% of the downloads made in Newton County used broadband of at least 25/3 Mbps. That is an eye-opening difference.

It's important to note that the FCC and Microsoft do not measure the same thing. The FCC measures the percentage of homes that have access and can purchase 25/3 Mbps broadband. Microsoft measures 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 inside the home, such as poor-quality WiFi routers.
- The burst technology can be a huge factor. What's the real download speed for a home buying 100 Mbps download broadband from a cable company if speeds drop below 25 Mbps after a minute?
- In rural areas, the biggest difference is probably due to the ISPs overstating the speeds to the FCC.

The differences noted by Microsoft are likely to become material over time as homes and businesses now often use broadband streams that last for a long time – as opposed to the bursty data we used in the past that was largely satisfied by burst technology. Any connection to a school or work server ties up bandwidth for the duration of the connection. We see more technologies, including gaming at homes and vendor portals at businesses that create long VPN connections.

Take the example of a business that has twenty employees connected to the server all day from home. That business is likely eating a non-stop 50 Mbps of broadband in both the upload and download direction all day – something they didn't do in the past – but something that might kill broadband for other purposes. Both DSL and cable company broadband technologies have slow upload speeds, so these kinds of activities and connections can kill a company's broadband connection and capability.

The Gap in Broadband Availability / Adoption

Broadband Availability

As mentioned above, there are likely some homes and businesses in Joplin that have limited broadband availability.

First, any neighborhood served only by AT&T can no longer be said to have any broadband option. AT&T won't connect a new customer. That means if somebody suddenly needs to work or attend school from home, AT&T won't connect them. I've heard stories of people who say that once DSL is disconnected for any reason that the company won't reconnect it. If somebody buys a house served only by AT&T, the new owner can't get DSL, even if the old owner had it. If somebody gets disconnected for late payment, they aren't being allowed to reconnect. I heard stories lately of customers who had technical trouble with DSL who have been told that the company can't and won't fix it.

Every market has homes and businesses that are not connected to the cable network. There were always reasons in the past why the cable company didn't build to a given area:

- An apartment building was already being served by somebody else like AT&T, and the landlord wouldn't let the cable company onto the property – landlords are not required to give access to ISPs. This is also a common occurrence for business buildings. An apartment or business building landlord might have some financial incentive to keep out other ISPs or might just not like a given ISP. We still occasionally run into a low-income apartment building where the landlord hasn't allowed any ISPs.
- When cable networks were originally built in the 1970s, the networks were built to serve only cable TV and were constructed in residential neighborhoods. This often meant that neighborhoods or streets that were primarily businesses never got wires from the cable company. Any residences that were sprinkled in such neighborhoods also were never offered cable. Since then, cable companies have embraced offering broadband to businesses, but in doing so, rarely build to every business in a city. We know of businesses in Joplin that are not connected to a cable network.
- Most cities have a few places that are extremely high cost to reach. This might be places that have very long driveways or places tucked into a geographic corner that are hard to affordably reach with new wiring. There are also places where the original utilities were buried where a cable company will decide it's not worth the cost of construction.
- Finally, many cities still have some private roads that are owned by businesses, landlords, or homeowner associations. Such road owners could forbid construction that disturbs road surfaces or demand high rights-of-way fees. The inability to use private roads could mean that customers that can only be reached through private roads also can't be reached,

We did not attempt to identify such places in the city as part of this study because it's incredibly difficult to do so. There are not going to be whole neighborhoods in the city that aren't connected to the cable network – rather a business here, a few homes there, maybe an old apartment building. In large older cities, this can amount to a significant number of places, and we've heard estimated in big cities like Dallas that 5% or more of homes can't connect to a cable provider. The smaller the city, the likely smaller the percentage of such homes – but it's inevitable that some exist. The cable company might be straightforward and agree to provide such a list – but we've never of one voluntarily doing so because the franchise agreement with the city likely requires a connection everywhere.

Broadband Adoption

The broadband adoption gap is when homes can get broadband but elect for some reason not to use it. 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.[10] The survey says there are around 28 million households in the U.S. that don't use broadband at home. The report below looks at some of these reasons. In rural areas, there are still homes that can't get any broadband option to work. The reasons residents in cities don't buy broadband are:

- Broadband is too expensive.
- Computers or other devices are too expensive.
- Residents don't have the literacy to use broadband.

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

- Residents are satisfied with free alternatives such as using broadband on a cellphone, at work, or in public places like a library.
- Finally, some people have no interest in using the Internet.

Comparing Joplin with the Rest of the World

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

FCC Adoption Rate

It's worth first looking at how Missouri compares to other states. In the 2020 annual report to Congress, the FCC reported on broadband adoption by various speeds by state. The adoption rate is the percentage of households that have purchased broadband that meets or exceeds various speed thresholds. For some reason that is not explained well, in the 2020 broadband report to Congress, the FCC reported broadband adoption rates for 2018. This means two things. The overall adoption rates are understated because we know that the overall number of homes buying broadband has been increasing every year. However, since the data used in the FCC report comes from the Form 477 data, the percentage that are buying a given speed is likely overexaggerated. That makes for some confusing results, but since the same issues affect every state, the overall rankings of broadband adoption by state are probably reasonable.

In the 2020 annual report to Congress, the FCC reports on broadband adoption by various speeds by state and 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	60.6%
Homes buying at least 25/3 Mbps	52.3%
Homes buying at least 50/5 Mbps	49.5%
Homes buying at least 100/10 Mbps	42.4%
Homes buying at least 250/25 Mbps	7.2%

To put the FCC numbers into perspective, the percentage of homes that get at least 10/1 Mbps broadband (60.6%) puts Missouri at the lower end of broadband adoption compared to other states. Only Alabama (59.3%), Arkansas (51.8%), Idaho (53.6%), Iowa (56.8%), Kentucky (59.7%), Mississippi (48.2%), New Mexico (50.4%), Oklahoma (58.2%), and West Virginia (55.2%) are lower than Missouri. The highest adoption rate is in Delaware, with 90.1%.

FCC Availability of Broadband

The FCC also looks at the availability of broadband by county, meaning the percentage of homes that are able to buy broadband at various speeds. Here's what the FCC reported to Congress in 2020 about the Joplin area:

Jasper County

Urban population:	90,038
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%

% with both	100%
Rural population:	30,584
% that can buy at least 25/3 broadband	100%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	100%

Newton County

Urban Population:	20,446
% that can buy at least 25/3 broadband	97.6%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	97.6%
Rural population	37,800
% that can buy at least 25/3 broadband	80.4%
% with 4G LTE coverage at 5/1 Mbps	100%
% with both	80.4%

The FCC data might be true for towns, although we've found that there are often small pockets of most medium and larger towns that are not reached by the cable companies.

The rural percentages are startling because the FCC data shows that 100% of the rural parts of Jasper County and 80.4% of Newton County can buy 25/3 Mbps broadband. We were told by multiple people that broadband speeds drop quickly in the surrounding rural areas. Houses that are right past where the cable network ends are unlikely to be able to buy 25/3 broadband. The poor reporting to Congress is due to ISPs that overstate broadband speeds to the FCC. But the statistics above is what is being told to elected officials.

Comparing Joplin with the Rest of Missouri

The broadband coverage in Missouri varies widely. There are three counties in the state – Bollinger, Ozark, and Schuyler – for which the FCC say there is less than 10% broadband coverage. In total, Missouri has 18 counties with less than 50% coverage.

According to the FCC data, Jasper and Newton counties have one of the higher amounts of broadband coverage in the state. As mentioned throughout the report, the broadband coverage claimed by the FCC looks high to us, but it's likely overstated for much of the rest of the state as well.

How Does the U.S. Rank with the Rest of the World?

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

The most recent report on broadband speeds is from 2019.[11] The rankings are based upon many millions of speed tests, and the 2019 average download speed for the U.S. is based upon over 132 million speed tests. The U.S. ranked 15th in the world in 2019 with a national average download speed of 32.89 Mbps which is behind countries like Taiwan, Singapore, Sweden, Denmark, Japan, Netherlands, Spain, Norway, Belgium, and others. The average speed in the U.S. has been increasing and was 25.86 Mbps in 2018 and 20.00 Mbps in 2017. During that time, the U.S. climbed from 21st fastest to the current rank of 15th. The speed increases are largely due to upgrades in speeds in urban areas by cable companies, although there are also fiber-to-the-home builds in both urban and rural markets across the country.

The Gap in Broadband Affordability

The FCC reports that overall broadband adoption for the country is around 87%. 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 that do not buy it. Numerous studies and surveys have shown that the primary reason for not buying broadband is price – people say they can't afford broadband.

Statistics on Affordability

In larger cities, it's somewhat easy to equate broadband penetration rates to household incomes. This is because in larger markets it's possible to match Census data to broadband data from the FCC.

The FCC included the following table in the 2020 report to Congress. This comparison of FCC 477 data and Census data shows a strong correlation between household income and having a home broadband connection. The table shows that only 38.4% of households in the lowest quartile of earnings buy broadband of at least 10/1 Mbps. The percentage that buys faster broadband speeds drop to only 4.7% of households buying broadband of at least 250/25 Mbps. The table shows that broadband adoption rates rise with income.

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%
Household Poverty Rate					

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

There are studies available for those who want to dig deeper into quantitative and qualitative research into broadband affordability for low-income households. The first was published by the Benton Foundation and authored by Dr. Colin Rhinesmith.[12] The second report is issued by the Quello Center and is authored by Bianca Reisdorf.[13] This report looks at a study conducted in three low-income neighborhoods of Detroit.

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

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

Demographics in Joplin

The various studies all suggest that demographic factors are a big influence on whether homes can afford broadband. This section of the report looks at some of the key demographics in Joplin. These statistics are based on the 2010 Census that has been updated with estimates to as recent as 2019. The detailed 2020 Census data probably won't be released until early 2022.

- Population Growth. The Census estimates that the city grew by 0.3% of its population between 2010 and 2019. Missouri as a whole grew by 2.5%.
- Population Ages. The city and the state have virtually identical population demographics in terms of the average age of the population – with nearly the same percentage of persons under 5 years old, persons under 18, and persons 65 and older.
- Homeownership. There is a significantly lower percentage of homeownership in the city at 57.7% than the State average of 66.8%. The average home in the city costs $125,900 compared to the state average of $157,200.
- Education. The percentage of those with a high school diploma at 89.6% is nearly identical to the state average of 89.9%. The percentage with a bachelor's degree or higher at 26.5% is lower than the state average of 29.2%.
- Disabilities. The percentage of adults with a disability at 11.2% is slightly higher than the state average of 10.3%.
- Income. Median household income at $45,449 is 82% of the statewide average of $55,461. Per capita income at $26,448 is 86% of the statewide average of $30,810. The percentage of homes living in poverty at 18.2% is significantly higher than the statewide average of 12.9%.

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

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

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

Many of the demographic factors indicate the likelihood that many households probably have a hard time affording broadband. Perhaps the most important factor is the poverty rate at 18.2%, which is significantly higher than the statewide average. This finding is reinforced by the finding in the statistically valid survey that 19% of homes in Joplin don't have home broadband.

Comparing U.S. Broadband Prices to the World

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

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

Low-Income Broadband Programs

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

Mediacom (Connect 2 Compete)

Mediacom has a low-income program called Connect 2 Compete that provides broadband to qualifying households. The program offers speeds of 25 Mbps and a free modem. Mediacom provides Connect 2 Compete for $9.95 per month.
Qualifying households must have at least one student in grades K-12 living at home and at least one child who qualifies for free or reduced-price school lunch through the National School Lunch Program (NSLP).

Sparklight

Sparklight did not historically have a low-income product. At the start of the pandemic in March, 2020, the company offered a low-income product that provided 15 Mbps download for $10 per month to qualifying families. This plan was originally slated to last for sixty days but got extended during the pandemic year.

Sparklight currently participates in the FCC's EBB program.

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

AT&T.

The company once participated in the FCC's Lifeline program. However, the company dropped the low-income product after the state granted them a petition to be unregulated for basic telephone service.

Federal Lifeline Program

Rise Broadband participates in the FCC's Lifeline program that is part of the Universal Service Fund. With the program, a customer can receive a discount in Missouri of $9.25 per month off a telephone bill or a broadband bill for qualifying customers. The program works by the ISP providing a discount to customers and the FCC then reimburses the company for the discount. This means it costs an ISP nothing to offer the discount – the discount is funded by the FCC.

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

FCC Emergency Broadband Benefit (EBB) Program.

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

The EBB provides a discount of up to $50 per month towards broadband service for eligible households. Eligible households can also receive a one-time discount of up to $100 to purchase a laptop, desktop computer, or tablet from participating provides if they contribute more than $10 and less than $50 toward the purchase price. The Emergency Broadband Benefit is limited to one monthly service discount and one device discount per household.

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

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

For a household to get this discount, its ISP must be a plan participant. Both cable providers in the city are participating in this program. The infrastructure that was recently passed by the Senate, but which is not yet law, adds many billion to this plan to carry it into the future.

The Computer Gap

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

A survey by Pew Research Center in 2019 shows a huge disparity between income and technology adoption. Consider the results of that survey:

	Less than $30,000	$30,000 to $100,000	Over $100,000
Home Broadband	56%	81%	94%
Smartphone	71%	85%	97%
Desktop	54%	83%	94%
Tablet	36%	55%	70%
All the Above	18%	39%	64%

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

A big problem for low-income homes is that they can't afford both broadband and the cost of buying and maintaining a computer or similar device. Computers are some of the shortest-lived electronics we can buy and typically must be replaced every 3 or 4 years.

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

The historical solution for homes that don't have a computer has been to put computers in libraries and public places. However, this solution is inadequate for many reasons. This 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 public computers to meet the demand. The best reason for getting 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 part of daily life and are convenient to use when needed.

We can't forget that computers aren't only for students. Adults need computers today just to participate in the modern world. Computers are needed to hunt for a job. Computers are needed to pursue online training and education. Computers are needed to work from home. Computers are needed today to interface with many government programs. In the recommendation section of the report, we'll discuss different approaches that communities have tried to solve the computer gap and the digital divide.

The Gap in Broadband Skills

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

Workers with technical skills are faring extremely well. For example, starting jobs for computer, engineering, and similar tech graduates are at an all-time high. It's a good time to be a high-tech worker. However, over half of all job openings in the country are classified as middle-skill jobs (with the three categories being high-skilled jobs, middle-skill jobs, and unskilled jobs). These jobs generally don't require a college degree. An analysis by the Benton Foundation a few years ago showed that over 80% of middle-skill jobs require some degree of digital literacy. Unfortunately, a lot of people seeking middle-skill jobs lack the digital skills needed to land these jobs.

This lack of sufficient digital literacy to find middle-skill jobs is perhaps the best way to describe the broadband skills gap. These are not jobs that need coders, but rather 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 perform other expected tasks in the average workplace.

In the early days of the computer age, the federal government operated many training programs that taught basic computer skills. Today it seems to be assumed that students graduate from high school with these skills. However, a student who has never had a home broadband connection or a computer and who only does homework on a cellphone probably doesn't have the needed digital skills. Since the federal and state governments don't typically offer training in basic computer literacy it's up to local communities to find solutions.

Earlier this year I interviewed Deb Socia, who heads the Enterprise Center in Chattanooga, Tennessee. This is a non-profit that is looking for ways to solve the digital divide in the city. Chattanooga is a city that has invested in broadband and offers gigabit broadband on fiber to every resident of the city. However, like in all cities, they found out that low-income homes couldn't afford broadband, didn't have computers, and didn't have the digital skills needed to use a computer. The Enterprise Center began offering basic computer training a few years ago and was overwhelmed by the huge number of people who wanted basic training.

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 our world of online misinformation, I would think that percentage is even higher today. Pew showed that 54% of adults are interesting in training that to better use the Internet.

Future Broadband Gaps

This gap analysis so far has discussed existing broadband gaps. It's important to realize that there will be new broadband gaps coming in the future that we can already predict. One of the issues to consider when looking forward is that broadband speeds are a moving target – that is, the demand for residential and business bandwidth grows every year. This is not a new phenomenon, and the need for bandwidth has

been growing at nearly the same rate since the early 1980s. Home and business need for bandwidth has been doubling every 3 to 4 years since then.

As an example, 1 Mbps DSL felt really fast in the late 1990s when it was introduced as an upgrade from dial-up Internet. The first 1 Mbps DSL connection was nearly 20 times faster than dial-up, and many people thought that speed would be adequate for many years. However, over time, households needed more speed, and the 1 Mbps connections started to feel too slow; ISPs introduced faster generations of DSL and cable modems that delivered speeds like 6 Mbps, 10 Mbps, and 15 Mbps. Cable modem speeds continued to grow in capacity and eventually surpassed DSL, and in most cities, the cable companies have captured the majority 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 broadband speeds by examining Internet traffic that passes through the major Internet POPs. Both companies estimate that home internet need for bandwidth downloading as well as the need for broadband speeds are growing currently at about 21% annually. Business use of bandwidth is currently growing at 23% annually.

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

Download Speeds in Megabits / Second

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

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

If we accept the premise that 25 Mbps was the right definition of broadband in 2015, then it's reasonable to believe that the definition of download broadband today ought to be at least 60 Mbps. That would infer that there is a broadband availability gap today for any household that can't buy 60 Mbps broadband.

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

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

This data shows several things. First, it shows extraordinary growth in the average use of broadband across the city. 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 15%.

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

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

4th Quarter 2018	4.0%
4th Quarter 2019	7.3%
1st Quarter 2020	10.0%
4th Quarter 2020	14.1%

Within these numbers are also what OpenVault calls extreme power users, which are households that use more than two terabytes of data per month. Power users were 0.3% of all households in 2019 and grew to be 1% of all households by the end of the third quarter of 2020. Extreme power used doubled in the fourth quarter of 2020 to 2.2% of all households.

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

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

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

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

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

Greater than 2 TB	0.1%	0.4%	1.0%	1.5%

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

The OpenVault data validates what has 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 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. People who have learned to videoconference during the recent months are likely to continue that practice in 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 good evidence that the FCC should be periodically increasing the definition of broadband. The agency looked at broadband speeds in a docket in 2018 and concluded that they were going 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 discussion is that we can't get hung up on the FCC 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 is also important to look towards the future when considering broadband needs. For example, if an ISP builds a new broadband solution today, that solution should be prepared to handle the broadband requirements a decade from now. Consider the following chart that predicts broadband needs moving forward. This applies the 21% historical annual growth rate for bandwidth to the broadband speed predicted by cisco for 2020. Forward predictions are always criticized for being too aggressive, but when considering that the need for broadband has been growing at roughly the same rate since 1980, it's not a big stretch to predict broadband needs into the future.

Download Speeds in Megabits / Second

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

The download speeds in this table get really large if extended even further into the future. If the demand for broadband download speed continues to grow at 21% annually, then the need in 2030 would be 438 Mbps, in 2035 would be 1.1 Gbps, and in 2040 would be 2.9 Gbps. It's easy to say that such future speeds are not possible, but recall that just 20 years ago, a 1 Mbps DSL connection was considered a blazingly fast broadband connection. A fiber network will be able to keep up with this kind of future demand. There are already affordable fiber electronics today that can deliver 10 Gbps broadband to residential customers.

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

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

One of the conclusions that can be reached by this analysis is that any new network built today ought to be capable of meeting the expected broadband speeds of the next decade. The only technologies capable of meeting the projected future needs for bandwidth are fiber-to-the-premise, cable company hybrid-fiber technology, and some wireless technologies using millimeter wave spectrum that are just now being trialed in a few markets. Cable companies will only be able to provide speeds above 1 gigabit by implementing another round of expensive upgrades to DOCSIS 4.0.

II. ENGINEERING DESIGN AND COST

A. Network Design

There are several major design parameters to consider when designing a fiber network. These include:

- Aerial versus buried fiber design
- Type of construction to be used
- The type of electronics to be used
- Local factors

Aerial versus Buried Fiber

After discussions with the city, we ended up only studying a 100% buried fiber network. This makes a lot of sense after considering the huge damage a few years ago from the tornado. There would have little damage to a buried fiber network from that storm.

There can be a significant cost differential between the two construction methods depending upon local conditions. A lot of the fiber network would have been buried in Joplin in any network design since it's typical to bury fiber where other utilities are already buried. In cities like Joplin, where there are already a lot of wires on existing utility poles, the cost differential between aerial and buried fiber is not a prohibitive cost difference. When building aerial fiber, the new fiber builder has to pay other utilities to move existing wires higher or lower on poles to accommodate the new fiber. This process, known in the industry as make-ready, can add a significant amount of cost to building aerial fiber.

There is one issue that heavily favors building buried fiber. The make-ready process is time-consuming since it involves interfacing on a pole-by-pole basis with the pole owner and the other utilities. This process can easily add six months to a year to the construction process compared to burying fiber.

Burying fiber avoids catastrophic fiber damage due to events like the tornado. But buried fiber comes with other risks. Buried fiber is most often damaged by fiber cuts from somebody digging in the streets or rights-of-way. Cities that own extensive fiber networks want to have strictly enforced locate rules and big penalties for contractors that disrupt other utilities. However, there are times, like with an emergency gas leak, where fiber is broken for expediency purposes.

One of the biggest issues with buried networks is providing access to the network. An access point is a place where a fiber drop from a customer is connected to the main fiber network. It will be described below, but the type and location of access points can be an issue with homeowners.

One last issue to consider with burying a network is that private landowners are not required to grant rights-of-way for fiber construction. Most cities contain some private rights-of-way. This might be long driveways to reach an apartment complex or a subdivision that owns its streets. Invariably there will be some private rights-of-ways owners that don't want any construction that will disturb streets. Since most places want fiber, we don't see fiber kept out of many neighborhoods – but there are invariably a few such places.

There are special circumstances in every city that can make it more expensive and time-consuming to build fiber. For example, it's often expensive and time-consuming to gain the needed rights-of-way to build fiber across bridges, under railroad tracks, or under freeway overpasses. There are often complicated rules that must be followed to build fiber through state and national parks and forests. We know of states where the Department of Transportation adds burdensome rules to build along state highways, even if those highways run through the city.

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

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

Construction Methods to be Used

The biggest cost component of deploying fiber is labor. From a material cost perspective, the costs of materials are similar between aerial and buried construction. Buried construction costs include the extra cost of conduit. However, there are also added costs for aerial fiber construction, including the cost of pole mounting hardware and the cost of extras like shielding against squirrel damage.

Labor costs vary around the country due to differences in hourly wages. The difference in local wages can be a big factor in choosing between the different construction methods. Following are the different types of fiber construction mostly seen in a market. The different construction methods are generally chosen to meet two criteria. The first is customer density, and different methods are used in towns versus along rural highways. The more important consideration is the condition of the soil and substrate under highways. Burying fiber can be extremely expensive in soil that contains a lot of rock. But even in rocky areas that may be existing roads where the substrate was excavated during the initial road construction, and in such places, it might still be relatively easy to bury fiber.

Trenching. This is buried construction where a ditch a 12-inch-wide ditch is dug in the street or along the side of the road, the fiber is placed in the open ditch, and then the ditch is refilled. This is generally the most expensive type of construction, particularly if ditches have to be dug in city streets – the cost of digging and then replacing asphalt can be costly. Trenching is disruptive, and streets must be blocked off until a new surface has been poured and cured in the ditch. Trenching is typically used only in situations where other methods of construction won't work. In a typical urban build, you would expect less than 1% of the total construction to involve trenching.

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

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

Microtrenching. This involves digging a 1 inch wide by 8- to 12-inch-deep trench in the street, putting in the fiber, and then refilling and sealing the hole.

To be conservative, the design in Joplin assumes 100% boring. There might be some parts of the city where a less expensive construction technique might be used. But even in the ideal case, most of the network would be bored.

Electronics Design

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

GPON / XGS-PON – Passive Fiber Technology

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

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

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

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

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

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

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

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

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

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

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

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

PON Advantages

- No electronics in the field. PON uses passive splitters to distribute the bandwidth over the fiber to the customers. There are only two active components in the PON distribution network – the Optical Line Terminal (OLT) and the Optical Network Terminal (ONT). The OLT sits in an environmentally controlled hut or building, and the ONT sits on the side of the home or inside of the home.
- Less field maintenance and more reliability. Because PON uses passive splitters in the field, there are fewer powered network elements in the distribution network. This equates to less maintenance, fewer field personnel required, more reliability, and fewer managed network elements in the distribution network. A PON network also means less land and rights-of-way required due to less need for large powered huts.
- Less fiber needed. PON uses significantly fewer fibers than an active system. A PON network carries up to 64 customers (we recommend not more than 32) on one fiber, while an active network needs a home run fiber for each customer. Less fiber means lower capital costs, less loading on poles, quicker fiber installations with less splicing, and smaller fiber management systems.
- Higher density electronics. Because PON electronics have only one optical port for every 32 customers, the PON chassis in the OLT can serve a large number of customers in a small space. This means less space for electronics, less power usage, less air conditioning, and reduced backup power requirements.
- Ability to still use active Ethernet. Most PON manufacturers offer the option to serve some customers on active Ethernet in the same chassis by the use of a separate core card.
- Location Flexibility There are a lot more options for locating passive devices and placing them close to customers. Network owners can deploy both large, centralized splitter sites and widely distributed tiny splitter cabinets.
- Takes the best advantage of oversubscription. All of the customers in a neighborhood node share the bandwidth delivered to the node. This is a more efficient use of bandwidth than sending a dedicated amount of bandwidth to each customer.

PON Weaknesses

- Distance Limitation. Customers have to be within 12 miles of the OLT core electronics. This can present a challenge in large rural networks.
- More Complex Engineering. Because of distance limitations and splitter requirements, a PON network requires an engineering plan to make sure that the OLTs and ONT operate within the limitations of the network. This is not a major issue since industry engineers are well versed in designing PON networks.
- More customers are affected by a single fiber cut. Cutting one neighborhood fiber could put up to 32 to 64 subscribers out of service.

Active Ethernet (Active E**)**

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

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

Active Ethernet Strengths

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

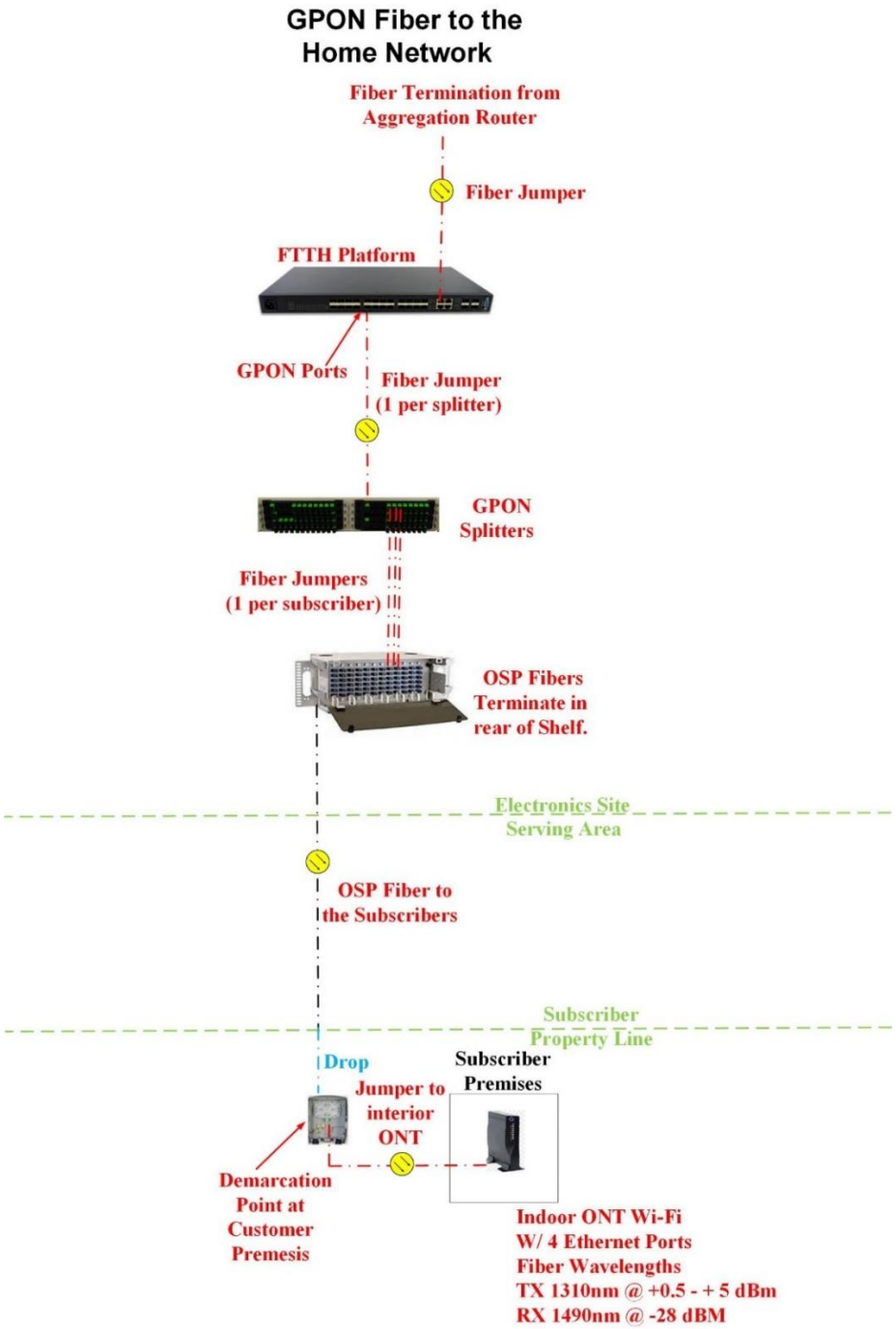
Active Ethernet Weaknesses

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

Finley Engineering chose passive technology as the best electronics solution for Joplin.

Network Configuration

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



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

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

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

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

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

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

PON Cabinet. Associated with a splitter cabinet is a PON cabinet. The cabinet is used to neatly arrange and manage the fibers coming into or out of the splitters to make it easy to identify the specific fiber serving each customer. The primary purpose of the PON cabinet is to accumulate customer connections at strategic points with the design goal that no fiber in the network needs to be larger than 288 fibers. The PON cabinets in the design are of varying sizes that depend on the customers served from a given hut location. These cabinets are usually sited in areas adjacent to road access. The exact location of PON cabinets would be determined as part of the detailed fiber plant design.

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



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

The customer drop is typically a small-count fiber (two to six fibers). There are two primary methods to connect a drop to the network. First is fusion splicing where the glass in the drop is melted and fused to the class on the network. The splices are housed in a splice case that is sized for each location depending upon the number of homes or businesses that can be served. Splice cases are installed everywhere in the network to provide future access for connecting customers – even in locations where there are homes or businesses that might not initially take service.

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

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

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

Some companies still put the ONT on the outside of the home to give their technicians 24/7 access to the units. Other ISPs prefer indoor units since they are protected from the weather. The industry is split on this choice, but it appears that internal units are becoming the most predominant choice for new

construction. One major benefit of an indoor ONT is that the device is paired with an indoor WiFi router to provide good wireless connectivity within the home.

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

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

Regardless of the type of ONT (indoor or outdoor), it will be necessary to drill through the side of the home to bring wiring. ISPs have widely differing ideas on the best way to do this – but most ISPs look for the installation method that requires the least amount of work inside of the customer premise. Much of the wiring needed inside a premise is driven by trying to get wires to a cable TV settop box, but our models assume that ISPs won't be offering traditional cable TV.

Fiber Design Parameters

The engineering study looks at building fiber to pass every home and business. The design of fiber networks and the associated electronics are fairly straightforward, but every network differs in the details of how the network will be deployed, the method of construction, geography, topography, the number of customers, and the long-term goals of the fiber provider. Below is a description of the local factors that affect the specific fiber design.

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

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

Finley Engineering primarily used the city's provided address points and sewer line information to understand passings. The GIS records were in enough detail that we could understand the density of passings in any part of the city. Our engineering software plotted every passing into our design system, and this helped to determine the size of the fibers that were needed to serve any particular neighborhood.

We counted passings as followed in the city:

Passings	
Single-Family, Duplexes, Townhouses	17,636
Larger Apartments	3,297
Businesses	2,564
Total	23,497

The passings include:

- The first category consists of single-family homes, mobile homes, duplexes, and townhouses. In an engineering design, each of these units is likely to have a separate fiber drop and a separate customer ONT.
- Larger apartments for the above count any residential building with three or more living units. See the fuller description below about serving MDUs (multi-dwelling units).
- Businesses. The passing data included a detailed listing of business locations – something we often don't get, and this category includes standalone businesses, churches, government buildings, schools, utility barns, and any other structure for which there might be a need for a fiber connection.

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

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

Finley utilized standard fiber cable sizes for the fiber network design; the fiber cable sizes used were 12, 24, 48, 72, 96, 144, and 288 fibers in a bundle. We always try to design using standard fiber sizes since such fiber is more readily available from contractors and vendors. Standard-sized fiber is also generally priced more competitively.

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

The study looks at the cost of building fiber in every part of the study area. The fiber designed shows that 309 miles of fiber must be constructed in the city. This is not the same as the number of miles or streets. Finley generally tries to follow city streets, but sometimes sees a lower-cost solution by building through alleys or any shortcuts already taken in the city by other utilities. The fiber design also excludes parts of the city that don't need fiber, like the University Campus and inside of parks.

Connectivity to the Outside World. There seem to be several good options in Joplin for connecting a fiber network to the Internet. The nearest major internet connection is in Kansas City. The second nearest is in Dallas. The ultimate network design will have connectivity in both of those directions so that a major outage in one area would not isolate a local fiber network. For example, if only one fiber leaves a new Joplin network going to Kansas City, then any fiber cut along that route would knock the entire network out of service.

Electronics Parameters

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

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

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

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

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

Distributed Design. The size of the city makes it impractical to serve all of the customers out of one electronics site. We elected to use a distributed fiber network design. We subdivided the town into five construction and electronics sectors. We arbitrarily chose five existing city locations that could act as a site for an electronics hub. The designs located an electronics hut near to a firehouse, a library, in Gavin Park, in Cunningham Park, and at Public Works. These sites are arbitrary, and five different sites could be chosen to still achieve the same network at the same cost.

Our design includes the assumption that there would be two core cuts that could each act as a network hub if one of the hubs went out of service for some reason. The natural primary hub would be at Public Works,

and any other the other four huts could be equipped to act as a secondary core. Each of the two core huts would be connected to transport to reach outside the city to the Internet.

There were a few reasons to choose the distributed network:

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

We elected to huts for each of the five neighborhood hubs. It might be possible instead to place electronics inside of public buildings. But standalone huts generally provide the most security. The huts come as prefabricated units that are already filled with racks and electronics. Each hut includes batteries that provide up to eight hours of emergency power in case of a power outage. Each hut was designed with a standby electric generator in the case of a prolonged power outage. The huts house the OLT, which is the core electronic platform for communicating with customers.

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

Distributed Splitter Design. We elected to use a distributed splitter design. A splitter is a passive device that splits one fiber to connect to 32 fibers to reach customers. This is the "passive" device in a GPON network because there is no power needed at locations where the fibers are split. The primary advantage of using distributed splitters is that the number of fibers needed to reach each residential street is smaller. If the splitters were all at the neighborhood hut, a fiber would need to go from that hut to each home and business in the sector. The design puts a few splitters inside the core hut to serve customers located near to the hut. But most splitters have been moved out deeper in the fiber network closer to customers. We tentatively attempted to locate splitters at city-owned locations, and if the City builds the network, you are likely to do that. But some of the splitters were also placed in the public rights-of-way. The design includes splitter locations that can handle 256, 576, or 1,152 customers.

Redundancy. When possible, a good network fiber design should include some consideration for fiber route redundancy. This can most easily be accomplished by the use of fiber rings that include self-healing electronics. A fiber ring is just what it sounds like – fiber is built to complete a full circle (but doesn't have to shaped like a circle). Fiber rings are most normally part of the feeder fiber network, so that cutting a fiber feeding one neighborhood doesn't knock out service for other neighborhoods. But redundant rings can also be built into distribution fiber serving homes. This is usually only done when there are specific neighborhoods or large business customers willing to pay extra for redundancy. The network design for Joplin includes a ring that connects the five neighborhood huts.

The big advantage of a fiber ring is that the fiber does not drop out of service from a single fiber cut. The electronics on a ring send all data transmissions in both directions around a ring, meaning that a fiber cut cannot disrupt the flow of data across the ring. In this design, we put all of the neighborhood huts on the fiber ring. This means that if any fiber is cut between the huts that all of the huts will continue to function.

Fiber cuts are inevitable, so the money spent on redundancy pays dividends in the long run. Adding fiber rings and redundancy adds costs because this configuration requires an additional set of electronics to light the redundant ring. This uses a different technology than the fiber used to serve customers. The electronics needed to light the ring require power, which is why these electronics are all included inside the neighborhood cabinets.

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

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

If an ISP sells a 100 Mbps download connection to 20 customers on a PON, then in aggregate, those customers can use as much as 2 gigabits of download data at the same time, meaning there is still unsold capacity – meaning that each customer is guaranteed the full 100 Mbps connection inside the PON. However, if an ISP instead sells a gigabit connection to 20 customers, then there are 20 gigabits of potential customer usage that have been pledged over the same 2.4-gigabit physical path. The ISP has sold more than eight times more capacity to customers than is physically available, and this particular PON has an oversubscription ratio of eight to one.

When people first hear about oversubscription, they are often aghast – they think an ISP has done something shady and is selling people more bandwidth than can be delivered. But ISPs understand how customers use bandwidth, and they can take advantage of the real behavior of customers in deciding oversubscription ratios. ISPs know that a home subscribing to a gigabit connection rarely uses the full bandwidth capacity. A home doesn't use much bandwidth when people are asleep or away from home. The residents of a gigabit home might spend the evening watching a few simultaneous streaming videos and barely use any bandwidth. The ISP is banking on the normal behavior of its customers in determining a safe oversubscription ratio. ISPs have come to learn that households buying gigabit connections often don't use any more bandwidth than homes buying 100 Mbps connections.

Most of my clients using GPON tell me that they average 40% to 50% utilization – meaning all of the customers on a PON collectively only use on average about 40% - 50% of the 2.4 gigabits of capacity at any given time. The extra capacity is there for those busy times when the neighborhood wants to use more broadband. In this example, an ISP could provision 100% gigabit products on the PON and still deliver full speeds to customers far more than 99% of the time. An oversubscription of 8 on a fiber network is an extremely high-quality broadband product.

Even should this example PON ever get too busy, the issue is likely temporary. For example, if a few doctors lived in this neighborhood and were all downloading big MRI files at the same time, the neighborhood might temporarily cross the 2.4-gigabit available bandwidth limit. Since transactions happen quickly for a gigabit customer, the overuse of the bandwidth would not last long, and even when it was occurring, most subscribers to the PON wouldn't see a perceptible difference.

It is possible to badly oversubscribe a neighborhood using some technologies. Anybody who has used a cable company for broadband can remember back a decade ago when broadband slowed to a crawl when homes first started watching Netflix in the evening. The cable company networks were not designed for steady video streaming and were oversubscribing bandwidth by factors of 200 to 1 or higher. It became routine for the bandwidth demand for a neighborhood to significantly surpass the network capacity, and when that happened, the whole neighborhood experienced a slowdown. Since then, the cable companies have largely eliminated the problem by decreasing the number of households in a neighborhood node, which lowers the oversubscription ratio.

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

As an aside, the oversubscription ratios in business neighborhoods are completely different. Businesses might engage in steady large bandwidth uses like connecting VLANs to multiple branches, using software platforms in the cloud, using cloud-based VoIP, etc. An oversubscription ratio that works in a residential neighborhood is likely to be too high in some business neighborhoods. An ISP gets to know its customers and decides how to configure the PONs in a business neighborhood according to the characteristics of the businesses in that neighborhood. A retail district might look a lot like a residential neighborhood, while ISPs might only put a few businesses on a PON in neighborhoods where the businesses use a lot of broadband.

To make the issue even more complex, the sharing of bandwidth at the neighborhood level is only one place oversubscription comes into play. Any other place inside the ISP network where customer data is aggregated and combined will face the same oversubscription issues. The industry uses the term chokepoints to describe places in a network where bandwidth can become a constraint. There is a minimum of three chokepoints in every ISP network, and there can be many more. In the Joplin network, there is a potential chokepoint at each PON, as described above. There could be a chokepoint on the fiber ring connecting the five huts. There could be several chokepoints inside the core hub in any device that processes all of the Internet traffic. For example, any router that decides how to route Internet traffic could get overloaded. Finally, the path to the Internet can be a chokepoint. This is outside of the control of the local ISP and is often the biggest source of network slowdowns.

Smart City Connections

One of the primary purposes of this study is to understand what it takes for Joplin to pursue the Smart Joplin Roadmap. That Roadmap will likely require numerous additional fiber connections throughout the city for smart traffic devices, smart lighting devices, smart parking devices, and numerous other smart initiatives over time. Our study does not set assign any electronics costs to support these ventures. Every Smart City initiative will find a unique way to connect throughout the city – some smart devices will be connected to fiber while others will be connected wirelessly. We didn't want to distort the basic cost of getting fiber everywhere by making assumptions of how the city might tackle each smart initiative. Instead, this study quantifies the cost of getting fiber to every home and business in the city.

In doing so, the network constructed to match this study would put fiber on every street in the city. This means that fiber will be close to any future smart device. In the fiber design, we've engineered extra fibers to satisfy smart city needs on every fiber route that is constructed.

If the city was building the network contemplated in this study, then you could look at the incremental cost of every smart application by starting with the assumption that there is spare fiber everywhere in the city that could be used to connect any smart device.

Multi-Dwelling Units (MDUs). In Joplin, about 15% of residential living units are in apartment buildings with three or more living units. The study assumes that the overall cost of serving an MDU customer is roughly the same as serving an equal number of single-family homes.

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

Two-third of the apartment units in Joplin are in buildings that have between 3 and 9 living units. ISPs have found that many such buildings can be served in almost the same way as serving single-family homes. For example, an ISP might decide for a quadplex to run four fiber drops and install four ONTs inside units if every unit subscribes to fiber.

The remaining one-third of apartments in Joplin are in buildings with ten or more living units. With modern wiring technologies, it's reasonably inexpensive to bring fiber into most older buildings. There are wiring techniques such as running an almost imperceptible fiber along the corners of ceilings in hallways that make it easy to quickly wire an apartment building.

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

But there are still roadblocks in serving MDUs, and any ISP that builds fiber will find out that there will be some apartments they are unable to serve. Following is a short discussion of the primary kinds of roadblocks that we see when trying to bring fiber everywhere:

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

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

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

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

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

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

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

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

rewiring some older buildings. But the telephone company might claim ownership of the copper wires.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B. Competing Technologies

Existing Technologies

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

- Sparklight and Mediacom use hybrid fiber coaxial (HFC) technology that is used by cable companies.
- AT&T serves the city with copper telephone wires using DSL technology.
- There is a relatively small amount of active Ethernet on fiber provided by Liberty Connect, AT&T, Sparklight, and possibly others. This fiber serves some businesses, schools, cell towers, etc.
- There are several fixed wireless carriers that claim coverage across the whole city, but in our surveys and interviews, we only ran across coverage from Whisper.
- Homes can buy broadband from satellites.
- Some residents are getting all of their broadband from their cellphone plan.

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

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

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

Cellular data speeds in the city have likely increased drastically in the last three years. The national average cellular speeds are now double to triple the speeds of just a few years ago. This is mostly due to the cellular carriers introducing new cellular frequencies.

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

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

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

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

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

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

Hybrid Fiber Coaxial Network

Sparklight (Cable One) and Mediacom are the incumbent cable companies in the city, with Sparklight covering most of the city. The technology each uses is referred to as Hybrid Fiber Coaxial (HFC). Hybrid refers to the fact that an HFC network uses a fiber backbone network to bring bandwidth to neighborhoods and a copper network of coaxial cable to deliver service to customers. HFC networks are considered lean fiber networks (meaning relatively few fiber strands) since the fiber is only used to deliver bandwidth between the headend core and neighborhood nodes. At each node is a broadband optical receiver that accepts the fiber signal from the headend and converts it into a signal that is sent over coaxial cable to reach homes and businesses.

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

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

There is a distance limitation on coaxial cable. Unamplified signals are not generally transmitted more than about 2.5 miles over a coaxial network from a network node. This limitation is based mainly on the number of amplifiers needed on a single coax distribution route. Amplifiers are needed to boost the signal strength for coaxial distribution over a few thousand feet. Modern cable companies try to limit the number of amplifiers on a coaxial route to five or less since adding amplifiers generally reduces broadband speeds.

In an HFC network, all of the customers in a given node share the broadband in that node. This means that the number of customers sharing a node is a significant factor—the fewer the customers, the stronger and more reliable the broadband signal. Before cable systems offered broadband, they often had over 1,000 customers on a node. But today, the sizes of the nodes have been "split" by building fibers deeper into neighborhoods so that fewer homes share a fiber data pipe for a given neighborhood. The architecture of using neighborhood nodes is what has given cable companies the reputation that data speeds slow down during peak usage times, like evenings. However, if nodes are made small enough, then this slowdown doesn't have to occur.

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

a cable company compresses video signals and puts multiple channels into a slot that historically carried only one channel.

The technology that allows broadband to be delivered over an HFC system follows a standard called DOCSIS (Data Over Cable Interface Specification) that was created by CableLabs. Most of the large cable companies upgraded about a decade ago to the DOCSIS 3.0 standard that allows them to bond together enough channels to create broadband speeds as fast as about 250 Mbps download. By now, most big cable companies have upgraded their networks a second time to a new standard, DOCSIS 3.1, that theoretically could produce broadband speeds as fast as 8–10 Gbps if a network carried only broadband and had zero television channels. Since there are still a lot of TV channels on most cable systems, most cable companies have increased the maximum broadband speeds to between 500 Mbps and 1 Gbps using DOCSIS 3.1.

One limitation of a DOCSIS network is that the standard does not allow for symmetrical data speeds, meaning that download speeds are generally much faster than upload speeds. This is an inherent design characteristic of DOCSIS 3.0 and DOCSIS 3.1 where no more than 1/8 of the bandwidth can be used for upload. Most cable companies have allocated even less than the 1/8 to upload. Earlier in the report was a lengthy discussion about the upgrade speed crisis that has arisen during the pandemic. The cable companies are likely hoping that issue will diminish in importance at the end of the pandemic because upgrades to provide more upload speeds are expensive.

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

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

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

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

CableLabs has developed the new DOCSIS 4.0 standard that was released in March 2020. The DOCSIS 4.0 standard allows for a theoretical transmission of 10 Gbps downstream and 6 Gbps upstream. Comcast just did a test of the technology and achieved a symmetrical 4 Gbps signal. Don't expect this to mean that

cable companies will be offering fast symmetrical broadband any time soon. There is a long way to go from the first lab test to a product deployed in the field. Lab scientists will first work on perfecting the DOCSIS 4.0 chip based upon whatever they found during the trial. It typically takes most of a year to create a new chip, and it would be surprising for Comcast to spend several years and a few iterations to solidify the chip design. Assuming Comcast or some cable company is ready to buy a significant quantity of the new chips, it would be put into the product design cycle at a manufacturer to be integrated into the CMTS core and into home cable modems.

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

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

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

DSL over Copper Wires

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

DSL works by using frequency on the copper that sits just above the frequencies used for telephone service. There are different kinds of DSL standards, each of which has a different characteristic in terms of how much bandwidth they deliver 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 Joplin is of older varieties and delivers slower speeds.

The most important characteristic of DSL is that data speed delivered to customers decreases with the distance the signal travels. The general rule of thumb is that most of the types of DSL can deliver a decent

amount of bandwidth for about two miles over copper – that's miles of copper wires, not two miles as the crow flies. DSL signal strength is also affected by the quality of the copper. The newer the copper and the larger the gauge of the copper wires, the better the signal and the greater the bandwidth. Many of the copper wires in the city are likely to be 50 to 70 years old and have outlived their original expected service life.

Metro Ethernet

Metro Ethernet is the primary technology used to deliver large bandwidth to a single customer over fiber. This technology is used in the city by Liberty Connect, AT&T, Sparklight, and maybe a few others to deliver fiber today to cell towers, schools, and some businesses. This technology is often also referred to as active Ethernet.

Metro Ethernet technology generally is deployed with lasers that can deliver 1-gigabit or 10-gigabit speeds, although lasers as fast as 300-gigabits are available. ISPs can choke these speeds to slower levels based upon what a customer is willing to buy. Most ISPs dedicate a fiber for each metro Ethernet customer, but that's not mandatory. For example, an ISP could light a fiber to deliver 10 Mbps and string that fiber to multiple customers, each buying 1 Mbps service.

Satellite Broadband.

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

The newest satellite option is low earth orbit (LEO) technology that uses satellites that orbit between 200 and 800 miles above the earth. Low-orbit satellites have one major benefit over geostationary satellites. By being significantly closer to the earth, the data transmitted from low-orbit satellites will have a latency of between 25 and 35 milliseconds—about the same as experienced in a cable TV broadband network. This is much better than the current latency for high-orbit satellites, which has been reported as high as 900 milliseconds. The low-orbit satellites should be able to easily support real-time applications like VoIP, video streaming, live Internet connections like Skype, or distance learning.

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

There has been a lot of recent news concerning the three primary companies that are vying in the market. Starlink and SpaceX are all over the news. Starlink has begun taking $99 deposits from prospective customers and quickly picked up 500,000 customers and a quick $50 million. There is no guarantee that any customer will be able to receive service. Starlink now has over 1,600 satellites in orbit and says it will begin offering regular service by the end of 2021. Starlink claims it will eventually launch 30,000 satellites, with over 11,000 in the first constellation.

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

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

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

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

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

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

OneWeb is taking a third path and plans to launch a 648-satellite fleet with larger satellites that are basically floating data centers. The company recently launched 36 satellites, bringing it to a total of 182

satellites in orbit. The company says it will be able to start serving the U.K., Alaska, northern Europe, Greenland, Iceland, and northern Canada after two more launches and plans to be able to serve the whole planet by the end of 2022. It's no longer clear after the change of ownership if the company will support residential broadband or will pursue connectivity for larger users like cellular towers and corporate users.

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

Future Technologies

5G Cellular Technology. Today's cellular network uses a technology called 4G LTE, although there are still many rural cell sites using 3G technology. The first columns of numbers below represent the average nationwide speeds for each of the cellular carriers in the U.S. that was measured by reviews.org at the end of 2020. The second set of numbers demonstrates that cellular networks are faster in big cities. These speeds are from tests taken in 26 major cities by *PC Magazine* in the summer of 2020.

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

Cellular data speeds are faster in cities for several reasons. First, there are more cell sites in cities. The speed a customer receives on cellular is largely a function of how far the customer is from a cell site. In cities, most customers are within a mile of the closest cellular tower. 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 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 Joplin are a little lower than in larger cities, but higher than the national average numbers.

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

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

From what is discussed in the IEEE forums, most of the 5G features are 3 - 4 years away. The same thing happened with 4G, and it took most of a decade to see 4G fully implemented – in fact, the first U.S. cell site fully meeting the 4G standards was not activated until late 2018. Over time, we'll see new 5G features

implemented as they are released from labs to field. New features will only be available to those that have phones that can use them, so there will be a 2-year to 3-year lag until there are enough phones in the market capable of using a given new feature. This means every 5G phone will be out of date as soon as a new 5G feature is released.

Most of what is being called 5G today refers to the introduction of new bands of spectrum. The new spectrum does not equal 5G – the 5G experience will only come with 5G features. Older cellphones cannot receive the new spectrum bands, so the carriers are pushing new phones that can receive the new spectrum and labeling that as 5G.

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

5G Hot Spots. There were a lot of TV commercials last year showing cellphone speeds of over a gigabit. This is not 5G. This is 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 frequency.

The most accurate way to think about this new technology as a 5G hot spot, similar to a hot spot that might be found in a coffee shop, only mounted outdoors on a pole. The signal only travels a short distance, mostly under 1,000 feet from a transmitter. It needs line-of-sight and can be easily blocked by any impediment in the environment. The signal won't pass from outdoor transmitters into buildings, even through windows. 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 that was 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 good way to get headlines. However, it's extremely unlikely that any carrier is going to invest in cell sites that close together outside of major downtown business districts. This technology is likely to never reach residential neighborhoods in cities, suburbs, small towns, or rural America. A lot of industry experts are asking why anybody needs gigabit broadband for cellphones, especially since this technology only works outdoors.

Fiber-to-the-Curb

One of the most intriguing technologies hitting the market is fiber-to-the-curb. Currently, the company pioneering this technology is Verizon. Verizon refers to the technology as fixed wireless access (FWA). The technology consists of building fiber along streets and beaming broadband wirelessly to customers using millimeter-wave spectrum. Verizon introduced the technology in 2018 and deployed small trials in Houston, Indianapolis, Los Angeles, and Sacramento. We mention the technology in this report because starting in June 2020, Verizon introduced the second generation of the technology, with the first new market being Detroit.

The first-generation technology required mounting an antenna on the outside of the home to receive the signal. The new technology hangs a receiver on the inside of a window that faces the transmitter on the pole outside the home. Verizon claims the new technology can be self-installed by customers. One of the

key requirements for using the technology is that there must be a good line-of-sight between the transmitter on the pole and the customer, which means no intervening trees, shrubs, or other impediments.

Verizon claimed that the first-generation equipment technology could deliver speeds up to 300 Mbps for up to 2,000 feet from a pole. Many engineers in the industry guessed that the more realistic distance was 1,000 feet or less. Verizon claims the new technology can deliver speeds up to a gigabit, but Verizon is no longer making any distance claims. The industry consensus is that this new technology also is likely limited to perhaps 1,000 feet from transmitter to customer window. Early reports from customers are still reporting speeds in the range of 300 Mbps. The receiver in the window needs to "see" the see the transmitter on a pole, so this is a line-of-sight technology where only homes within sight range of a pole can receive the broadband.

Verizon publicly claims that the technology will meet all 5G specifications. Currently, there are no 5G features yet being used in the field, and so the current generation of technology is basically a millimeter-wave Ethernet radio path to a home. When 5G is finally introduced in the field, this technology might benefit some if it can use the 5G features that tailor bandwidth paths to customer demand. But since most 5G features are intended to benefit cellular traffic, this specific technology is not likely to improve much even if layering on 5G features.

From a deployment perspective, this is an expensive technology. It requires building fiber deep into residential neighborhoods. The industry analysts at MoffetNathanson looked at the first-generation equipment and said they didn't see how the technology could be any cheaper than building fiber-to-the-home. The expensive part of a FTTH network is the fiber along a street, and that is still needed for this technology as well.

Verizon recently said it hopes to pass 25 million homes and businesses with the technology by 2025. The pricing on the product is simple, offering unlimited broadband at $50 for Verizon Wireless customers and $70 for anybody else. This technology will compete well against cable since these prices are below standalone cable broadband prices. This product has a much faster upload speed than cable broadband, but Verizon hasn't made any claims about upload speeds. Any neighborhood that gets this technology ought to see some price competition—and if not price competition, at least expanded customer choice.

This technology doesn't make sense everywhere. It's a technology aimed at streets with single-family homes or rows of small businesses. It's not going to handle apartment buildings where there are units that don't have a street-facing window. The technology doesn't work well in neighborhoods where utilities are buried since this needs to be on poles. This could be placed on light poles, but it's more expensive to get fiber to light poles than it is to utility poles. The technology won't work well on streets with heavy vegetation or streets that are highly curved. This technology will be hard to justify in places with neighborhoods with large lots and lower housing density, and this technology makes no sense in rural areas.

This is a new technology, and the only company currently offering it is Verizon using proprietary technology. There are likely to be commercial vendors offering this technology, but that could still be some years away. It's too early to have any customer or industry review to talk about how it really works. However, if it operates anything like how Verizon claims, it could be a serious competitor to cable company broadband.

III. FINANCIAL ANALYSIS

This section of the report looks at the detailed assumptions that were made in creating the financial business plans. The business plans created are detailed and contemplate all aspects of operating a broadband business. The business plan assumptions represent our best estimate of the operating characteristics for such a business. As a firm, CCG consults with hundreds of communications entities that provide rural broadband. This has given us a lot of insight into how rural ISPs operate. We believe that the financial results shown in these models are characteristic of similar operations elsewhere, and we believe our assumptions are realistic.

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

A. Operating Models

There are several operating models that the city can consider. Following are the operating models most prevalent in the U.S. market today.

Retail Model – Single Provider as the ISP

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

CCG has learned from experience that if a market can't be profitable with one provider, then other options like partnerships and open-access can't be successful. By definition, these other operating models divvy up profits among multiple entities - if there's not enough profit for one provider, then there is not enough profit to support multiple parties.

Advantages

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

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

Disadvantages

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

Financing. The primary impediment to building and operating a fiber ISP is the cost of building the fiber network. Cities often wonder why commercial ISPs don't build fiber networks when it looks profitable to do so. There are a few reasons why ISPs are not rushing around the country building fiber in markets like Joplin. First, there are not many entities capable of borrowing the money needed to finance sizable fiber networks. Most small ISPs are limited by the amount of equity they can bring to a new market and by the collateral they can pledge to a borrower. But even if funding is available, the financial analysis below doesn't show a high return for building fiber in Joplin – there are paths to be profitable, but not to make the returns that commercial ISPs expect.

Open-access

In this scenario, the municipality builds a fiber network and makes it available to multiple ISPs. The ISPs market and sell broadband and other products to customers. This model operates financially by the fiber owner selling access to the ISPs in an arrangement that is often referred to as selling loops. The loop charges are the only source of revenue for the municipal network owner.

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

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

That hasn't happened in the U.S. There is only one example of a big telco operating on somebody else's network, and it's in nearby Springfield, Missouri, where CenturyLink is in the process of using a network built by the city. However, it's hard to know where that venture will go since the Missouri operations are part of the sale of assets from CenturyLink to Apollo Asset Management. We don't know of any other

examples where one of the largest telcos or cable companies has agreed to operate as a competitor on somebody else's network to serve residential customers. The large ISPs in the U.S. often lease fiber outside of their footprint to serve large business customers but have never competed for smaller businesses or residents in each other's monopoly footprints.

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

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

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

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

- The Public Utility Districts (PUDs) in Washington State. These are countywide municipal electric companies. The PUDs are restricted to offering open-access due to legislation passed a number of years ago. There are numerous different open-access models being tried at various PUDs, with the largest networks in Chelan County PUD, Grant County PUD, Douglas County PUD, and Pend-Oreille PUD.
- Utah has a similar law that applies to municipalities. This led to the creation of an open-access fiber business in Provo and another network called Utopia that serves a number of small towns. The Provo network was losing a lot of money, and the city decided to sell the network to Google Fiber for $1. Utopia is still operating a wholesale business but had significant financial problems during the first decade after inception. However, after several rounds of refinancing, the Utopia network is growing vigorously and adding new towns to the consortium.
- A similar law was passed in Virginia after Bristol Virginia Utilities (BVU) built a retail fiber network. The legislation grandfathered BVU as a retail provider but only allows other cities to operate open-access networks. So far, the wholesale model has been adopted by a few cities, the largest being Roanoke, which offers open-access on a limited basis to only parts of the city.
- Tacoma, Washington chose an open-access model where the city was the retail provider of cable TV, but connections to the network for telephone and broadband were sold wholesale to ISPs. That was a losing venture, and the city is now leasing the network to an ISP.
- Ashland, Oregon operates an open-access network, but the city also operates as a retail ISP on the network and competes against a few local ISPs that sell on the network.
- There are a number of municipal networks that have built fiber rings, and which are promoting "open-access" to carriers. For the most part these networks only serve business customers.

- Other communities have tried to build open-access networks but then were unable to find any ISP partners. For example, Longmont, Colorado tried to launch an open-access network, but when they were unable to find ISP partners, they decided to offer full retail services directly to residents.

Advantages

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

Disadvantages

Retail/Wholesale Revenue Gap. There is a big difference in the revenue stream between collecting the retail revenue stream from customers versus collecting only the fees charged to ISPs. For example, the average retail revenues on a fiber network serving residential customers might be over $120 per customer per month. The average revenues on an open-access network are far smaller, at perhaps $30 - $40 per customer per month.

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

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

Leads to Cherry-Picking. The open-access model, by definition, leads to cherry-picking. When ISPs are charged to use the network, they tend to concentrate on selling to customers that bring the highest margin – and tend to not sell low-priced products with low margins. All of the open-access networks listed above had this issue. The only way to get broadband to everybody in an open-access network is for the network owner to lower their fees – and that makes it impossible to pay for the network. CCG has never seen an open-access network that has a customer penetration rate as high as would be expected if the same community had a municipal retail provider. Cherry-picking means fewer customers on the network and a smaller revenue stream for the network owner. Municipalities often build networks with the goal of getting broadband to the neediest citizens in the community, and open-access makes it a challenge to do so.

No Control over Sales Performance. The network owner in an open-access network has no control over the customer sales process. That means they only do as well as the ISPs on the network. In

CCG's experience, many of the small ISPs operating on open-access network tend to not have the resources for major marketing efforts or else only want to serve a niche market and don't try to mass market. A retail ISP that owned the same fiber network would try to sell to everybody – but that never happens on an open-access network.

Stranded Investments. One interesting phenomenon that especially affects open-access networks is stranded investments at customer premises. A retail ISP typically strives to keep customers on a network once it has made the initial capital investment to connect a customer. However, in an open-access network, the ISPs don't make this same effort. Over time, an open-access network owner will see a growing inventory of homes and businesses with a fiber drop and ONT that are no longer used, and which are not contributing to the bottom line.

Public-Private Partnership (PPP)

There are a wide variety of public-private partnerships that can be created between a government entity and an ISP. There are also a wide variety of ways that revenues, profits, and risks can be shared between partners. The following discussion examines the pros and cons of each of the operating models described above.

PPPs initially arose internationally as a way to finance infrastructure needs that local, regional, or national governments could no longer pay for upfront or could only insufficiently finance from taxes, bonds, or other methods of raising government monies. Over the last fifty years, governments collectively in the U.S. have been unable to fund all of the needed infrastructure - and PPPs have been formed to help finance the infrastructure deficit.

There are three major ways that a fiber PPP can be structured depending upon who pays for the network. A fiber network could be mostly funded by the government, mostly funded by a commercial entity, or funded jointly by both.

PPP Funded Mostly by a Government. There are still only a relatively small number of communities that have financed a fiber network that is operated by a partner. This scenario means that a government takes all of the financial risks of building a network and then hands the operations to somebody else. This is the arrangement that is in place in the Google Fiber partnership with Huntsville, Alabama. Reports are that Google Fiber is responsible for the costs inside the customer premise and the city for the rest. There are similar partnerships between Ting and Charlottesville, VA and Westminster, MD. CenturyLink has reached a similar arrangement with Springfield, MO.

PPP Funded Mostly by the Commercial Provider. There are many examples where a commercial provider has built a fiber network with some upfront assistance from a community. In most cases the parties don't think of these arrangements as a PPP. ISPs often ask for some concessions when building a fiber network. The first few markets for Google Fiber are reported to have this arrangement. It's widely believed that Kansas City granted major concessions to Google Fiber to get them to build fiber there. The city might have provided concessions like free rights-of-way, expedited permitting, use of city land for placing facilities, etc.

For this kind of arrangement to be considered as a traditional PPP, a municipal entity would have to get something in return for the concessions they make to an ISP. This could be almost anything that is perceived to be of value. It might be free or reduced telecom prices provided to government buildings, or fibers connecting government locations together. It could also be the ISP agreeing to help the city meet some social goal, such as building to poorer parts of the city that a commercial ISP might otherwise not have considered.

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

- Zayo partnered with Anoka County, MN. This is a suburban county just north of the twin cities. Each party contributed money to build a fiber network together. The county received access to a 10-gigabit network connecting all of its facilities, and Zayo received connections to all of the major business districts. Zayo owns the network, but each party has affordable access to the whole network as needed. Each party is also allowed to build outward from any point on the jointly built network at their own cost.
- Nashville, Tennessee partnered with a commercial fiber provider to build fiber to city locations as well as to commercial districts. Both parties made capital contributions. The city eventually sold its interest in the network but still retains fiber to most city buildings.
- There are dozens of small cities where the city built an initial fiber network to connect to schools, water systems, etc. and now allows commercial providers to build spurs from the city-owned ring. The financial arrangements for this vary widely. Sometimes the two parties just swap access to various locations on each other's network, and in other cases, they each pay to lease access on the other's network. However, both parties share some parts of the network, portions of which each has funded.
- In Sibley and Renville Counties, MN, the counties, cities, and townships together contributed an economic development bond that is being used to fund 25% of the cost of a fiber-to-the-premise network.
- Several of the Public Utility Districts (PUDs) in Washington have built fiber into business and residential neighborhoods but then allow ISPs to build fiber loops and electronics and connect to the core network.
- Google Fiber recently announced a partnership with West Des Moines, Iowa, in a network that can best be described as open-access conduit. The city will build empty conduit along every street in the city and also extend the conduit to each home and business in the city. The network will be available to any ISP, but Google Fiber is the first announced network tenant. Google will pay to pull fiber through the conduit, and the company says it plans to serve the whole city. In this partnership the city has tackled the most expensive part of the network, but ISPs still have to make a sizable investment to pull fiber to reach customers.
- There are hundreds of examples of government entities that have built fiber routes jointly with a commercial partner. This is referred to in the industry as fiber sharing, and generally, each contributor to the fiber route gets some specific number of fibers for their contribution. For example, this is a common practice with school system fiber networks.

There are several kinds of contributions that a government can make to somebody else's fiber network. This could include cash, real estate, excused fees, or sweat equity. Governments can allow a commercial provider to use parcels of lands or give them an existing building. Excused fees might mean not charging

for something that would normally be due, such as permitting fees or property taxes. The government could excuse payments for poles, conduit, existing fiber, or towers. It could mean the commercial provider might not need to pay taxes or fees for some period of time, as is often done in many economic development projects. Sweat equity is assigning a value to the time contributed by the city. For example, we've seen a city assign extra employees for free for tasks like the permitting process during a major fiber construction project.

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

- The government builds the network and hires an ISP to operate the network.
- The government builds the fiber network and fiber drops, and the ISP partner provides customer electronics and everything inside the home.
- The government builds only the fiber, and the ISP supplies everything from the street to connect to the customer.
- The government owns none of the network. Instead, the government takes steps to help an ISP succeed. That might mean being an anchor tenant and giving all business to the ISP on a long-term contract. It might mean contributing land, building space, or other hard assets. It might mean relaxing construction requirements such as permitting, locating, and inspections to lower the cost of building the network.

Following are the advantages of public-private partnerships.

Advantages

Smaller Government Investment. The extent to which the private partner funds the network reduces the needed investment from the public partner.

Help in Financing. A commercial partner can bring cash to the business that might be hard to raise elsewhere.

Disadvantages

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

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

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

Process Driven by Commercial Partner. Our experience is that the commercial partner drives the structure of the business as a likely precondition for investing.

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

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

B. Services Considered

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

Telephone Services (VoIP)

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

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

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

Cable TV

The study does not include a cable TV product. A large number of small ISPs have been dropping the cable product in the last few years since it has become unprofitable. The driving factor of the high cost of traditional cable TV has the large and seemingly never-ending annual increases in the fees charged for programming. Local network affiliates (ABC, CBS, FOX, and NBC) and the big national programmers

have all been increasing the cost to buy programming at a rate that is significantly faster than the rate of inflation. This has resulted in the average cable customer paying more than $100 per month for a traditional cable lineup. The programming contracts also generally require that ISPs carry all of the programming available from each programmer, meaning there is no opportunity to save money by slimming down the channel lineup. We now actively discourage new ISPs from offering traditional cable. The start-up costs to add the product can easily cost more than $500,000, and it's exceedingly hard to sell a product that has a positive margin.

Small ISPs have been hopeful that they could become agents for alternative online programming like Sling TV, Hulu plus Live TV, or YouTube TV. However, such deals are still not available to smaller ISPs, although there is a reported arrangement between Windstream and several programmers. We find it likely that there will be no real margin in these arrangements as well.

High-Speed Bandwidth (in excess of symmetrical 100 megabits)

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

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

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

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

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

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

Managed WiFi

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

This is a profitable product. A quality WiFi router costs around $100, and ISPs are charging between $5 and $10 per month for the service. CCG knows of ISPs that have already sold this product to more than 60% of their customers.

Other Future Products

Today many ISPs are expanding their product lines to add additional product lines that rely upon broadband. Perhaps the best example of this is Comcast. They now offer a wide range of new products. For example, they have sold home security monitoring to many millions of customers. Comcast is probably the largest nationwide provider of smart home products, with a line of products including smart lighting, smart watering systems, smart door locks, smart thermostats, etc. Comcast has also been selling cellular service to compete with the big wireless carriers. Comcast even recently tested bundling solar panels with their other products in a few markets.

CCG finds it likely that any ISP operating a fiber network will eventually offer some of these same kinds of products along with products that have yet to be developed. This could include things like medical monitoring to help the elderly live in their homes longer. It might involve intensive gaming connections, including virtual reality and holograms.

It's impossible to build a business case for products that have yet to be developed, but it's reasonable to believe that any sizable ISP will offer new products over the time frame of this study. Our business plans incorporate a small future revenue stream from undefined future products.

Wholesale Bandwidth Products

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

Following are the kinds of customers that buy wholesale connections:

- Cellular carriers in most markets buy fiber connectivity and bandwidth to connect to the traditional tall cell towers. In the last few years, we've seen cellular companies build small cell sites placed on power or light poles. Both kinds of cell sites require a fiber connection.

- Nationwide businesses like hotel chains, banks, manufacturers, etc. often have an arrangement with a single ISP to serve all of their locations nationwide. These ISPs will consider buying local connectivity from a new fiber network.
- Complex businesses like hospitals and universities usually have complex needs and look for ISPs that can provide more than just bandwidth.
- Businesses with multiple locations in Joplin need connections between branches. This might include grocery stores, local banks, or other businesses that might operate multiple locations inside the city.
- Giant bandwidth users. This could be things like data centers or large stock trading houses that want large bandwidth with low latency.

Products. Following are the typical wholesale products that are sold to the above kinds of businesses:

- Dark Fiber. This involves selling a fiber that is not connected to electronics. The ISP buying the dark fiber is responsible for providing and operating the electronics necessary use the fiber. Dark fiber might be sold by the mile of fiber or else by a set fee per dark fiber connection.
- Transport. Some wholesale providers only sell connections between points A and B. This might mean the retail ISP might need to buy several transport paths to serve a customer – for example, there might be one transport connection between an end-user connection and the wholesale hub and a second transport connection between the wholesale hub and the ISP hub.
- Dedicated Bandwidth. Dedicated bandwidth means that the customer doesn't share it with anybody else. The typical products on an FTTP network share bandwidth at some point in the network, but some businesses are willing to pay to buy raw, unshared bandwidth. The network can deliver speeds up to 100 Gbps.

There are only minor wholesale revenues included in the studies. There is a chance over time for higher revenues than we have projected.

C. Financial Assumptions

Incremental Analysis

All of the projections have been created on an incremental basis. This means that the studies only consider new revenues, new expenses, and new expected capital costs. This is the most common way that businesses of all sorts look at potential new ventures since the incremental analysis answers the question of whether any new business line will be able to generate enough revenue to cover the costs. An incremental analysis is basically a cash flow analysis. It looks at the money spent to launch and operate a new venture and compares those costs to the revenues that might be generated from the venture.

An incremental analysis is not the same as a prediction of the accounting books of a new venture. For example, if one of the existing ISPs in the area was to undertake one of these business plans, they would allocate some of their existing overhead costs to the new venture. The classic textbook example of this is that some of the existing cost of the general manager of the ISP would be allocated to the venture in the accounting books. However, the cost of the salary of the existing general manager is not considered in an incremental analysis since that salary is already being paid by the existing business. If these studies were to show an allocation of the general manager, then they would not be properly showing the net impact of entering the new market.

Timing

Timing is critical to any business plan. The faster that a business can start generating revenues, the sooner it can cover costs. These studies are somewhat conservative in the predictions of the speed of the roll-out of the business venture. An ISP that could connect customers faster than predicted by the projections would see better financial results.

All scenarios anticipate that the first customers will be added to any new networks in October of the first year after starting the project. It could be possible for an existing ISP with customers in the region to start customers a little earlier.

Following are the major milestones as predicted by these forecasts:

- Financing. All the forecasts assume that the financing is available in January 2022. This is illustrative for study-only purposes and could be changed to any other future date to match available funding.
- Construction. Fiber construction is assumed to last for three years to build the whole city. It might be possible to build in less time, but the task of reaching every nook of a city is a complicated one.

Pricing Strategy

We assumed that the products would be as simple as possible. We assumed that an ISP would offer only a few telephone options. For example, for residential service, we have assumed only two products - a basic telephone line and a telephone line with unlimited long distance. Broadband is also simplified with only three tiers of speeds for residential or business customers. Businesses could buy customer speed packages as negotiated.

There are a number of different pricing strategies used around the country by various ISPs for broadband. Following is a discussion of some of the more common models and a discussion of the pros and cons of the various approaches to pricing.

Competition. When building broadband into a market that already has existing competition, it's important to consider the prices and the likely reaction of existing ISPs. In Joplin, we think a new ISP is likely to base prices according to what Sparklight charges. We don't think AT&T DSL is a factor since the company won't connect new customers. Mediacom only serves a portion of the city and is not as big of a factor.

Market Rates. This asks the important question of what people are willing to pay for broadband. As somebody who works for a lot of ISPs, I observe that a lot of ISPs are not good at this. I regularly see ISPs that set prices too low based upon the assumption that nobody will change providers if prices are near to existing market rates. However, I have numerous clients that charge market rates for broadband and get similar penetration rates to ISPs with lower rates.

General Pricing Philosophy. ISPs often come to the market with predetermined notions of how prices ought to work. A pricing philosophy is often based upon the overall goals for the business and the way that an ISP thinks about business. For example, some ISPs have a goal of maximizing cash flow or of

maximizing profits (not the same thing). Other ISPs are more community-based and want to bring fast broadband to as many households as possible. These basic philosophies are often the driving force behind a pricing strategy.

For example, some ISPs believe in simplicity and only offer a few products. Other ISPs stress bundles of services. Some ISPs think that the way to sell a lot of services is by having low prices. Other ISPs think it's better to have higher prices and fewer customers. Some ISPs think it's important to the community to have a low-priced product for low-income households. Some ISPs charge the same prices to residents and businesses - others charge businesses a lot more.

If the city ever contemplates partnering with an ISP, it's important to understand the pricing philosophy of that ISP. The various philosophies result in a couple of different pricing schemes that we see in the marketplace. A few key examples include:

- One Broadband Product. A few ISPs like Google Fiber, Ting, and a handful of smaller ISPs have one broadband product. They sell a gigabit of speed for a set price. Google Fiber had gone to a 2-tier broadband offering but announced in 2020 that it is returning to the flat-rate $70 gigabit. Any ISP with this philosophy is likely not trying to capture a huge share of the market but is content to sell a high-margin product to a smaller number of homes.
- Low Basic Price. Some ISPs set a low price for basic broadband. This is done more often by municipal ISPs, but there are small commercial ISPs with the same philosophy. As an example, in your market, an ISP might try to capture a huge part of the market with a basic broadband product like 50 Mbps for $40.

CCG Consulting has access to the prices and the resulting customer counts from nearly 200 ISPs and what we have learned is that most customers will buy the basic broadband product if the speed is okay. A basic product with slow bandwidth is not likely to sell, but in today's market, a product with a decent speed like 50 Mbps or greater will be perceived as acceptable to most households.

Even if an ISP with low rates captures much of a market, it's obvious that low rates leave a lot of margin on the table. In setting rates for this study, we began by considering existing market rates in Joplin. We only considered permanent rates and not advertising special rates that last for a year before reverting to full price. We've seen ISPs that make the mistake of setting their own permanent rates to compete with existing providers' special rates.

Following are the core rates in the market today:

- Sparklight' s basic broadband product of 100 Mbps costs $55 plus a modem for $10.50. The downside of the product is that it has a 300-gigabyte monthly data cap, and customers that use the national average amount of broadband will pay up to $40 additional per month for exceeding the data cap. Sparklight has a small tier increase of $10 extra to get 200 Mbps service with a bigger data cap, and then an additional $15 jump to $80 to get 300 Mbps and a 900-gigabyte data cap. The company leaps up to $125 per month for the gigabit product – a price that suggests it might not want to sell a lot of the product, perhaps due to network limitations.
- Mediacom is a lot more expensive and starts with a 60/5 Mbps product for $69.99 plus $10 extra for a modem – this product also comes with a stingy 400-gigabyte data caps. Mediacom also punishes customers that don't buy a bundle and there is an additional $15 charge to buy standalone

broadband. This puts the all-in price for standalone broadband at $94.99 – the highest of the large cable companies. The Mediacom gigabit product is at $139.99 before the extra fees.

- While customers can no longer buy AT&T, there are still many customers using the DSL product. AT&T DSL pricing is simple, with all speeds (all under 25 Mbps) priced at $60 plus a $10 charge for the modem.
- We don't think there are enough WISP customers in the city for this to be a factor in setting prices – and for the most part, their prices are high anyway.

It's worth remembering that the two cable companies can match the download speeds of a fiber provider up to 1 gigabit. Fiber has a much lower latency, and most customers will say that a 100 Mbps product on fiber feels faster than a 100 Mbps product on cable - that is because web sites appear on the screen faster due to lower latency. But as far as performance goes, the cable products are the same in terms of download capacity.

Where a fiber product shines in today's market is fast upload speeds. Anybody trying to work or do school from home on a cable company connection will occasionally have problems staying connected or having a quality connection. A fiber data connection will handle upload demands with ease.

In the models for this study, we used $60 as the starting price for broadband, with a $5 modem fee. That is essentially the same rate as Sparklight. But a fiber product will have lower latency, much faster upload speeds, and no data caps.

Price Steps or Tiers. If an ISP has multiple broadband products, then the price difference between products is an important consideration. Consider three different pricing structures that begin with a $60 broadband product:

	Rate 1	Penetration	Rate 2	Penetration	Rate 3	Penetration
100 Mbps	$ 60.00	95%	$60.00	75%	$60.00	60%
250 Mbps	$ 90.00	4%	$75.00	20%	$70.00	30%
Gigabit	$120.00	1%	$90.00	5%	$80.00	10%
For 1,000 Customers:						
Revenue	$61,800		$64,500		$65,000	
Increase			4.3%		5%	

The difference in the steps or tiers is that Rate 1 prices are set $30 between products, Rate 2 tiers are at $15, and Rate 3 tiers are at $10. The experience of ISPs is that it is that it's easier to upsell customer to faster products with smaller tiers. CCG derived the relative rate structure for the various tiers above based upon the experience of some of our clients. Customers might voluntarily choose a fast product when the step between tiers is small, and small tiers make it easier to convince a customer to upgrade if their speed is bogging down or inadequate. Conversely, when the steps are too large, customers buy and then stick with the lowest-priced tier rather than increase their bill too much.

We have also seen that having too many price tiers confuses customers. The above examples three price tiers. We know of ISPs with seven to ten price tiers, and in looking at their penetration rates, we see that

this confuses customers. We have seen the most effective rate structures having no more than four tiers, which can be explained to customers on a fiber network as fast, faster, and fastest and gigabit.

Setting Business Rates. Philosophies vary widely on setting broadband rates for businesses. The incumbent telephone companies and cable companies generally charge a lot more to business than to residential customers. At one time, the philosophy behind this was that businesses consume more resources and cost more to serve than residential customers. While that might still be true for medium and large businesses, ISPs will tell you that the average home today uses considerably more bandwidth than the average small retail business. The exception might be a coffee shop supporting a public hotspot or a business that deals in large files like photographers or engineers.

We know a few ISPs that charge the same rates to businesses and residences, although that is rare. Most ISPs follow the incumbent pricing practices and charge more for businesses.

One thing that a first-time ISP learns quickly is that most incumbents don't have standard rates for businesses, but rather they negotiate with each business. It's not unusual to find two similar small businesses in the same neighborhood paying rates for the same products that are 50% apart. This creates a challenge for new ISPs. Some ISPs set standard business rates that apply to all businesses, while others set custom rates based on what a business is currently paying.

The other thing that a new ISP learns quickly is that most businesses care more about reliability than price. They want their broadband and telephones to always work during business hours. They don't want to pay more than they can afford, but they are not afraid to pay for a quality connection. While a new fiber provider might see good appreciation for a fiber-based ISP saving them money, the chances are that they decided to change ISPs due to outages they have had in the past with their current provider – if they perceive fiber to be a more stable technology.

Rate Bundles. The large cable companies are well-known for having bundles of products where they provide a discount to customers buying more than one product. Generally, customers have no idea of the cost of any product inside of a bundle. Most small ISPs that CCG knows do not use bundles. Most small ISPs set prices to be competitive and don't discount them further. Interestingly, Verizon recently announced that they are doing away with bundled rates for new customers. It will take a few years for customers with older plans to migrate to unbundled rates. Verizon describes the new rates structure as more open and honest and believe this is what customers want.

Introductory Rates. The big telcos and cable companies are also well-known for advertising low introductory rates that increase dramatically after a term contract of 1 to 2 years. Most of the rates you'll see from these companies on the web or in advertising are the introductory rates, and the real rates of these companies are generally buried in the small print if shown anywhere.

Customers dislike the introductory rate process because they invariably get socked with a big, unexpected rate increase when rates jump back to list prices. The time of big introductory discounts might be starting to come to an end. AT&T decided last year to stop renegotiating customers to low rates after the end of introductory offers. This cost AT&T nearly two million customers on DirecTV, but the company says they'd rather have fewer customers that are profitable than maintain customers that don't contribute to the bottom line of the company. A few medium-sized cable companies have made this same change.

Most small ISPs do not offer introductory rates. Such rates require having customers signing contracts and then negotiating rates when the contracts expire.

Low-Income Pricing. This is covered in more detail Section I.C. of the report. Some ISPs offer discounted products to low-income households. Most try to set rates to make it affordable, and most have some criteria for how customers qualify for the low rates, such as having students using the free lunch program. Most ISPs try to set the rates at a level that at least covers costs and perhaps returns a tiny margin.

Rates Used in This Study

Telephone Rates

The studies used the following very simplified pricing for residential phone service:

Basic Local Line	$15.00
Line with Unlimited Long Distance	$25.00

We've assumed that both products include a full package of features like voice mail, caller ID, etc. The above prices also include any extra fees that the incumbent telcos show separately on the bill, but which are part of the rate. These rates would not include true taxes on the service, such as the tax that supports 911.

It's worth noting that customers buying landlines from AT&T still have a limited calling scope where customers must pay long distance rates by the minute when calling outside of the immediate area. Customers who buy the unlimited long-distance plans considered by these studies would be able to call anywhere in the country as part of their plan. Similar plans today often include Canada, Mexico, and even some other international locations.

The studies are less specific with business phone rates. The models have assumed an average monthly telephone revenue of $55 per business. There are a few larger businesses that would pay more than this, so the financial projections are conservative. It's worth noting that most ISPs allow home-based businesses to buy residential broadband products.

Broadband Products

The studies do not specify data speeds. We have shown data speeds by three tiers. A typical mix of products in three tiers on fiber might be something like 100 Mbps, 250 Mbps, and 1 Gbps.

Residential Fiber Broadband	**Price**	**Percentage**
Tier 1	$ 60.00	75%
Tier 2	$ 75.00	20%
Tier 3	$ 90.00	5%
Business Fiber Broadband		
Tier 1	$ 75.00	65%

Tier 2	$ 95.00	25%
Tier 3	$110.00	10%

These are what we consider as market-based rates – the starting rate is about the same as what Sparklight charges. The financial models assume that the data products don't have data caps and provide unlimited broadband usage to customers. If there were data caps, then customers that exceeded those caps would be charged more than the basic prices. Both Sparklight and Mediacom have data caps in the market today.

Managed WiFi

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

Many ISPs are now offering managed WiFi. This product places high-quality carrier-class WiFi routers in the home that are placed and operated by the ISP. This likely means better broadband coverage than when homeowners place WiFi routers. ISPs often assist customers when adding a new device to the wireless network. The managed WiFi router provide a secondary benefit to an ISP because it provides a network monitoring location inside the home, meaning that the ISP is more easily able to pinpoint problems.

The studies assume a monthly rate for managed WiFi of $5.00 for residences and $10.00 for businesses. It's further assumed that 70% of residents would buy this product and 60% of businesses.

Large Broadband Products

There are customers in Joplin that buy larger bandwidth products. The studies are conservative and predict minor revenues for such sales. Such sales are typically made to bring service to cellular towers, schools, electric utility locations, or large businesses.

Cell towers are an interesting challenge. In some parts of the country, we have clients with rural fiber networks that get almost every cellular tower as a customer. But we have other similarly situated clients that get none of this business. The cellular carriers like to buy large volumes of connections from a single regional provider, and they often already have a long-term contract for an area much larger than the city.

The new opportunity for cell towers will be for small cell sites. These are smaller cellular transmitters that are placed on utility poles or light poles and that bring improved cellular service into neighborhoods. We are already seeing small cell sites popping up in towns the size of Joplin, and over time this should be a growing market opportunity.

It's also possible for a new ISP to break into the market for larger data customers. However, this is a highly competitive market, and the companies that sell to places like factories often offer a suite of products that a local ISP can't compete with. For example, a big ISP might offer a suite of cloud services, voice-over-IP, backup storage, and specialty software that a local ISP can't bundle with broadband. But over time, local ISPs often have the ability to win the contracts to sell to schools and local government.

Network Capital Costs

The telecom industry uses the term capital costs to describe is the industry term for the cost of assets required to operate the business. The capital expenditures predicted in these models reflect the results of the engineering analysis described in Section II of this report.

Capital for broadband networks includes several broad categories of equipment, including fiber cable, electronics for FTTP, huts and wireless towers, wireless electronics, and customer devices like cable settop boxes and WiFi modems. In addition to the capital needed for the network, there are operational capital costs predicted in the projections for assets like furniture, buildings, computers, vehicles, tools, inventory, and capitalized software.

We have tried to be a little conservative in our estimates so that the actual cost of construction will be something lower than our projections. However, it is important to remember that the engineering used to make these estimates is high level. The detailed engineering needed to be more precise is expensive and would involve having an engineer examine all places in the potential network to look at local construction conditions. That kind of engineering is generally not done until a project is ready for construction. Instead, the engineering was done using some field examination of the city, along with maps and other tools. Finley has made many such estimates over the years, and we know that this level of engineering is generally good enough to assess if a project is worth further consideration.

The cost of the needed assets to build a new fiber network varies according to the number of customers added to the network. Below shows the ranges of costs for customer penetration rates of 45%, 50%, and 55%. In all three cases the numbers represent the cost of the network by the end of the fifth year, by which time we've assumed the business achieves the target customer penetration rate.

	45%	50%	55%
Fiber	$52,302,616	$52,302,616	$52,302,616
Drops	$ 6,300,045	$ 6,995,450	$ 7,660,150
Electronics	$ 9,434,346	$10,068,491	$10,695,694
Huts	$ 1,255,081	$ 1,255,081	$ 1,225,081
Operational Assets	$ 652,272	$ 661,380	$ 666,795
Total	$69,944,360	$71,283,018	$72,580,336
Cost per Passing	$ 2,977	$3,034	$3,089

Customer Costs

Residential Fiber Electronics Costs: The model assumes that the hardware electronics for an ONT cost $413, including the cost of the labor for installation at the home, including inside wiring. In the projections, it was assumed that the installation would be done by external contractors. It might be less expensive to do installations using existing company personnel or local contractors who can install at a lower cost.

We've also assumed that most businesses use the same ONT electronics used to connect to homes. Only larger businesses would require a larger ONT with more data ports.

We've assumed that the service provider will supply a WiFi router for customers that want one. We've assumed these routers cost $159.

Fiber Drops: Fiber drops are the fiber that connects from the street to the customer premises. In this study, the cost of fiber drops is significant. The assumption has been made that with the volume of drops needed plus the anticipated speed of network deployment, that the drops during the first five years of the project would be installed by external contractors. The cost for fiber drops is estimated to be $575.

The costs included in the study represent recent costs from projects in your region. The drops are the one portion of the fiber network where an ISP might be able to save significant money compared to our study. For example, an ISP might be able to assemble its own construction team to build drops for less. They might find a local contractor that will build the drops for less.

Customer Penetration Rates

One of the most important variables in the study is the customer penetration rate or the percentage of the homes and businesses in Joplin that will buy broadband service.

The analysis looks at customer penetration rates in several different ways. The base scenario begins with what we call expected rates. We used an expected penetration rate of 50%. This is lower than what was predicted by the statistically valid survey, which showed a 62% residential interest in buying broadband – but we want to be conservative with our first look at a model because it's a big challenge for any ISP to win 62% of customers in any urban market.

We note that the state of broadband in Joplin should be conducive to a new ISP that builds fiber. AT&T has largely walked away from the copper network and has not built any fiber that we know about to residences. The predominant ISP is Sparklight. Customers don't hate them, but a lot of their customers are the ones saying they'd rather have a fiber alternative. Mediacom only serves a small portion of the study and also has high rates. Bother cable companies have stingy data caps that mean that a lot of households are billed extra each month for using broadband.

Expense Assumptions

As a reminder, unless otherwise noted, all scenarios are created from the perspective of an ISP offering the services. The following assumptions also assume that the same ISP owns the network and operates the business.

Expenses are the recurring costs of operating the business once it's built. We strive when building financial projections to be conservatively high with expense estimates. It's often less costly for an existing service provider to add a new market than what is shown in these projections.

As mentioned earlier, expenses are estimated on an incremental basis, meaning that the models only consider new expenses that would be needed to open the new market for an existing ISP. In an incremental analysis, it's assumed, for example, that the existing ISP is already paying for positions like a general manager, an accountant, etc. and that the ISP only needs to hire employees needed to open a new market and add additional customers.

The primary expense assumptions are as follows:

Employees: Labor is generally one of the largest expenses of operating a broadband network. The models assume that an ISP will need to hire additional staff to take care of the new customers. We have assumed salaries at market rates with an annual 2.5% inflation increase for all positions. We've assumed that the benefit loading is 38% of the basic annual salary. That would cover payroll taxes and other taxes like workers' compensation, as well as employee benefits.

As stated earlier, these models are incremental and only consider the additional labor needed to service the added customers. We are estimating that at a 50% market penetration that the market will need the following new employees:

Customer Service Representative: Takes new orders, answers customer questions about billing, services, etc. We've assumed the business will grow over four years to need six CSRs.

Install/Repair Technician: These technicians provide maintenance and repair calls. The technicians would maintain both network electronics and facilities as well as customers. We've assumed the business will grow to need six technicians over the first five years.

Electronics Technician. We think the business will need to hire one inside technician that takes care of electronics. If the ISP that operates is from the immediate vicinity around Joplin, this position might not be needed.

Operations Manager. There are enough technicians being hired that the business likely would hire a supervisor or manager for the group.

Salespeople. There are enough businesses in the city to justify two full-time salespeople.

Marketing Analyst. It's also a large enough market to justify somebody to lead the residential sales effort – although this function could also be outsourced.

General Manager. This would be a large enough market with almost 12,000 customers to justify a general manager. But ISPs might handle this role instead with a regional manager that oversees other markets or maybe from headquarter if the ISP is close enough. Even if a full-time person wasn't put into the market, there would be a similar dollar cost for handling this in some other way.

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

Start-Up Costs: There are some start-up costs included in each scenario. There are expenses associated with launching a new business or new market, and rather than list them all specifically,

we have included them as start-up costs. There are start-up costs even for an existing ISP when entering a new market. We've assumed the start-up costs at $300,000.

Sales and Marketing Expenses: Every scenario is going to require a significantly high customer penetration rate to be successful. We used the assumption that there would be a marketing effort to sign customers. It's possible that such money would be spent earlier than shown in the model. The marketing budget for the first four years of operations is set at $360,000 per year.

Delivery of Products: The projections assume that the ISP will buy wholesale telephone service. The studies assume that a wholesale basic telephone line can be purchased wholesale at $6.00 per month. A line with unlimited long distance is assumed to be $9.00. It's possible to buy telephone lines for less than these estimates.

The studies assume no cable TV product.

Maintenance Expenses: There are a number of routine maintenance expenses that the new business would incur on an incremental basis. These include:

- Vehicle expenses to maintain the vehicles required for the field technicians.
- Computer expenses to support the computers used by employees.
- Tools and equipment expenses.
- Power expenses to provide power to the network.
- General maintenance and repair of the outside plant network and the electronics to repair damaged or nonfunctional electronics.
- Internet Backbone. Since this is an incremental analysis, we have shown only incremental increases in the cost of internet bandwidth. If this business were served by a new ISP, then the cost of bandwidth would be higher to also cover the cost of transport to reach the Internet.
- Internet Help Desk. The monthly fee for this service covers several different functions. This fee would cover functions needed to deliver broadband, such as spam monitoring and security. This also includes network monitoring. The fee includes the help desk function, which is the function of assisting customers with broadband and network issues. The models assume a monthly cost of $5 per customer. That is a conservatively high number and anticipates buying a whole suite of outsourced services. This could be done for less, and some of these functions can also be done by ISP employees.

Software Maintenance: Triple-play providers maintain a complex software system called BSS/OSS (billing and operational support systems). This software provides a wide range of functions: order taking, provisioning new customers, tracking of customer equipment, tracking of inventory, creation of customer bills, tracking of customer payments (or nonpayment). Since most such software is billed to providers on a per-customer basis, we have assumed an expense for this maintenance.

Billing: Billing costs are shown as the incremental cost used to bill customers. We assumed that there would be some mix of mailing paper bills, of charging bills to credit cards, and of charging bills directly as debits to bank accounts.

Taxes: The model assumes that the ISP that operates the business will pay state and federal income taxes. These taxes would not apply if this were operated as a municipal business or as a non-profit.

We have assumed no property taxes on assets, but it's possible that some amount of this might apply. There are a few places in the country that charge property taxes on fiber networks, but most of the country doesn't. The issue of charging or not charging is usually city-specific.

The forecasts do not include any taxes that are assessed to customers. For example, this business would be expected to charge and collect various telephone taxes. These kinds of fees are normally added to the customer bill, and thus customers pay these taxes. The models don't show these taxes, and the assumption is that the taxes would be collected and sent to the tax authorities on the customers' behalf. They are not shown as revenue or expense to the forecasts but rather are pass-through.

Overhead Expenses: The forecasts include various overhead expenses. Again, since this is an incremental model, it does not include allocated expenses such as an allocation of corporate salaries. But there are incremental costs attributable directly to the new business. This would include things like legal expenses, accounting audit expenses, consulting expenses, business insurance, and other similar expenses that are directly related to entering a new market.

Depreciation and Amortization Expense: The forecasts include both depreciation and amortization expense. These are the expenses recognized by writing off assets over their expected accounting lives. For example, the depreciation rate for a vehicle is 20% per year (is written off over five years). All hard assets are depreciated except land. Depreciation rates are set according to the expected life of the assets—something that is usually determined to comply with IRS rules and accounting standard practices. Soft assets like software are instead amortized, using the same process as depreciation.

D. Financial Results

It is never easy to summarize the results of complicated business plans to make them understandable to the nonfinancial layperson. In the following summary are some key results of each study scenario that we think best allows a comparison of the numbers between scenarios.

The way to measure profitability in a new business will differ according to the structure of the business. A municipal business, for example, generally measures success by the ability of the business to generate enough cash to operate without any external subsidy. While a for-profit business would generally use something like net income and return on equity to measure profits.

Following are the results of the various scenarios. Note that a table of all the financial results is included in Exhibit II. That Exhibit makes it easier to compare different scenarios.

Why the Projections Are Conservative

We always try to make our business plans conservative. By conservative, we mean that an actual business plan ought to perform a little better than we are projecting. Following are some of the conservative assumptions used in the business plan:

- Our model assumes a regular replacement of electronics. However, it is possible that upgrades will be needed less often than we have shown. Further, our assumption is that the cost of electronics at the time of each upgrade would cost as much as the equipment that is being retired. The experience of the electronics industry is that electronics get cheaper and more efficient over time, so the cost of upgrades is probably going to be less than is shown in the model. The vendors in the industry have also gotten better at having phased upgrades that allow for keeping older equipment in place and not having to replace everything, making upgrades less expensive than we have projected.
- There are steps that the new business could take to improve upon these projections.
    - Preselling. We've seen service providers that are able to get earlier revenues when they presell to customers. This gives them the opportunity to begin connecting the network to the homes of presold customers while the network is being built. This would allow customers to be turned on in "nodes" or neighborhood-by-neighborhood as construction to specific neighborhoods is completed.
    - Adding Customers Sooner. These models assume that most customers will be gained by the end of the fourth year. There is a significant cash boost from selling faster and adding customers sooner.
    - More Concentrated Build Schedule. It's always possible to build faster than shown in these forecasts by using extra construction crews.
    - Get Temporary Help. There are often other bottlenecks at small companies that can slow down customer installations. This could mean the need for more sales and marketing staff, additional customer service reps, or inside technicians needed to provision new customers.
- In a market like Joplin, there should be opportunities to generate revenues from some larger customers and opportunities that are not reflected in the model. As an example, the city government or the schools could be an anchor customer for an ISP. It's conservative to not show such revenues, but it's possible to get them.
- As will be discussed later in this report, there is an opportunity in today's environment to get some grant revenue to help to build fiber to selective neighborhoods or opportunities. There hasn't been an opportunity like this in cities for a long time, if ever. Such grants would not be nearly large enough to cover the cost of the whole network, but any amount of grant money can help to cover the cost of building fiber.

Fiber to All of Joplin

This following scenario looks at different ways to finance fiber everywhere. The first scenario shows an external ISP that finances and operates the network. The following two scenarios show the city financing the network and acting as the ISP. This does not reflect a recommendation that the city should be an ISP but is a way to highlight the difference in municipal and commercial financing.

Base Study	Bank Financing	GO Bonds	Revenue Bonds	Breakeven

Asset Costs	$70.78 M	$71.28 M	$71.28 M	$68.84 M
Equity	$ 9.80 M	$ 0.00 M	$ 0.00 M	$ 0.00 M
Bank Debt / Bond	$65.60 M	$83.40 M	$88.90 M	$64.90 M
Total Financing	$75.40 M	$83.40 M	$88.90 M	$64.90 M
Penetration Rate	50%	50%	50%	42%
Cash after 10 Years	$ 8.26 M	$10.21 M	$ 8.75 M	$ 0.86 M
Cash after 20 Years	$20.07 M	$27.43 M	$25.47 M	$ 3.75 M

There are a number of findings that are demonstrated by these results:

- Building fiber in Joplin is financially feasible with traditional bank financing or municipal bond funding. At a 50% market penetration, there is enough cash generated to be profitable under all of these scenarios.
- This summary shows that larger amounts of money must be borrowed to use municipal bonds compared to traditional bank financing. Bond borrowing is larger for several reasons. First, it would be typical for a bond to borrow enough money to cover the interest payments for the first two or three years of the bond. Revenue bonds also likely would require a debt service reserve fund, which is basically a cushion that is kept in escrow to defend against future defaults on making bond payments.
- But even with the greater amount of borrowing, there is more cash generated over time with bond financing. This is due to two reasons. In today's market, the interest rate on municipal bonds is likely lower than the rate on bank financing. But more importantly, bonds can be borrowed over a longer period of time. The scenarios above are comparing bank financing over twenty years compared to bond financing over 30 years. These two factors would mean lower annual debt payments on the bonds.
- Note that the first column using traditional financing assumes equity from the ISP of almost $10 million, representing 15% of the cost of financing the project. There are not a lot of smaller ISPs that have that kind of free cash, and having no equity makes it harder to get traditional bank financing.
- Finally, I would note that the return on the first scenario would be considered as really low by an ISP. An ISP puts almost $10 million in equity into the market and hasn't even earned back the initial equity after ten years. Further, earning an additional $10 million more than initial equity would be considered a very low return over a twenty-year period. There are not a lot of ISPs that would find this scenario to be attractive – which is a big part of the reason why ISPs aren't busy building fiber to markets the size of Joplin.

Breakeven Scenario. This scenario calculates how low the customer penetration rate can drop before the business cannot maintain a positive cash flow. When assuming the key variables in this example - $60 starting rate and 3.5% interest rate for the ISP, the breakeven penetration rate is 42%. As long as an ISP can obtain that market share, the business will be cash self-sufficient. As might be imagined, the breakeven penetration rate will change in relation to changes in other variables – for example, increasing prices could drive the breakeven even lower.

Alternate Tax Funding

Some cities have helped to finance fiber by using an alternate source of revenue to help fund the network. This could mean revenues like property taxes, sale taxes, or any other form of funding that comes from a source other than the fiber business plan.

In today's environment we can also consider the scenario of infusing a one-time down-payment towards fiber. For example, the city could use ARPA funding to make a one-time contribution towards building fiber.

The first column shows the municipal ISP using revenue bond financing. The second column looks at a scenario where the city contributes $1 million per year for ten years using some form of alternate revenue. The third column shows the impact of contributing a one-time $10 million payment.

Alternate Financing	Base Study	$1 Million For 10 Years	One-Time $10 Million
Asset Costs	$71.28 M	$71.28 M	$71.28 M
Bank Debt / Bond	$88.90 M	$81.40 M	$75.00 M
Total Financing	$88.90 M	$81.40 M	$75.00 M
Penetration Rate	50%	50%	50%
Cash after 10 Years	$ 8.75 M	$16.76 M	$12.55 M
Cash after 20 Years	$25.47 M	$38.42 M	$37.39 M

The impact of infusing extra cash into the fiber business from some other source has the primary impact of lowering the size of the bond borrowing. In the first example the bond needed is $7.9 million less. In the second it's $13.9 million less. In both cases, the extra cash contributed early is eventually returned to the city due to the savings on interest expense.

Perhaps the biggest benefit of alternate funding is to remove the cashflow pressure on the business in the early years. The business is far more forgiving for having a slow-start or for having something unexpected happen to the business – such as what might have happened last year during the pandemic.

Sensitivity Analysis

We looked at the impact of changing the various key assumptions – which we call a sensitivity analysis. This allowed us to quantify the impact on cash flow for changing key variables.

Changing Customer Penetration Rate

The base analysis considered a penetration rate of 50% for both residents and businesses. We looked at scenarios of raising the penetration rate to 55% and 60% - based upon the results of the residential survey that predicted a penetration rate of 62%. We also looked at the impact of lowering the penetration rate to 45%.

The impact of increasing penetration rates to 55% is an increase in cash over 20 years of $10.3 million. This means that the impact to the business of a 1% change in penetration rate is a little more than $2 million over 20 years. The impact of raising the penetration rate to 60% was similar at $20.4 million, also around $2 million for each increase of penetration of 1%. The impact from lowering the penetration rate to 45% was similar, with a drop in cash over 20 years of $10.2 million.

We view this as a high sensitivity since getting 1% more of overall customers changes cash flow by $2 million. This would make it vital if launching the business to achieve the target penetration rate.

Changing Broadband Prices

We looked at a scenario of changing broadband prices. Increasing broadband prices by $5 per month (changing a rate from $60 to $65) changed cash flow over 20 years by $9.3 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $1.9 million. The impact of lowering rates was nearly identical.

This is also a significant sensitivity and provides a cautionary warning to any ISP that would tackle this business plan. An ISP must stick to target prices after launch to meet the business plan. If a future decision was made to cut rates to be more competitive, the impact on the bottom line could be huge.

Changing Financing Terms

We looked at the impact of changing the various financing parameters.

Interest Rate. We looked at a scenario that lowered the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 3.5% to 3.0%). This increased cash flow by over $2.8 million over 20 years. The impact of higher interest rates was similar and changed cash over 20 years by $2.9 million.

This is not nearly as drastic as the impact of changing prices or customer penetration rates. This is still a warning that an ISP that wants to build the network must keep a close eye on interest rates and be ready delay financing if interest rates move too high. We've been lucky for the last decade that interest rates have held steady for years at a time, but over history, it's more normal for interest rates to fluctuate.

Loan Term. We looked at the impact of increasing the loan term from 20 years to 30 years. This increased cash over 20 years by over $21.7 million. This provides a great incentive to consider the longest loan maturity that can be achieved. Longer loans mean lower annual debt payments (just like with a home mortgage). Most loans or bonds can be repaid earlier or refinanced, but the longer the loan term, the smaller the annual required debt payments and the less the pressure on cash.

We also looked at decreasing the loan term from 20 years to 15 years. This had only a minor impact on overall cash flow over 20 years, but it drove the project to fund out of cash. By year fifteen of the bond issue, the project was $2.2 short on needed cash – not something that an ISP wants to experience. It doesn't look reasonable to finance for a period much shorter than twenty years.

This has significant implications in that it eliminates and lending sources that aren't willing to loan for that long of a loan term.

Changing the Cost of Fiber by 5%

We examined the impact of increasing the cost of the network. In this case, we chose to increase the cost of construction by 5%, or about $2.1 million This changed cash over 20 years by $1.8 million. This shows that there is only a relatively minor impact of changing the cost of the capital needed to build the network – as long as this is known and done before financing is closed. It's never good to go over budget once financing has been completed, particularly with bond financing that borrows the cost of the project upfront.

The Additive Nature of the Variables

The impacts cited for the various variables are somewhat additive. For example, the above discussion describes an improvement to cash generated by the business from finding a lower interest rate on debt than shown in the models and for spending less on the network. These improvements are roughly additive, meaning that you can add the results above together and will come close to the impact of making both changes in the projections.

Other Operating Models

Operator for Hire

In this scenario, the city funds and builds the network but decides that it doesn't want the responsibility of being an ISP. The city would hire an ISP to operate the business for a fee. The ISP would have full operational authority – it would hire employees and operate the business as if it was its own. But the revenues from the business go to the city owner. In the scenario below, I assumed that the ISP would earn an operating fee of $1 million per year to operate the business.

Following is a summary of financial results of the operator for hire scenario. The first column is the retail ISP version with the city as the ISPs from above for comparison.

	Base Study	Operator For Hire
Asset Costs	$71.28 M	$71.28 M
Equity	$ 0.00 M	$ 0.00 M
Bank Debt / Bond	$83.40 M	$83.40 M
Total Financing	$83.40 M	$83.40 M

Penetration Rate	50%	50%
Cash after 10 Years	$10.21 M	$ 3.57 M
Cash after 20 Years	$29.43 M	$13.37 M

The bottom line for this scenario is that a lot of the profits of the business go to pay for the operator. However, if the business has a high enough margin, the city could still hire an operator and be profitable, as shown below. The downside risk is that the ISP won't have the same motivation and drive to succeed as would an ISP that owned the business.

Open-access

We explored the open-access scenario. In this scenario, the city would build the fiber network and the electronics and would lease individual loops to ISPs to reach customers. All retail revenues would go to the ISPs. The assumptions for wholesale loop rates for residential customers are as follows:

Basic broadband loop	$35
Faster broadband loop	$45
Gigabit loop	$55

These are typical rates for an open-access network, and we see rates between $30 and $45 nationwide. Setting the wholesale loop rate can be a real challenge because raising the wholesale rates invariably means higher retail rates – and that likely means a lower customer penetration rate.

Following is a summary of financial results of the open-access scenario. The first column is the retail ISP version with the city as the ISP from above for comparison.

	Base	Open-access	
	Study	City	ISPs
Asset Costs	$71.28 M	$68.60 M	$ 2.43 M
Equity	$ 0.00 M	$ 0.00 M	$ 0.90 M
Bank Debt / Bond	$83.40 M	$74.30 M	$ 1.80 M
Total Financing	$83.40 M	$74.30 M	$ 2.60 M
Penetration Rate	50%	50%	50%
Cash after 10 Years	$10.21 M	($12.49 M)	$16.58 M
Cash after 20 Years	$29.43 M	($41.12 M)	$48.83 M

These results are spectacularly unfavorable for the city. The city still has to build almost the identical network as if it was going to be a retail ISP. But the city's revenues are drastically lower – it collects only the loop charges instead of the much higher retail rates charged to customers. The city would also still have to employ several technicians to care for the network and the electronics.

There are a few observations of these results:

- The city would incur significant losses implementing open-access, and there doesn't appear to be any way to do much better than shown above. If the open-access loop rates are increased, the number of customers sold will drop. If the city tried to cut capital costs by asking the ISPs to pay for the home electronics or the fiber drop, we know from experience that the penetration rates will drop since ISPs are not interested in this model if they have to spend upfront capital.
- You might think that ISPs love open-access, but this operating model puts them into a competitive situation where they compete on price with other ISPs. Every ISP is using the same fiber network and has no technical advantage. The only way for ISPs to differentiate is through pricing or customer service.

Public-Private Partnership – Partner Leases the Network

In this scenario, the city would finance and build the network and would lease it to a single ISP. In this scenario, the city has no employees, meaning a tiny ongoing operating expense – the ISP that leases the network is expected to maintain the network as part of the partnership.

In this scenario, the lease cost is set at an amount to fully cover the city's cost of debt. As you can see, under this scenario, the city is taking almost no risk since the ISP is essentially guaranteeing to cover the debt. The big question to answer is if there is an ISP willing to take this much risk. The ISP takes all of the risks of failure, including the ISP is covering the cost of the city debt before it has all of the customers. The only example of this scenario we know about is the arrangement between Google Fiber and Huntsville, Alabama – an arrangement that I don't think Google Fiber would ever duplicate.

This is scenario worth considering if the city can find an ISP willing to take on the risks. It might be possible to give access to the network to more than one ISP, although that gets to be complicated from an operational perspective.

Following is a summary of the financial results of this scenario. The first column shows the retail ISP version with the city as the ISP for comparison.

	Base	Network Lease	
	Study	City	ISPs
Asset Costs	$71.28 M	$68.42 M	$ 2.67 M
Equity	$ 0.00 M	$ 0.00 M	$ 1.10 M
Bank Debt / Bond	$83.40 M	$74.30 M	$ 5.70 M
Total Financing	$83.40 M	$74.30 M	$ 6.80 M
Penetration Rate	50%	50%	50%
Cash after 10 Years	$10.21 M	$ 0.10 M	$ 4.66 M
Cash after 20 Years	$29.43 M	$ 0.08 M	$17.62 M

There may be scenarios where an ISP will consider this arrangement. The results show a good return for the ISP considering the tiny equity investment. This is the kind of arrangement that might be made with a local non-profit ISP or perhaps a cooperative that doesn't have a big profit motive.

Public-Private Partnership – Dark Fiber Lease

We don't know the exact terms, but this scenario is similar to the arrangement between CenturyLink and the Springfield. In this scenario, the city still builds fiber everywhere, but the ISP lights the network. This presentation has been simplified to show only one ISP leasing the entire network – where Springfield expects additional ISPs to help cover the cost of the network.

In this scenario, the city would have to maintain the technicians that take care of the fiber network but would have little other costs.

In the scenario below, the dark fiber lease is set to fully cover the city's cost of debt plus a fixed annual amount to cover operating expenses. This would be an almost risk-free venture if one ISP agreed to lease the whole network. More likely, this is a high-risk venture. Any additional ISPs coming to the network will have to pay to light the portions of the network they want to use. The big question faced by Springfield or anybody else using this model is if enough ISPs will agree to lease the network under these terms. For example, in Springfield, it looks like CenturyLink has a head start over other ISPs. Will other ISPs be willing to make the investment needed to compete with CenturyLink? If the city is unable to find enough ISPs to cover the full financing costs, the city would end up permanently subsidizing the network.

However, this is a scenario worth considering if the city can be happy to recover most, but perhaps not all, of the cost of debt. The big question is if the benefits to the city of having fiber everywhere outweigh the cost of subsidizing the network.

Following is a summary of the financial results of this scenario. The first column is the retail ISP version with the city as the ISP from above for comparison.

	Base	Dark Fiber Lease	
	Study	City	ISPs
Asset Costs	$71.28 M	$60.48 M	$11.24 M
Equity	$ 0.00 M	$ 0.00 M	$ 2.70 M
Bank Debt / Bond	$83.40 M	$69.40 M	$13.60 M
Total Financing	$83.40 M	$69.40 M	$16.30 M
Penetration Rate	50%	50%	50%
Cash after 10 Years	$10.21 M	$ 2.69 M	$ 1.15 M
Cash after 20 Years	$29.43 M	$ 0.00 M	$14.25 M

One of the downsides of this model is that it requires an ISP to make a substantial capital investment in the electronics to use the network. That requirement will drastically curtail the list of ISPs willing to operate on a municipal network.

What Conclusions Can We Draw from the Financial Results?

There are a number of conclusions we can draw from the results of the business plan analysis:

It Looks Feasible for a Broadband Business to Succeed

We were a bit worried in considering an all-buried network that the cost of the network would make it difficult to be profitable. However, all of the scenarios we considered for a retail ISP – whether done by a commercial ISP or with the city, show a decent chance of success.

Probably the most important result of the analysis is the calculation of the breakeven customer penetration of 42% of the market. That is far below the 62% result of the residential survey of residents who said they would likely buy broadband from a new fiber network. There is always the risk of building the network and not achieving the needed 42% penetration rate – but the numbers all align to say that a well-run ISP has a chance to succeed in the Joplin market.

The Business is Sensitive to a Few Key Variables. All the scenarios are sensitive to changes in a few key variables. This sensitivity would apply to both the city and a commercial ISP operating the business.

- Penetration Rate: The most important variable is customer penetration rate. Our analysis assumed a 50% customer penetration. We note that this is not as high as what is predicted by the statistically valid survey, but we want to be somewhat conservative. In the study, we looked at the impact of increasing the penetration rate to 55% and 60%.

  The impact of increasing penetration rates to 55% is an increase in cash over 20 years of $10.3 million. This means that the impact to the business of a 1% change in penetration rate is a little more than $2 million in cash flow over 20 years. The impact of raising the penetration rate to 60% was similar at $20.4 million, also around $2 million for each increase of penetration of 1%. The impact from lowering the penetration rate to 45% was similar, with a drop in cash over 20 years of $10.2 million.

- Broadband Prices: The financial results are also sensitive to broadband prices. The studies all used an assumed starting price of $60 for the basic broadband product. Increasing broadband prices by $5 per month (changing a rate from $60 to $65) changed cash flow over 20 years by $9.3 million. This means that a $1 change in broadband prices changes 20-year cash flow by approximately $1.9 million. The impact of lowering rates was nearly identical.

- Interest Rate: We also considered the impact of changing the interest rate on debt. We looked at a scenario that lowered the interest rate by 50 basis points, or 0.5 % (such as changing the interest rate from 3.5% to 3.0%). This increased cash flow by over $2.8 million over 20 years. The impact of higher interest rates was similar and changed cash over 20 years by $2.9 million.

- Loan Terms. We looked at the impact of increasing the loan term from 20 years to 30 years. This increased cash over 20 years by over $21.7 million. This provides a great incentive to consider the longest loan maturity that can be achieved.

> We also looked at decreasing the loan term from 20 years to 15 years. This had only a minor impact on overall cash flow over 20 years, but it drove the project to run out of cash, and by year fifteen of the bond issue, the project was $2.2 short on needed cash. An ISP could compensate for this by raising rates or lowering expenses, but it's not the kind of problem you want to see in a forecast. The bottom line is that it looks challenging to finance for a period much shorter than twenty years.

It is essential before deciding to get into the business to pin down these key variables. This means that an ISP can't take the financial results listed above or in Exhibit II as the straight answer, because changing any of the key variables can change the result of any financial projection. To some extent, the effects of the variables are additive. For example, the improvements that might be achieved through raising the rates or lowering the interest rate on debt can be added together if both variables change. The more the ISP knows about how a project will be financed, the more concrete any projection becomes.

Open-access Doesn't Look Possible. The scenario where the city leases fiber loops to multiple retail ISPs doesn't look feasible. The losses for the city were gigantic over time, while the ISPs will likely be profitable.

In this scenario, the city leases loops at prices between $35 and $55 per customer. That's the only revenue source for the city, and it's not high enough to cover the cost of debt. There is no way to make the business work by raising loop rates because the higher those rates, the more the retail ISPs would charge, and the lower the customer penetration rate. There doesn't seem to be an open-access network that comes even close to breaking even.

Partnership Options Look Possible. There are scenarios where the city could partner with one or more ISPs to operate the network and business.

> Operator for Hire. This scenario can work as long as the base case without the operating partner is strong enough. In this scenario, the city builds the network and hires an ISP to operate the business. The network and ISP business still belongs to the city. This might make sense for a city like Joplin that doesn't operate an electric utility. A professional operator would bring technical and industry expertise. It would also be a way to isolate the business from any influences from local politics. Like with any partnership scenario, the challenge would be to find an ISP willing to tackle operating the business.
>
> There are some operational benefits of this plan. Employees would work for the ISP and not the city. That means the city wouldn't increase its burden for future retirement and pension costs.
>
> Leasing the Network. In this scenario, the city would build the fiber network and lease it to an ISP. The city's only revenues would be from the lease, and the customers all belong to the ISP. The ISP would fully operate the fiber and electronic network. The ISP would pay for any electronics after the first generation. This scenario would be almost no-risk for the city if a lease can be set to fully recover the cost of debt. The big challenge with this scenario would be finding an ISP willing to take on the risk of leasing the network. That ISP gets to avoid the whole ordeal of financing a large network, but the ISP also would take on all of the downside operating risk. If the ISP can't

generate enough cash to make the lease payments, the ISP could end up in a permanent subsidy situation.

Leasing Dark Fiber. This scenario is similar to the arrangement between CenturyLink and Springfield, Missouri. In this scenario, an ISP leases dark fiber from the city. The ISP is responsible for funding and operating all network electronics. This scenario could break even if a lease is set high enough. In this scenario, it's likely that the city would still have to maintain the fiber network and would need a few outside technicians.

Springfield's goal is to find multiple ISPs to promote competition. That means the lease for the first ISP is almost certainly not high enough to cover the city's full costs. The challenge with this scenario is getting the right mix of ISPs together to pay for the network. That's not going to be easy. Each ISP has to make a significant investment to light the network – many ISPs won't be willing or able to make an investment on a network it doesn't own. Further, the first ISP leasing the network will have a market advantage over subsequent ISPs if the first ISP gets a jump start on the market.

This business could work, and with enough ISPs on the network, the city might even make a profit. But there seems to be a considerable risk for not getting enough ISPs onto the network to cover the city's costs, which would mean a permanent subsidy situation. There are cities that are tackling this kind of concept with eyes open that the city will have to fund part of the fiber network from tax revenues. The reason that the benefits to the community and to the city are greater than any shortfall on covering bond costs. But a city should make a specific policy decision up from to subsidize the network rather than find itself in an unexpected cash loss situation.

IV. OTHER ISSUES

A. Funding for Broadband Networks

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

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

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

Private Financing Options

When commercial ISPs build networks, they must rely on traditional private financing, meaning loans. Following are the key elements that determine the cost of bank financing:

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

Equity can take a number of different forms:

- Cash: Cash is the preferred kind of equity and lenders like to see cash infused into a new business that can't be taken back out or that doesn't earn interest.
- Preferred Equity: For a stock organization (like an LLC or other type of corporation) the business can issue some form of preferred stock that then acts as equity. Preferred equity usually gets some sort of interest rate return, but the payments are not usually guaranteed like they are for bank loans. If the business gets into a cash crunch, they must pay bank loans and other forms of debt before they pay preferred equity interest.
- Assets: It's possible to contribute assets as equity. For example, a new fiber venture might be seeded by having one of the partners contribute an existing fiber route or another valuable asset to the business. In such a case, the contributed asset often must be assigned a market value by an independent appraiser.
- Non-recourse Cash: Non-recourse cash means accepting a contribution to the business that is not guaranteed to be paid back. To give an example, a broadband cooperative was launched in Sibley and Renville counties in Minnesota. The local government provided an economic development bond to the business as a non-recourse loan. This means that the new fiber business will make their best effort to make the bond payments, but if they are

short of cash, then the government entities that issued the bonds would have to make the bond payments. The banks involved in that project looked at the contributions from the bonds to be the same as equity.

Bank Loans: The banking industry as a whole does not like to finance long-term infrastructure projects. This is the primary reason why the country has such an infrastructure deficit. Fifty or more years ago, banks would fund things like power plants, electric and water systems, telephone networks, and other long-term revenue-generating assets. But various changes in banking laws have required banks to maintain larger cash reserves which makes them less willing to make long-term loans. Banks have also increased their expectations over time to want to earn higher interest rates. Many attribute this to the fact that giant publicly traded banks have captured most of the banking market. Banks don't like long-term loans since the interest rates get locked in for many years, possibly depriving the banks of earning more on their own equity.

Most banks prefer not to make loans with a term much longer than 12–15 years, and many telecom projects can't generate enough cash in that time period to repay the loans.

There are exceptions. A few of the large banks like Key Bank and Bank of America have divisions that will make bank loans to municipal ventures that look a lot like bonds. These loans will have long payment terms of 20 years or more and reasonable interest rates. However, most of these loans go for things like power generation plants and other projects that have a strong guaranteed revenue stream. These banks have done a tiny handful of telecom projects, but they view most broadband projects to be too risky.

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

There is one unique banking resource available to companies who want to build fiber projects. This is CoBank, a boutique bank, and a cooperative. This bank has financed hundreds of telecom projects, mostly for independent telephone companies and electric cooperatives. CoBank is a relatively small bank and has strict requirements for financing a project. They are leery of start-ups, and we can't think of a start-up they have financed recently. They also expect significant equity to be infused into a new venture. They tend to offer somewhat short loan terms of 10–12 years.

Cooperatives also have another bank that lends only to cooperatives. This is RTFC (Rural Telephone Financing Cooperative) that is owned by cooperatives.

One interesting source of bank financing is local banks. Historically local banks were the source in many communities for car and home loans. But over the last few decades, those loan portfolios have migrated to other lenders, and local banks have been struggling for a decade to find worthwhile projects in their regions. We know of many commercial projects for small telcos that have been financed by local banks.

The biggest challenge of borrowing from a local bank is that they typically have a relatively small lending limit. Most local banks won't make an individual loan for more than a few million dollars. That obviously doesn't go far in a fiber project. However, local banks have become adept at working in consortiums of multiple banks to make larger loans. This spreads the risk of any one loan across many banks. A banking consortium usually begins with a local bank in the area of the project, with the local bank taking the role of finding other banking partners and of servicing the loan. This approach requires a lot of extra effort from a local bank, but the approach has been used to finance good telecom projects.

Collateral. The biggest issue that banks have in lending to broadband projects is the lack of collateral, which is the assets they inherit if the project should fail. Banks like hard collateral like buildings, vehicles, shares of stock, and things they know they can readily sell for a reasonable price. Banks don't like broadband networks as collateral because even a little bit of web searching shows them that networks are sometimes sold for pennies on the dollar.

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

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

Federal Loans

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

RUS. makes broadband loans and loan guarantees to:

- Finance the construction, improvement, and acquisition of facilities required to provide broadband, including facilities required for providing other services over the same facilities.
- Finance the cost of leasing facilities that are required to provide broadband if the lease qualifies as a capital lease under Generally Acceptable Accounting Procedures (GAAP). The financing of such a lease will be limited to the first three years of the loan amortization period.

- Finance the acquisition of facilities, portions of an existing system, and/or another company by an eligible entity, where acquisition is used in the applicant's business plan for furnishing or improving broadband. The acquisition costs cannot exceed 50 percent of the broadband loan amount, and the purchase must provide the applicant with a controlling majority interest in the equity acquired.
- Finance pre-loan expenses, i.e., any expenses associated with the preparation of a loan application, such as obtaining market surveys, accountant/consultant costs for preparing the application, and supporting information. The pre-loan expenses cannot exceed 5% of the broadband loan, excluding any amount requested to refinance outstanding telecommunication loans. Pre-loan expenses may be reimbursed f they are incurred prior to the date on which notification of a complete application is issued.

RUS. is allowed to make loans to a wide range of entities. Borrowers can be either non-profit or for-profit and can be one of the following: corporation; limited liability company (LLC); cooperative or mutual organization; Indian tribe or tribal organization as defined in 25 U.S.C. 450b; or state or local government, including any agency, subdivision, or instrumentality thereof. Individuals or partnerships are not eligible entities.

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

- Submit a loan application. We note that the loan application requires a lot of work, including such things as pre-engineering, surveys, mapping, financial business plan models, environmental impact studies, and other things which make the application expensive to prepare.
- Agree to complete the build-out of the broadband system described in the loan application within three years from the date the borrower is notified that loan funds are available.
- Demonstrate an ability to furnish, improve, or extend broadband in rural areas.
- Demonstrate an equity position equal to at least 10% of the amount of the loan requested in the application; and
- Provide additional security if it is necessary to ensure financial feasibility as determined by the administrator.

The following describes how RUS. loans have been administered over the past few decades:

- The rules say that a project needs at least 10% equity, but in reality, this is often expanded to be anywhere from 20% to 40% at the discretion of the RUS. In effect, the RUS. acts as a bank and they will require enough equity that the project can adequately cover debt payments.
- The loan terms are generally in the range of 12 years, sometimes up to 15 years for fiber projects. This is much shorter than the terms available on bond financing, meaning the annual payment would be higher under a RUS. loan than with a bond.
- It is exceedingly hard to get a project funded for a start-up business. The RUS. typically wants the whole company of the borrower pledged as collateral. Thus, the bigger and the more successful the existing company, the easier it is to meet their loan requirements.
- Their collateral requirements are overreaching in other ways that make them hard to work with for municipal projects. For example, if the project is going to share fiber with some existing network, such as one built by a school system, they would want that asset as collateral. This is generally not possible.

This makes the RUS. a very unlikely funding source for a municipal venture or for any start-up venture. To the best of our knowledge, the RUS. has never yet successfully funded a municipal venture and they rarely approve a project for a start-up business unless it is extremely well funded by a demonstrably successful company.

The other big drawback of these loans is that they take a long time to process. They often have a backlog of loan applications at the RUS. of 12–18 months, meaning you have to wait a long time after application to find out if they will fund your project. Very few existing companies are willing to wait that long unless they are certain they will be funded. If you are coordinating these loans with other forms of financing, this wait is not practical. The loans are granted by using a very detailed checklist and rating system. This system gives a big preference to making new loans to existing RUS. borrowers.

However, the loan fund is quite large and currently sits at more than $1 billion. Congress generally has been adding additional funds to the RUS. pot each year. The RUS. also has some discretion and they have it within their power to make a grant as part of the loan. This is something that can't be counted on, but we know of projects where the borrower only had to pay back 80% of what they borrowed. The interest rates can be lower than market in some cases, but for the last several years, with low interest rates everywhere, the RUS. loan rates were not much cheaper than commercial loans.

These loans also require a significant paperwork process to draw down funds along with significant annual reporting requirements.

Public Financing Options

The two primary mechanisms used for public financing are revenue bonds and general obligation bonds. There are some major benefits of using bond financing. First, the term of the bond can match the expected life of the assets, and it is not unusual to find bonds for fiber projects that stretch out for 25 or 30 years. It's also possible to finance a project completely with bonds, meaning that no cash or equity is needed. The primary historical source of public money used to finance telecom projects is through the issuance of tax-exempt municipal bonds, meaning the buyers of the bonds don't have to pay federal and/or state income taxes on the revenue from the bonds.

> **Revenue Bonds**: Most of the municipal fiber networks that have been built have been financed through revenue bonds. Revenue bonds are backed by the revenues and the assets of the fiber network and the associated business. With a pure revenue bond, a local government will not have to repay the bonds if the project fails. With that said, having a bond default is a financial black eye that might make it hard for a community to finance future projects. So, to some degree, most governments feel obligated to pay back revenue bonds since there is a big long-term cost for not doing so.
>
> It has gotten harder to finance broadband projects with pure revenue bonds due to some failures on the part of other municipal networks. Among these are Monticello, MN; Crawfordsville, IN; and Alameda, CA. These kinds of failures have made investors leery about buying bonds that are only backed by the business. This reluctance has made financing with revenue bonds more expensive.

The cost of a bond issue cannot be judged only by the interest paid. In fact, the other financing costs of bonds can outweigh the interest rate for the bottom-line cost of repaying a bond issue. Because of market reluctance to buy revenue bonds, they often have higher interest rates than general obligation bonds, but they also can incur the following costs:

Debt Service Reserve Fund (DSRF): Many revenue bonds require borrowing additional funds to be kept in escrow as a hedge against missing future payments. The DSRF is often set to equal a year's worth of principal and interest payments. This money is put into escrow and is not available to operate the business.

Capitalized Interest: Bonds begin accruing interest from the day the money is borrowed. Since fiber businesses take a number of years to generate enough cash to make bond payments, the bondholders require capitalized interest that is used to make the interest payments for up to the first five years of the project. Basically, the project must borrow the amounts needed to make debt payments which can add a significant amount to the size of the bond issue.

Bond Insurance: Bond insurance is an up-front fee paid to an insurance company that will then pay one year of bond payments to bondholders in case of a default. We've seen bonds issued that have required both a debt service reserve fund and bond insurance.

For the last decade, the interest rates charged to bonds have been lower than the interest rate on commercial loans. But that has not always historically been the case. The difference between bond interest rates and commercial interest rates both change over time; that difference is referred to in the industry as the "spread." Sometimes the spread favors bonds, and at other times, it favors commercial borrowing. In our financial analysis, we assumed that the interest rates are lower on bonds. Interest rates are also not the same for all kinds of bonds. For instance, the interest rate for revenue bonds can be considerably higher than general obligation bonds due to the perceived higher risk.

General Obligation Bonds (GO Bonds): If revenue bonds aren't an option, then the next typical alternative is general obligation bonds. General obligation bonds are backed by the tax revenues of the entity issuing the bonds. This backing can be in the form of various government revenues such as sales taxes, property taxes, or the general coffers of a government doing the borrowing.

What these pledges mean is that if the broadband project fails and can't make the bond payments, then the backing, then the pledge revenue source, such as property or sales tax, would have to be used to make the bond payments.

Many states require a referendum to approve general obligation bonds. Most states have a few exceptions for things like economic development bonds that don't require a referendum, but local governments sometimes hold a referendum anyway just to make sure the public supports the initiative being financed.

There are other financing mechanisms that have been used by other municipalities to fund revenue-generating projects. These include:

Variable Rate Demand Obligations (VRDOs): A VRDOs is a bond where the principal is paid in a lump sum at maturity. However, the borrower has the right to repay the bonds in whole or in part at any time (upon an agreed-upon notice). VRDOs are effective in circumstances when the borrower wants to match the repayment of the bonds to a revenue stream that varies year to year or a revenue stream that can vary from initial estimates and changes over time. In the case of the new telecommunications system, this type of financing provides the flexibility to make bond payments that match the actual revenues received. If revenues are slower than anticipated, principal payments do not need to be made. If revenues come in faster than anticipated, repayment of the bonds can be accelerated without penalty. We can recall having only ever seen this used once for a municipal telecom system by the city of Alameda, California. This kind of financing is used fairly routinely for other kinds of municipal needs.

VRDOs are most commonly structured as 7-day floating rate bonds. Interest rates are reset each week, and this adds a lot of risk to this type of financing. Unlike fixed-rate bonds, the borrower doesn't know what the interest rate will be on the VRDOs over the life of the issue. Interest rates on VRDOs are on the short end of the yield curve and have historically been lower than interest rates on fixed-rate bonds even with the additional ongoing costs for a liquidity provider and a remarketing agent. There is typically a maximum rate stated which the VRDOs cannot exceed. But if there is a significant increase in market interest rates, this kind of financing could end up being significantly more expensive.

Capital Appreciation (Zero Coupon) Bond (CABs): A CAB is bonds that is issued at a deep discount, and which do not bear any stated interest rate. Like a Series E savings bond, a CAB is bought at a price that implies a stated return, calculated on a basis of the bond being payable at par at maturity. With no stated interest rate, there is no interest paid until maturity, at which time all the compounded accreted interest is paid. With no interest payments required in the beginning years of the bonds, this would enhance the cash flow in the beginning years of the business.

A CAB has several drawbacks over other types of available financing. First, the interest rates on a CAB is typically higher than both the fixed-rate and VRDOs. Second, investors prefer not to have a prepayment option on a CAB, which limits the flexibility of the government to call the bonds early if revenue collections are better than anticipated or if a restructuring of the debt is needed. This structure is used frequently for various government borrowings, but we've not ever heard of this being used for telecom—although there is no reason why it could not be used.

Comparing Bond and Bank Financing

Benefits of Bond Financing: There are several major benefits for using bond financing:

- The term of the bond can match the expected life of the assets, and it is not unusual to find bonds for fiber projects that stretch out for 25 to 30 years. It's difficult to finance a commercial loan longer than 15 years. The longer the length of the loan, the lower the annual bond payments.
- Bonds can be used to 100% finance a project, meaning there is no need for cash or equity to fund the new business. Lack of cash equity is generally the requirement that creates a challenge for traditional commercial financing.

- Bonds often, but not always, have lower interest rates than commercial debt. The interest rate is dependent upon several factors, including the credit worthiness (bond rating) of the borrower as well as the perceived risk of the project.
- It's generally easier to sell bonds than to raise commercial money from banks. Sometimes bonds require a referendum, but once bonds are approved, there is generally a ready market for buying the bonds and raising the needed funds.

Benefits of Commercial Financing: There are also a few benefits for commercial financing.

- Generally, the amount that must be borrowed from commercial financing is lower, sometimes significantly lower. This is due to several issues associated with bond financing. Bond financing often contains the following extra costs that are not included with commercial loans:
    - Surety: Bonds often require a pledge of surety to protect against a default of the bonds. The two most common kinds of surety are the use of a debt service reserve fund and bond insurance. A debt service reserve fund (DSRF) borrows some amount of money, perhaps the equivalent of one year of bond payments, and puts it into escrow for the term of the bond. The money sits to be used to help make bond payments should the project have trouble making the payments. Bond insurance works the same way, and a borrower will pre-pay an insurance policy at the beginning of the bond that will cover some defined amount of payments in case of a default.
    - Capitalized Interest: Bonds typically borrow the interest payments to cover bond payments for some period of time, up to 5 years.
- Construction Loans: Another reason that commercial financing usually results in smaller debt is through the use of construction financing. A commercial loan will forward the cash needed each month as construction is done, and interest is not paid on funds until those funds have been used. However, bonds borrow all of the money on day one and begin accruing interest expense on the full amount borrowed on day one.
- Deferred Payment: Commercial financing often will be structured so that there are no payments due for the first year or two. This contrasts with bonds that borrow the money required to make these payments. Fiber projects, by definition, require several years to generate revenue, and deferring payments significantly reduces the size of the borrowing.
- Retirement of Debt: It's generally easy to retire commercial debt, which might be done in order to pay a project off early or to refinance the debt. This contrasts to bonds that often require that the original borrowing be held for a fixed number of years before it can be retired or refinanced.

Grants

It currently feels like it's almost raining grants because there currently is a lot of grant programs all hitting the street at the same time.

Federal Broadband Grants: Most of the traditional federal broadband grants are aimed at improving rural broadband, so none of these funds would be available in Joplin. Following are the traditional grant programs that are always mentioned when talking about federal broadband grants:

ReConnect Grants.[16] In the 2017 Farm Bill, Congress created a grant program called ReConnect. The program awarded $200 million in grants, $200 million in loans, and $200 million in a combination of grants and loans in 2019. The program awarded $661 million in grants from the 2020 grant program. There will be an even larger amount of funding in the program, with the grant amounts to be announced later this year.

Community Connect Grants.[17] This program specifically targets the poorest parts of the country and ones with little or existing broadband. This program has awarded $160 million since 2013. Grant awards for the program are generally between $100,000 and $3 million and require at least a 15% matching from the grant recipient.

Broadband U.S.A Program.[18] This program is part of the Department of Commerce's National Telecommunications and Information Administration (NTIA). The agency provides an annual database of grants that can sometimes be used for broadband (and are often used for other purposes). Examples include the Appalachian Regional Commission and the Community Development Block Grant (CDBG) Program.

The NTIA is also overseeing a grant program for $280 million that is aimed at rural partnerships. The NTIA is also currently overseeing a $1 billion grant program for Tribes.

EDA Grants. The Economic Development Agency awards grants for counties in the U.S. that are economically challenged. EDA grants can be used for a variety of purposes, and for the last decade, many rural communities got grants to fund broadband. The agency was recently given $3 billion in funding for grants, and the rules and grant deadlines should be announced sometime this fall.

2021 Grants. There are a lot of new grant opportunities for grants that are funded by the $1.9 trillion American Rescue Plan Act (ARPA).

Emergency Connectivity Fund. This is $7.171 billion in E-Rate funding that is to provide funding for expenditures that have already been requested by schools for emergency educational connections and devices for library patrons and school students. This is to provide funding to make sure that schools and libraries have enough laptops, tablets, hotspots, and broadband subscriptions for students to function in the current fall school year. Any funds remaining after accepting all applications for future purchases will be used to reimburse past eligible purchases made during the COVID-19 pandemic.

Coronavirus Capital Projects Fund (CCPF) is intended to fund "capital projects directly enabling work, education, and health monitoring, including remote options, in response to the public health emergency." The U.S. Treasury Department is in charge of this funding and has indicated that the money will be predominantly used for broadband. Treasury's goal is to use the money to fund projects that will meet the "continuing need for connectivity in response to the COVID-19

[16] https://www.usda.gov/reconnect
[17] https://www.rd.usda.gov/programs-services/community-connect-grants
[18] https://www.broadbandusa.ntia.doc.gov/new-fund-search

pandemic." There are also opportunities for capital projects that provide other forms of connectivity access, such as community co-working hubs with digital assets.

Coronavirus State and Local Fiscal Recovery Funds provide $370.9 billion to state, local, territorial, and tribal governments. These funds can be used for several major categories of infrastructure, including power, water, and broadband. This is the most interesting and possible the most useful funding because the city has money that it can direct to those kinds of infrastructure. There is still a lot of debate at the policy level about how cities like Joplin can use the funding. Already it seems like there is a consensus it could be used to bring broadband to low-income parts of the community that are on the wrong side of the digital divide. By this fall it's likely that this will all be finalized.

Other Grants. The ARPA grant spread money around to a lot of other programs that could benefit parts of the community. There are grants that can be used for broadband training and for digital inclusion programs.

As an example of how widely the funding was dispersed through the government, there are nearly a dozen grants that could be used to assist the libraries. The biggest is a $200 million grant to the Institute of Museum and Library Services. This is an independent federal agency that provides grant funding for libraries and museums. $178 million of the $200 million will be distributed through the states to libraries. Each state is guaranteed to get at least $2 million, with the rest distributed based upon population. This is by far the largest federal grant ever made directly for libraries. There are other grants that can be used to pay for hotspots, modems, routers, and laptops.

Future Federal Grants.

The broadband industry is abuzz since the U.S. Senate included a huge broadband grant program in the recently approved infrastructure plan. This still has a way to go to become law since the House must now pass an infrastructure bill, and then the two bills reconciled.

The Senate bill proposes a $42,45 billion grant program that would be administered by the NTIA, with the money going to the states to distribute to broadband projects. Of those funds, there is a 10 percent set aside for high-cost areas based on the proportion of unserved locations in high-cost areas in the state compared to those in all states, and with at least $100 million going to each state. The remaining amount would be allocated to states based on the proportion of unserved areas in the state relative to the unserved areas in all states.

State Grant Programs

Missouri Broadband Program.[19] 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.

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

- Increase broadband adoption & awareness
- Promote efficiencies and opportunities in broadband development

Missouri Broadband Grants.[20] This grant program was established in 2018. For now, this is only a rural broadband grant program because it will only fund projects in places where broadband speeds are 10/1 Mbps or less. The grant funds can be used to build basically any technology because a project must deliver speeds of only 25/3 Mbps. 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. It seems unlikely that this fund will ever be available for fiber in cities.

As this report was being written, Missouri Governor Michael Parson announced that he will ask the legislature in January to use $400 million of the State's share of the American Rescue Plan Act for broadband. This money, if approved, would likely be administered through this grant program, although the rules on what can be funded would change. We'll have to see the rules for this funding because it's possible that some of this funding could be used in cities for reaching low-income neighborhoods or other uses – but all to be defined by the legislature and the Office of Broadband Development.

Capital Projects Fund. The ARPA legislation also give $10 billion to states to build broadband, and Missouri's share is $196.7 million. This will likely turn into a grant to be administered by the state broadband office, although the legislature must act to make that happen. While the state will choose the specific grant winners, the grant plan must be approved by the National Telecommunications and Information Agency (NTIA). The NTIA has made it clear that states should strive to take care of needed rural areas before using the money in cities, so it's hard to know how much of this money might be available to communities like Joplin. The federal funding rules are more relaxed than many grant programs, but the disposition of the funding is going to rely on the how the Legislature decides to spend the money.

Loan Guarantees

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

These guarantees are not free. There is an application process to get a loan guarantee in much the same manner as applying for a bank loan or a grant, meaning lots of paperwork. And the agency making the guarantee will generally want a fee equal to several interest points upfront. To some extent, this process works like insurance, and the agency keeps these fees to cover some of the cost of defaults. If they issue enough loan guarantees, then the up-front fees can cover eventual losses if the default rates are low. These points are a payment to the agency for issuing the guarantee and are not refundable.

[20] https://ded.mo.gov/content/missouri-broadband-grant-program

There are several federal agencies that might be willing to make loan guarantees for telecom projects. The following agencies are worth considering:

HUD 108 Program: The Department of Housing and Urban Development has a loan and loan guarantee program that is allotted for economic development. There is both federal money under this program as well as money from this program given to the state to administer. While these loans and loan guarantees generally are housing-related, the agency has made loan guarantees for other economic development projects that can be shown to benefit low- or moderate-income households. If enough of a fiber project can be said to benefit low-income residents, then these loans can theoretically be used for a fiber project.

Small Business Administration 504 Loan Program: This program by the SBA provides loans or loan guarantees to small start-up businesses. These loans or loan guarantees must be made in conjunction with a bank, with the bank providing some loan funds directly and with the SBA loaning or guaranteeing up to 50% of the total loan.

U.S.DA Business and Industry Guaranteed Loans (B&I): The Department of Agriculture provides loan guarantees through the B&I program to assist rural communities with projects that spur economic development. Such a project must, among other things, provide employment and improve the economic or environmental climate in a rural area. These loan guarantees are available to start-up businesses. The program can guarantee up to 60% of a loan over $10 million or greater percentages of smaller loans.

Opportunity Zones. Congress created a new tax opportunity as part of the 2017 Tax Cuts and Jobs Act. The Act created Opportunity Zones in which investors can get special capital gains treatment and other tax breaks for investing in qualified infrastructure within an opportunity zone. Each state governor then designated specific opportunity zones. The good news is that there is a sizable Opportunity Zone in Joplin.



Qualified investments made inside an Opportunity Zone can get special tax treatment. The first benefit is that taxes can be deferred from past investments if the gains are invested inside of an opportunity zone. For example, if an investor had a capital gain from the sale of a property, they could invest those gains and not pay taxes on the gains now, but have those gains deferred until as long as 2047. Investors have until 2026 to make such investments.

An investor also gets tax forgiveness on new investments made inside the opportunity zones if that investment is held for at least ten years. Most of the opportunity zones include sizable areas of low-income residents, and a qualified investment must meet a test of benefitting that community in some significant way. A fiber network that will bring broadband to all the homes in an opportunity zone should meet that test – there are lot of demonstrable benefits of fiber.

Any ISP building a network in Joplin should consider getting at least part of their funding from one of the many Opportunity Zone funds that have been created to invest in qualified investments. This portion of the financing portfolio would likely have a lower interest rate and might not have to pay back the full cost of the investment.

New Market Tax Credit. The New Markets Tax Credit (NMTC) Program was established in 2000 as part of the Community Tax Relief Act of 2000. The goal of the program is to spur revitalization efforts of low-income and impoverished communities across the United States and Territories. Most of rural America qualifies for new market tax credit financing. New market tax credits are normally used to fund only a small portion of a project.

The NMTC Program works by giving big tax credits to investors that are willing to invest in infrastructure projects in qualifying communities. The tax credits are so lucrative that often the other terms for accepting the funding are modest. The tax credit equals 39% of the investment paid out—5% in each of the first three years, then 6% in the final four years, for a total of 39%.

The Community Development Financial Institution (CDFI) Fund and the Department of the Treasury administer the program. The process of how the Treasury allots credits is a complicated one, and we won't cover it, but in essence, there are entities around the country each year that are awarded tax credits, and these entities work as brokers to allot the credits to specific projects. The credits are often purchased by the large national banks or other firms that invest in infrastructure.

Generally, in practice, these funds act like a mix of loans and credits to the recipient. For instance, a community that received these funds might have to pay some modest amount of interest during the seven years of the tax credit, and at the end, would have a balloon payment for the principal. However, often some or even all of the principal will be excused, making this look almost like a grant.

Because the entities that get the credits change each year, and because you apply with the entities that hold the credits and not with the federal government, the process for applying for this money is somewhat fluid. However, there are entities and consultants who help find New Market Tax Credits and who can help you through the maze of requirements.

Customer Financing

When no ISP or municipality is able to finance a project, we've seen citizens to step up and agree to somehow directly fund some or all of a broadband project. There are several examples of places where this has been done in the country:

Property (or Other Kind of Tax) Revenues. It is possible to obtain some or all of the cost of a broadband network through a pledge of future tax revenues. That pledge can then support a bond. This is different than most bonds for a broadband network where the network would be secured by revenues of the broadband venture. But a pledge of some other kind of tax revenue is one of the easiest ways to get a bond. There are some real examples of this kind of financing:

- Lyndon Township, Michigan: This is a township of about 1,000 homes that voted to raise property taxes to fund a fiber network. The township then partnered with a local broadband cooperative to provide services.
- UTOPIA, Utah: UTOPIA is a consortium of a number of small towns in Utah that banded together to get fiber. Each town has pledged property tax revenues to fund part of the cost of the network.
- Cook County, Minnesota: Cook County funded about half of their fiber network using a federal grant awarded from the Stimulus funding program in 2008. The city held a referendum and used a sales tax increase to pay for the matching funds needed to build the project.

Direct Customer Contributions: It's also possible to pay for some of a broadband project through a direct contribution of possible customers. This has never been done on a large scale because it would be exceedingly difficult to get a lot of residents to agree to write a check to fund a network. But there are some examples to consider:

- Contribution to Aid in Construction: Most utilities have a program where they will agree to extend their network to customers if those customers agree to pay the cost of the connection. We are aware in the broadband area of numerous cases where small pockets of rural homes raised the needed money to get connected to a nearby broadband network.
- Ammon, Idaho: This is the only municipal attempt at funding a network in this way. The City of Ammon will connect customers who agree to contribute $3,500 up-front to cover the cost of construction.

Public-Private Partnerships

A public-private partnership (PPP) is formed when a government entity and commercial entity fund a project together. There is no one model for a PPP, and such an arrangement can be structured in many ways. The main benefit of a PPP is that the commercial operator of a project benefits by getting some bond financing from the municipal partner. This allows the business to blend the benefits of bond and commercial financing and is one of the ways that makes it easier to get through the first few years of the project.

The general benefits of bond financing are what makes public money attractive to a commercial partner - low interest rates, long repayment term, and small or no payments for the first few years. But the downside

is that there are more overall financing costs, and in the long run a bond adds to the cost of a project. The safety of a bond in the first few years, though, can be very attractive.

Combining Public and Private Financing. There are benefits to combining the two kinds of financing:

- Banks will often consider the financing that comes with bonds as the equivalent of equity, meaning that the commercial partner will not require as much, or even no, cash equity.
- In terms of the amount borrowed, the two methods work well together if construction loans are used to cover the construction, and bond financing is used for the longer-term financing costs.
- Combining the two methods works to produce a payment term that is longer than a traditional commercial loan.
- Combining the two methods also usually means lower debt payment during the first few critical years while the network is being built.
- Both municipalities and commercial telcos have a natural borrowing limit—meaning that there is always some upward limit on the amount of money they can borrow. Combining both kinds of financing can mean that neither partner has to hit their debt ceiling. Just as an aside, the debt ceiling is often the main impediment to funding projects 100% with bonds. Fiber projects are generally large projects, and the required funds can easily exceed the ability of a government to fund it 100%.

Following are two examples of this type of PPP, both from Minnesota:

- RS Fiber: RS Fiber is a new broadband cooperative that was formed in Renville and Sibley Counties. The project was funded from various sources, including a loan for 25% of the project supplied by a bond backed by the cities and cities involved in the project. The Cooperative raised the other money with a combination of bank loans and grants.
- Swift City: The city government there contributed a significant percentage of the cost needed to construct a broadband network in the city. The bond proceeds were loaned to Federated Telephone Cooperative and are expected to be paid back over time.

Other Sources of Financing

We've seen entities get very creative in finding sources of financing. Take the example of the RS Fiber Cooperative formed in Sibley and Renville Counties in Minnesota. Their financing includes two unique revenue sources we have not seen used before:

- **Loans from Individuals**: The Cooperative borrowed money directly from individuals and businesses in the service area. These loans had loan contracts and covenants like any other loan. The money borrowed in this manner reduces the amounts that must be borrowed from the larger external sources, and generally, these loans avoid the large fees associated with external financing.
- **Loans from Other Cooperatives**: Since RS Fiber is a cooperative, they found that they were able to borrow from an electric cooperative at low interest rates. Cooperatives are a unique type of business that is required by law to either invest their profits back into the business or else return it as dividends to members. Because the level of dividends is limited by law, cooperatives often find themselves with large cash reserves. They are allowed to loan out these cash reserves, but only to other cooperatives.

B. Benefit / Risk Analysis

It's always important for a community thinking about building a fiber network to assess both the benefits and the risks of doing so. The first question that cities typically ask is if there are benefits that a citywide fiber network brings that cannot be satisfied by the existing broadband providers. If there are, then a secondary question to consider is if the city needs to take an active role in finding a broadband solution. Most of the benefits for a community of having fiber broadband come whether the fiber network is built by the city or a private ISP. However, there are some benefits that are specific to a city-controlled fiber network – such as having a way to tackle the digital divide.

Community Benefits from a Fiber Network

Following are the most common benefits that have been reported for communities that are upgraded to fiber:

Choice. Customer choice for broadband in Joplin largely fell off a cliff when AT&T stopped offering DSL and has not built any fiber. AT&T won't connect a new customer. That means if somebody suddenly needs to work or attend school from home, AT&T won't connect them. I've heard stories that if DSL is disconnected for any reason that the company won't reconnect it. If somebody buys a house served only by AT&T, the new owner can't get DSL, even if the old owner had it. If somebody gets disconnected for late payment, they aren't being allowed to reconnect. I heard stories lately of customers who had a technical trouble with DSL and were told that the company won't fix it.

This means Joplin is facing the reemergence of a pure monopoly situation for the cable providers. We have a lot of experience in the country knowing how monopolies act – and it's just a matter of time until the cable companies in Joplin start acting like pure monopolies. It's been less than a year since AT&T bowed out of the market, but over time you can expect the cable companies to raise rates, cut back on maintenance, and delay or defer upgrades.

Higher Prices. We know that overall prices are lower in markets that have multiple fast broadband networks. A fiber network in the community would provide a major new competitor. One only has to compare broadband prices in places where Google Fiber or a municipality has built a fiber network to see that it makes a difference. Cable companies typically react to competition by lowering prices to meet (but not beat the competitor) and by stepping up customer service.

A city with a municipal fiber network will see that broadband prices in the community will rise at a slower rate than in surrounding communities. Over time, the saving for everybody in a community with fiber can be gigantic. Lower prices benefit everybody in the community, even those who don't subscribe to the fiber network.

Without a fiber network, higher prices will be one of the major outcomes of being in a monopoly market. Monopolies raise rates because there is nothing to stop them from doing so. The big cable companies all set rates at a national level. We already can see that Comcast and Charter are on the path towards $100 basic broadband. It's likely that without competition that Sparklight will follow the bigger companies. Mediacom might already be the most expensive cable company in the country.

The price increases in a monopoly market are more subtle than the basic rates being charged. Cable companies have offered special rates in the past to lure customers from DSL. Over time these introductory rates will disappear because, in a market where AT&T is the ISP, the companies know they will eventually get the rest of the customers without incentives. Cable companies also offer bundling discounts, and over time those discounts will shrink and disappear in monopoly towns. Finally, in a competitive environment, cable companies are open to negotiating with customers who threaten to leave. But in a monopoly town, there is no reason to negotiate – customers can't leave. These various discounts will continue for a while, but as it finally sinks in on the cable companies that they are in a monopoly position, they will pull back from giving discounts. If no other ISP ever comes to the city, everybody will eventually be paying the full list prices from broadband, telephone, and cable TV.

Degraded Maintenance. If the city doesn't find another fast ISP to compete with the cable companies, then over time the city will experience the impacts of degraded maintenance. This won't happen overnight, but it's inevitable due to the way that big ISPs operate. There is always pressure from corporate for local managers to cut costs – this is the primary reason that there are problems with the cable companies today. Cable companies don't conspire to be poor ISPs at the corporate level, but they have budgetary practice and a bonus structure that rewards local employees for cutting corners and costs. One of the easiest things to eliminate in a monopoly environment is maintenance. The local managers for the cable companies likely will not eliminate jobs but rather fail to fill vacant positions over time. We've seen this in practice for decades from the big telcos, which have eliminated a huge percentage of technicians over the last few decades.

Faster Broadband Speeds. A fiber network in the city would put pressure on the cable company to offer better speeds, particularly upload speeds.

Cable technology has been improving rapidly over the last decade. It looks like both cable companies in Joplin have upgraded for download bandwidth to the DOCSIS 3.1 standard. We think both companies stayed with the older DOCSIS 3.0 standard for upload speeds. Within a few years, cable companies will have the option to upgrade again to DOCSIS 4.0 – an upgrade that will allow for symmetrical gigabit broadband products to compete against fiber. Cable companies are not motivated to upgrade in a monopoly market. They may end up doing so over time as part of a corporate-wide effort to have the same technology everywhere. But the companies will always upgrade competitive markets before non-competitive ones.

The upload speed issue was described in detail in the broadband GAP analysis. The pandemic highlighted the problems with upload speeds as people experienced big problems in working and schooling from home. The current technologies deployed by the cable companies offer a meager upload data path. The cable companies would need to make a significant investment to achieve faster upload speeds.

Fiber networks can provide symmetrical uploads data speeds that can easily handle the newly created demands from homes and businesses. There is a lot of consensus among industry experts that a lot of the uses we've found for upload broadband are not going to go away when the pandemic is over. Many companies now understand that employees can be productive working from home while saving the company from operating expensive office space. Telemedicine is likely going to become a routine way to connect with doctors for visits that don't require a physical examination. Video chat has now become a routine way for people to communicate. Gaming continues to grow explosively.

Improved Medical Care. Telemedicine is likely to become a routine facet of healthcare. Telemedicine requires a solid upstream and downstream connection, which often requires more broadband than a connection to a school or office. It's going to be interesting to see if telemedicine stays after the end of the pandemic. In the past year, telemedicine visits have skyrocketed. During March and April of 2021, the billings for telemedicine were almost $4 billion, compared to only $60 million for the periods just before the pandemic.

There was a recent article about the topic in Forbes[21] that postulates that the future of telemedicine will be determined by acceptance of the technology by doctors and insurance companies. Many doctors have now had a taste of the technology. It seems likely that the telemedicine platforms in place now will get a lot of feedback from doctors and will improve in the next round of software upgrades.

The recent telemedicine experience is also going to lead a lot of doctor's offices to look harder at their broadband provider. Like most of us, a doctor's office likely relied a lot more on download speed than upload speed. I think many doctor's offices are going to find themselves unhappy with cable modem service or DSL broadband that has been satisfactory in the past. Doctor's will join the chorus of those advocating for faster broadband speeds – particularly upload speeds.

I don't think anybody is in a position to predict how insurance companies will deal with telemedicine. Most of them now allow it and some have already expanded the use of telemedicine visits through the end of 2021. The Forbes articles suggest that insurance companies will want to compensate less for telemedicine visits, and if so, that's probably not a good sign for doctors continuing the practice.

I guess that telemedicine visits will not stay at the current high level, but that they will be here to stay. I think when somebody books a visit to a doctor that they'll be given a telemedicine option when the reason for the visit doesn't require an examination. The biggest issue in Joplin for telemedicine is the significant number of homes that don't have a broadband connection – this is not the kind of thing that people will do from a library computer. One thing we can count on - telemedicine is going to lay bare all of our broadband shortcomings.

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.

Broadband also is opening up new medical technologies that will benefit communities immensely. For example, good broadband can support a suite of monitoring and communications technologies that will allow the elderly to stay in their homes for more years. Good broadband is also proving to be beneficial

[21] https://www.nytimes.com/2020/08/03/health/covid-telemedicine-congress.html

for supporting monitoring devices after surgeries and procedures. A number of studies show significantly improved results for patients that are closely monitored after surgery by identifying problems early.

Superfast broadband on fiber enables doctors to review large medical files from home without having to travel to the office or the hospital in an emergency or the middle of the night.

Improved Education. It's likely after the pandemic that a lot of schoolwork will continue to be offered online. Already before the pandemic, 37% of all graduate degrees contained a significant portion of the coursework online. Fiber is one of the only technologies that allows a busy households with multiple family members to easily pursue online schoolwork or training. We note that 57% of the respondents to your statistically valid survey reported that home broadband was not sufficient to support schoolwork.

We know there were a lot of problems with broadband during the pandemic when all students were sent home. But the broadband issues go far past the pandemic. The concern for the schools is that they are unable to send computer-based work home with students since they know that many of them don't have good home Internet. It's incredibly hard to raise kids today in a home without adequate broadband. The issue is not just data speeds but also the total amount of downloaded data that even elementary school students need to do homework. Schools want students to be able to use broadband outside the school. An increasingly common practice in places with adequate broadband is to have students watch video content at home as homework and then discuss it later in the classroom. That frees valuable classroom time from watching video in class. The whole education process is increasingly moving to the web, and kids without access to the web are lacking the tools that their peers take for granted.

There was a major study performed to look at what is being called the homework gap by the National Center for Education Statistics (NCES),[22] an agency within the U.S. Department of Education. That study compared test scores for 8th grade students both with and without a home computer. The results showed:

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

There was recently a definitive study that quantified the impact of the homework gap. The study was released in March 2020 and was done by the Quello Center, part of the Department of Media and Information at Michigan State University.[23] I call this a definite study because it used study techniques that isolate the impact of broadband from other factors such as sex, race, and family incomes. The study involved 3,258 students in Michigan in grades 8 – 11 from schools described as being in rural areas. The study was done in such a way to get results of schoolwork concerning students without violating student confidentiality.

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

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

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

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

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

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

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

The pandemic showed us how hard it can be to connect to schools or the office from home. A connection between a student and a school is typically activated through the creation of a VPN (virtual private network). This is a dedicated connection of bandwidth that is carved out of the Internet path and that remains live for as long as the connection to the school WAN is open. One of the important aspects of a VPN is that it carves out upload bandwidth as well as download bandwidth. All of the broadband technologies in Joplin other than fiber have much smaller upload speeds that download speeds. Residents who buy fast download bandwidth might not be able to establish a VPN connection due to the inadequacies of the upload path. A VPN typically requires a 2-way video connection that can use a 1 – 3 Mbps connection for both upload and download at the same time. Students without good home broadband cannot participate in this kind of remote classwork.

There are characteristics other than broadband speeds that matter. Both VPN connections and video conferencing require reasonable latency (delay) to maintain a connection. Doing schoolwork from home

also means using a significant amount of bandwidth during a month, and that raises the issue of data caps and data overage charges. Both cable companies in Joplin have relatively small data caps.

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

The U.S. Bureau of Labor Statistics reported earlier this year that the average American baby boomer held 12.3 different jobs between the ages of 18 and 52 - that was 12.5 jobs for men and 12.1 jobs for women. It's much harder to measure a change in careers, meaning a change to doing something drastically different than prior jobs, but researchers have looked at the data and said that most people change careers at least several times during their work life. The above statistics don't tell the whole story because many people are now working well past 65 years of age, including many older workers trying a new career at the end of their working life.

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

The biggest group of online learners (outside of the COVID-19 crisis) are students pursuing a post-secondary education online. There are almost 20 million college and graduate students across the country, many that now routinely have a part of a college curriculum online, even if they attend live classes. Secondary education has already been in the process of migrating online. Eduventures estimated that the percentage of students already tackling an online degree before the pandemic was 29% of those pursuing an associate degree, 42% for a bachelor's degree, 27% for a master's degree, and 3% of those working towards a doctorate.

Digital Divide/Affordability. In every city there are households that can't afford broadband. A municipal fiber network might afford the opportunity to bring broadband to these households. Cities that own fiber networks usually include solving the digital divide as one of their goals. Cities understand that the community will be stronger if everybody is connected to the Internet. That will be more important in the future as cities start implementing smart city technology to provide better digital access to city services.

Economic Development. Many cities claim huge economic development benefits from building fiber. Cities often tout fiber as part of the package used to attract new businesses and industries. An example is Lafayette, Louisiana, which leveraged fiber to attract several major companies that engage in computer animation – and much of the animation and special effects seen in movies is now created there. One of the biggest claims for the benefits of municipal broadband is detailed in a study by Bento J. Lobo that quantifies the benefits of fiber in Chattanooga, Tennessee, to be $2.69 billion over ten years.[24]

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

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

Before the pandemic, we rarely saw the percentage of people working from home to be more than 6% or 7% in most communities. Your survey showed 13% of homes in the city now include somebody working full-time from home. Another 22% of homes include somebody working part-time from home. People who want to work from home are going to include affordable and fast broadband as one of the most important characteristics when choosing where to live.

Of course, cheap fiber also benefits traditional economic development and can be used to help lure new businesses to the city. Cities without ubiquitous fiber are now at a major economic disadvantage compared to communities with fiber.

Keeping Profits at Home. The profits on telecom and broadband have always left the city and gone into the coffers of the big telcos and cable companies. Economists universally estimate that keep such profits within the community has an overall multiplier benefit of 7 to 9 times the cash that doesn't leave town. A municipal network would keep all profits within the community. A partnership with a local ISP will keep some of the profits in the community.

Better Cellular Networks. 5G is going to eventually allow for faster cellular networks. For 5G to work optimally, a cell site must be closer to customers than today's cellular network. That means placing smaller cellular transmitters on utility poles and light poles throughout the city. A city with a fiber network will be able to accommodate the best 5G network since cellular companies will be able to place small cell sites in the optimum locations.

Ubiquitous or Expanded Public WiFi. Many cities provide some WiFi access to citizens in places like libraries, city halls, and perhaps in a few locations like parks or other commonly used public spaces. However, with a fiber network, a city could offer WiFi in many more places since the WiFi hot spot transmitters could be connected to almost any pole in the city. This idea also comes with a word of caution. Many cities have been sold on the idea that they can generate enough revenues from public WiFi systems to cover the cost of the network. We have never heard of a WiFi network that was able to generate enough revenues to cover costs. But is an awesome public service.

More Efficient Businesses. Many of the businesses we heard from during the study said that there are things they could do better and more efficiently if they had faster broadband. This is discussed earlier in the report.

Smart City. This project was initiated as result of Joplin's Smart City Roadmap.[25] That Roadmap, which was adopted by the City Council in September 2019, lays out a vision for a smart Joplin. It rightfully identified better broadband as a key element for a smarter city. The Roadmap lays out a list of key future technologies and initiatives that are as vital for Joplin's future. This includes smart streetlights, workforce development and education programs, smart transportation, and the creation of an innovation district. Better broadband is a key precursor for all of these plans.

Smart Government. A subset of smart city is being referred to as Smart Government. This entails leveraging the benefits of fiber to make the city more efficient – which benefits everybody in the community. Some aspects of smart government include:

- Saving Money. With a fiber network, all of the government locations within the city can be connected without paying for telecom services to outside ISPs. This savings alone can sometimes justify building fiber between city buildings. Most cities that provide fiber establish gigabit speeds within the city, which brings numerous benefits for working between departments and for connecting with the public.
- Smart Applications. We're starting to see cities that use a fiber network connected to sensors to provide some interesting and valuable applications for citizens. For example, Lincoln, Nebraska allows citizens to watch the progress of snowplows in real-time. Cities are using sensors to notify when public trash cans need to be emptied. There are cities that can turn up temporary WiFi networks when needed to support big public events like street fairs.
- Smart Law Enforcement. Video is becoming a big part of law enforcement and having a city broadband network makes this easier and more functional. Many cities have gone to a virtual arraignment where prisoners don't have to be transported from jail to the court to make an appearance before a judge. With broadband everywhere, this can be expanded to work from anywhere in the city. We know courts during the pandemic that are allowing virtual witnesses. We have a few clients that are making it easier for police to upload files from personal cameras. For example, the city can create numerous high-bandwidth WiFi hotspots in places that are convenient for squad cars. Files can be automatically uploaded by parking near these locations. Many cities are also partnering with citizens to create surveillance networks based on Ring security cameras.
- Public Safety. There was a big push a few years ago to provide enough broadband in neighborhoods to assist firefighters and EMT personnel. However, this effort has largely been replaced by the national FirstNet network that is to connect all law enforcement with priority cellular broadband. This network has established a frequency that is only used for public safety, plus provides the ability to preempt other cellular frequencies in big emergencies.
- Public Alerts. Because of the big tornado in Joplin, you understand the need for a robust public alert system probably as well as anywhere. We've found that an effective warning system has to use every outlet available to reach the most people quickly. This includes contacting people by email and text, using public airways, and using sirens. Joplin has the highest percentage of homes without broadband at 19% that we've seen in cities in recent years. Getting more homes connected to broadband should be a city goal.

Resiliency. If the cable companies are a de facto monopoly in Joplin, then connectivity in the city is dependent upon those networks staying functional. Having a citywide fiber network provides an alternative source of broadband in the city. This is vital to key anchor institutions like the hospital and

[25] http://mo-joplincdbgdr.civicplus.com/DocumentCenter/View/865/Smarter-Joplin-Roadmap

public safety organizations. The largest businesses in the community all want broadband feeds to multiple ISPs to make sure they don't lose connectivity.

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

Entrepreneurship. The fastest growing segment of many local economies is the growth of small businesses, many of which start in the home. Small businesses often begin with a few employees and grow over time as they succeed. Start-up businesses generally are highly reliant upon good broadband.

Other Anchor Institutions. Better broadband can unleash non-profits and other community organizations to provide better services to the community. This can be as simple as allowing churches to broadcast services live. But the even bigger benefits come from non-profits that leverage broadband to help citizens in need. During our interviews, we learned that Joplin has a robust non-profit community, and it would be even better with good broadband everywhere.

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

One of the most common reasons cited by the big telcos and cable companies to not build new fiber networks is that the money should not be spent to provide better Netflix. As you can see by all of the other benefits listed above, better broadband for entertainment is never on the list of reasons why a community would invest in fiber. However, great broadband allows citizens to better engage in gaming and other leisure activities.

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, either providing updates or just to make sure that the connection is still live. Many cars now communicate with the cloud when they are within range

of a home broadband connection to provide the status of all car sensors and to upload driving data that can later be used by the car owner. Cisco predicted early this year that machine-to-machine 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.

Risks For an ISP to Serve in Joplin

This section of the report talks about the risks any ISP faces in coming to a major new market like Joplin. We think it's important for the City to understand these risks, because these are the issues that any ISP that you'll talk to will be worried about. Most of these risks apply to any ISP, but a few apply only to a municipal ISP.

Risks Specific to a Municipal ISP

Legal Risks. Missouri law has a provision that bars municipalities and municipal electric utilities from selling or leasing telecommunications services to the public or telecommunications facilities to other communications providers. Following is the direct language from Missouri Statute § 392.410(7)).

> *7. No political subdivision of this 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 for which a certificate of service authority is required pursuant to this section. Nothing in this subsection shall be construed to restrict a political subdivision from allowing the nondiscriminatory use of its rights-of-way including its poles, conduits, ducts and similar support structures by telecommunications providers or from providing to telecommunications providers, within the geographic area in which it lawfully operates as a municipal utility, telecommunications services or telecommunications facilities on a nondiscriminatory, competitively neutral basis, and at a price which covers cost, including imputed costs that the political subdivision would incur if it were a for-profit business. Nothing in this subsection shall restrict a political subdivision from providing telecommunications services or facilities:*
>
> *(1) For its own use;*
> *(2) For 911, E-911 or other emergency services;*
> *(3) For medical or educational purposes;*
> *(4) To students by an educational institution; or*
> *(5) Internet-type services.*

Part of this law was challenged the whole way to the U.S. Supreme Court in *Nixon v. the Missouri Municipal League*[26]. In 2004, the Supreme Court ruled that states have the authority to pass laws that govern what cities can do. While the challenge that led to the court ruling was the Missouri law cited

[26] https://www.supremecourt.gov/qp/02-01238qp.pdf

above, the court did not make any specific findings about telecom but just affirmed that states have the authority to pass such laws.

It seems that there are ways around this law. The City of Springfield is in the process of building a citywide network in partnership with CenturyLink. The reasoning behind the city's ability to do this is that the law above only prohibits cities from providing telecommunications service. Springfield and other cities in the state believe that Missouri law does not classify broadband as a telecommunications service.

There is some external evidence for this interpretation. The FCC, under Chairman Ajit Pai, declared that broadband is not a telecommunications service at the federal level. In regulatory law, that sort of declaration flows downward to states unless a state wants to take a specific exception to an FCC ruling. There is further proof that the regulatory world in Missouri agrees that broadband is not a telecommunications service. In 2017, a bill was introduced in the Missouri legislature to expand the law cited above to specifically prohibit cities from providing broadband. That legislation wasn't enacted, which provides a legal authority for cities like Springfield to build a fiber network for the purposes of providing broadband.

There has been at least one minor challenge to the ability of municipalities to be an ISP. The town of West Plains offered gigabit broadband to a few businesses and residents as part of a pilot project. The incumbent telephone company, Fidelity Communications, responded by building fiber to a number of neighborhoods in the city. Fidelity also lobbied vigorously against the city, but there was never a legal challenge to stop the city from providing services. This is further verification that cities are allowed to build fiber.

The current legal environment seems to free Joplin to be an ISP or to build fiber and partner with ISPs like Springfield pr West Plains has done. One would think that Springfield is a large enough market that the cable company there would have challenged the fiber buildout if there was a chance to stop that project.

Unfortunately, this is somewhat of a backdoor regulation, in that no regulatory authority has positively rules that municipalities in Missouri can offer broadband. There is always some risk in the future that the current regulatory understanding could be upset. For example, the consensus among industry regulatory experts is that the current FCC is likely to regulate broadband again at the federal level. The easiest way for this to happen is to again declare broadband to be a telecommunication service so that broadband would fall under Title II regulation at the FCC. It's hard to say if that happens how this could impact Missouri. It's highly unlikely that there would be any pushback against cities that undertook broadband when it was clearly not a telecommunications product. But such an act by the FCC could trigger to Missouri statute after the federal change was made.

The bottom line is that there is always some regulatory risk in pursuing a path for which there is not definitive and positive law in place. For now, there appears to be smooth sailing for Joplin or other cities to pursue broadband – this just may not always be the case.

Municipal Purchasing Rules. There is a big pile of contracts to negotiate and materials to buy to build a fiber network, and we've seen cities struggle badly with the process when coping with municipal purchasing rules. While purchasing rules have the goal of making sure that a municipality doesn't overpay for goods and services, the rules can add significant time when buying all of the needed components and service vendors involved in a broadband network launch.

We've also seen the municipal purchasing process add cost to purchased goods and materials. Most of the vendors in the telecom world are not used to dealing with the municipal purchasing process, so many of them pad their prices when bidding – fully expecting to negotiate the prices lower later, only to sometimes find that their bid price was accepted without negotiation. We also find that there are quality vendors that refuse to participate in the municipal purchasing process.

Political Risks. We always advise government entities to work hard at the beginning to shield a broadband business from day-to-day politics. Administrations and politicians change over time, and a fiber business must be shielded against future politicians that want to interfere with or even dismantle the fiber business.

There is one anecdote that probably highlights the problem of mixing politics and operating a business. The City of Bristol, Virginia was one of the first cities to build a municipal fiber business. About a year after the business launch, the Bristol City Council voted to cut rates by 15% in response to an upcoming local election. As it turns out, this put the business underwater and into a quick dive in terms of cash creation, and in the year following the rate decrease, the City Council was forced to raise rates higher than the original rates to bail out the business. After this debacle, the City Council moved the fiber business to a standalone utility and killed the City Council's ability to affect rates.

Another political risk is that the incumbent providers may lobby against the broadband network long after it's been built. For example, a common tactic is to tell the public that a municipal fiber business is losing money when it's actually generating positive cash. This is easy to do because a fiber network generates a lot of depreciation expense. This is something cities don't usually care about since the primary purpose of depreciation is to offset income taxes. But depreciation expense means that there may be many years when the business shows a book loss, when in fact, the business might be successful in the eyes of the city. Cities generally judge businesses in terms of cash flow, and a municipal business that is cash self-sufficient generally is deemed to be a success. That's something that can be hard to explain to the public if there is a headline every budget cycle that the fiber business is losing money.

Risks Faced By Any ISP

The Reactions of the Incumbents. There is always the risk of a significant response from existing service providers. One worry is that the incumbent providers would respond with a price war – but cutting rates so low that the new municipal ISP could not succeed. This hasn't happened many times, but there are a few examples where incumbent service providers engaged in a serious price war with a new ISP. In a price war, prices can go so low that all service providers in the market lose money. Large incumbents can ride out the operating losses in a price war, while a new operator can't. There haven't been any price wars that's heard about for the last ten or fifteen years.

There is also the risk that a competitor could overbuild a new fiber network. It doesn't happen often, but it has happened. The example cited above in West Plains is such an example. Another example is in Monticello, Minnesota, where the incumbent telephone company TDS reacted to a municipal fiber network by building a second fiber network. In parts of the North Carolina research triangle and in Austin, Texas, both the incumbent telephone company and the cable company built fiber-to-the-home as a reaction to fiber built by Google Fiber. That means a few lucky households in that community are served by three gigabit fiber networks.

A more common response from incumbents is to make it harder for a new competitor to thrive. For example, the ISPs might offer low special rates and lock up customers in 2- to 3-year contracts before a new ISP is open for business. Incumbents might saturate the market with advertising or engage in negative advertising against new market entrants. Incumbents often improve customer service by reducing waiting times when customers call them and by responding more quickly to trouble calls. Most communities view improved performance by the incumbents as a plus because it means that everybody in the community is better off.

Financial Risks. There are always financial risks for a city that funds a fiber network:

- Fiber networks are expensive, and the debt used to finance a fiber network will last for many years. ISPs of all kinds are always nervous about incurring large amounts of long-term debt.
- There is no guarantee that a new fiber business will make enough money to be financially self-sufficient.
- We've enjoyed low and stable interest rates for over a decade. This could change quickly and has done so many times over the last century.

Financial risks can be mitigated by having a solid financial plan and sticking to it. But not everybody does this. For example, we know ISPs that have hired far more employees than predicted by a business plan and then suffered smaller profits or even losses. We've seen ISPs who let marketing department cut rates in order to try to gain more customers, but then fail to meet the needed revenues to cover costs. It takes discipline to operate an ISP.

Operational Market Risks. Operating an ISP business is highly technical and complicated. There is always an operational risk of failing to execute the business plan. For example, a new ISP might build a world-class fiber network but stumble badly in the sales and marketing process or some other key component of the business.

There is danger in botching the launch of a new network and of tarnishing the reputation of the new ISP business before it gets going. An example of this was the FTTH network in Lafayette, Louisiana that suffered from huge problems with their video product. This was due to their vendor Alcatel not delivering the product that was promised. The TV was so bad that many customers dropped the city ISP and word-of-mouth stopped a lot more customers from trying the new network. It took over a year to fix the video problems, and during that time the business fell significantly short of the business plan projections. Over time the city regained a reputation as a quality service provider and today is financially successful and is expanding into the surrounding suburbs. But that one mistake badly hurt the launch of the business - any bad blunder can hurt a new business.

The Cost of Success. In the telecom world, there is a phenomenon that CCG calls the cost of success. It's costly to add a new customer to a fiber network, and if a new venture does better than expected, then a new ISP can find itself without the capital funds needed to add new customers. The alternatives are to borrow more money to fund the growth or else make customers wait until the project generates enough cash to cover customers in a queue. It's often not practical for a municipality to borrow extra money past the original bond issue.

Local Rules and Regulations. ISPs can face a maze of different construction rules in a single market. For example, the rules for building fiber along county, state, and federal roads might differ significantly from rules for city streets. There also can be challenging obstacles to building across bridges, across railroad tracks, or through Interstate exit interchanges. When a city is to be the ISP they are often surprised when they must follow the same rules that they require of other utilities.

Market Forces. Every fiber business is subject to external market forces. These can hit in different ways:

- A local prolonged economic turndown might mean smaller revenues than expected – although some fiber ISPs swear that they do better in bad times.
- We are currently seeing big delays in the supply chain for fiber and electronics. Supply chain issues are arising for a variety of reasons, all of which might come together to create a perfect storm for the industry. One reason for shortages is due to the increase in demand. For example, Corning saw revenues jump by 21% in the recently ended second quarter compared to a year earlier. Factories that are already working at or near capacity can't flip a switch and produce 20% more products. Raw demand is likely going to grow a lot more. The consulting firm RVA LLC recently predicted the broadband industry plans to build past 61 million homes between this year and 2025 – that's far more fiber than has been built in the country.

  Supply chain issues are also still suffering from the lack of the raw ingredients needed to manufacture key components. This is one of the key issues behind the chip shortage and the shortage of electronics cases that are made from resin. Much of the global supply chain has not recovered from the impacts of the pandemic – and as the delta variant sweeps the world, this issue is far from behind us.

  There are also more mundane supply chain issues. There is still a shortage of truck drivers to deliver the glut of materials and products hitting the market as the economy is rapidly improving. Apparently, during the break from the pandemic, many truckers decided they were tired of life on the road and are pursuing something else. The industry is having a hard time training new truckers at the needed pace, and truck driving schools are working overtime.

  There are also more subtle changes behind the scenes. For example, many manufacturers have quietly looked for sources other than China during the pandemic. Many companies have come to realize that their own success was tied too closely to supply chains that were wholly within specific regions of China. The pandemic made it clear how problems in China quickly affect everybody else, and it's not hard imagining problems in China in the future other than the pandemic. However, switching supply sources to other countries is not something that happens overnight, and many of these new relationships are still growing and maturing.

  Some of these issues will get solved over time. But the bigger issue of there being more demand than supply of telecom gear and materials is likely going to plague us for much of the next decade. AT&T is not going to give up on the half-million homes it won't reach this year and will just shove that into next year.

C. Other Issues

This section of the report will address several questions that were asked in the RFP that are not covered under other topics. This includes a synopsis of the broadband situation for each major set of stakeholders in the city, a look at other cities of a similar size that have been able to build a broadband network, our opinion on the key issues that have limited broadband expansion within the city, and a map that summarizes the broadband situation in the city today.

Stakeholder Summary

Single Family Homes, Duplexes, Townhouses. Much of this report has discussed this issue. Residential customers have a limited choice of broadband providers. The situation worsened when AT&T stopped selling DSL last year, but DSL is so slow that most residents don't view it as an acceptable broadband alternative. The average resident can buy new broadband from the cable company – for most, that's Sparklight (Cable One), with Mediacom serving some of the city. Our prediction is that unless the city can attract a new ISP to compete in the market that the residential market will devolve to a traditional pure monopoly situation where the cable companies will dictate all aspects of broadband – price, outage repairs, etc.

We're not sure what motivated the city to study the broadband situation, but the fact that the residential market is becoming a monopoly is your biggest long-term broadband issue. We know that residential broadband demand is going to continue to grow at a rapid pace – the household demand for broadband capacity has been doubling every three years and is expected to continue to do so. The big question is if the cable companies are poised to meet future demand if they aren't being pushed by competition to do so? The cable companies already have relatively slow upload broadband speeds, and the survey's told us that a number of homes are dissatisfied with broadband. Over half of homes with students at home told us that they didn't think their broadband was adequate for schoolwork.

If the cable companies aren't prodded to keep up with future demand, we envision more and more residents each year who will be dissatisfied with broadband but won't have any options to consider.

MDUs and Apartment Buildings. Apartment buildings are in a unique position. Small apartment buildings with less than ten units are likely in the same situation as other residential customers in the city. But larger apartments have more options. There are two main factors that determine the broadband available to apartment residents. First is the landlord because landlords have to right to allow or exclude ISPs from serving their properties. Some apartments likely have inadequate broadband because the landlord is not seeking a faster solution. The only solution to that issue is for residents to loudly demand better broadband or to relocate to a building with a more responsive landlord.

We know that there are some apartment buildings that are connected to fiber today, and we talked to a landlord with fiber. ISPs view a large apartment building or complex like a large business, and they might build fiber to apartments willing to sign a long-term agreement to buy fiber broadband. But all apartment buildings in the city can buy gigabit broadband from the cable companies. The driving factor for apartment buildings getting fiber is the willingness of the landlord to pay for the connection and the cost to extend fiber to reach the apartment building.

Apartment buildings served by coaxial cable have even more of an issue with upload speeds than single-family homes since multiple apartment units share the upload link at the same time.

Small Businesses. There are some lucky small businesses served by fiber because they happen to be in a building where the landlord has bought fiber broadband, or they are lucky enough to be very close to a larger business that got fiber. But most small businesses have the same situation as residential customers. While they might still use AT&T, the only option for a new connection is the cable companies. Businesses differ drastically in the need for broadband because each business has a wide range of different ways to use broadband. Two similar retail stores might have significantly different broadband needs according to the way they've dealt with using the web. For example, one store might be old-school and only use broadband for ordering supplies and handling email, while another similar store might host an e-commerce website and transact all of its business transactions in the cloud.

One of the biggest concerns we heard from businesses is that the current ISPs have periodic outages that harm the business. Many businesses slow to a crawl when losing a broadband connection, and as more functions move to the cloud, this is going to become more prevalent. We heard from businesses in Joplin that reliability is more important than price for most businesses.

National statistics say that the broadband capacity needs for all businesses collectively is growing a little faster than residential demand. But it's impossible to take that statistic and apply it to the business community as a whole. Every business has a unique story. What we found in the surveys and interviews is that most businesses in the city have a broadband wish list of things they could do better if they could get bigger bandwidth and better prices. The only way for that to happen is with fiber.

Large Businesses. There has been some fiber built in the city to reach the large businesses. For example, we talked to one large manufacturer that has fiber feeds from two different ISPs that are also diversely routed. This business operates largely in the cloud and would lose more than $10,000 in revenue per hour if it lost broadband. But those kinds of fiber connections are the exception in the city. ISPs in almost every city the size of Joplin have built fiber to reach the big customers – the factories, hospitals, schools, and industrial parks. Fiber is sometimes extended to smaller businesses that happen to be within a short construction distance from existing fiber. But there are no ISPs in Joplin with a vision to extend fiber to a wider area. These ISPs are selling a dedicated large bandwidth connection for a premium price.

Government and Anchor Institutions. Anchor institutions in Joplin have a mixed experience with broadband. Larger institutions like schools and the hospital got fiber because those entities have been willing to pay the premium price for broadband that justified building fiber. But most of the anchor institutions in the community are not on fiber. There's no fiber built to firehouses, non-profits, and other smaller anchor institutions that can't afford high-priced broadband.

Future Broadband Demand

Joplin clearly has some significant residential broadband gaps. Our statistically valid survey showed a surprisingly large percentage of homes, at 19%, that don't have a broadband connection today. That puts the city significantly below the national average in terms of broadband adoption. According to the FCC statistics, broadband adoption is just shy of 90% of homes.

It's possible that the federal government may help to solve some of the adoption gap by providing subsided broadband for low-income homes. The current EBB program that's funded be the American Recovery Plan Act is providing a $50 discount on broadband for qualifying households. But that program will run out of money sometime next year. The recently passed Senate infrastructure bill would extend a $30 monthly subsidy for three or four years – but that legislation still has a way to go to become law. Even if it passes, a permanent source of subsidy must be funded beyond this law. Nobody can predict how Congress will handle any social welfare program – such programs always seem to be on somebody's chopping block.

There are issues other than broadband subsidies for which the city could help find a solution. Many homes that don't have broadband can't afford a computer. Other cities have worked with non-profits to find a local solution for this issue. It's also likely in a city with so many homes without a broadband connection that many residents don't have the training and knowledge to comfortably use broadband. This is something that the city can also work locally to help solve.

One industry trend doesn't favor this issue. Cable companies have been collectively increasing broadband rates, which are headed for $100 per month. This means broadband will fall out of the range of affordability for many households. The only way to offset this is to attract another competitive ISP to compete against the cable companies – we know that competition can hold down rates locally.

If the federal subsidies are in place for the next four or five years, then it's likely that residential broadband adoption rates will grow. This could be bolstered by local broadband adoption and training programs.

We think that every business that needs broadband has it. We didn't hear any stories of businesses that are unable to get a broadband connection. We did hear from businesses that want faster and more reliable broadband. As mentioned previously, the number of businesses that are unhappy with broadband options will grow over time if the cable companies don't do another big technology upgrade. The upload link on a cable network is not going to be adequate for businesses that want to use the cloud more or that want to make daylong connections to multiple employees connecting from home. We think that if the city wants to maintain a competitive business environment that you are going to have to push for more fiber to businesses and business districts.

The bottom line is that the city needs to find a competitive ISP to compete against the cable companies. That improves the chances for businesses to get the broadband they want. It would mean providing choice for both small businesses and residents, with the only choice today being the cable incumbent.

Our conclusion is that low-income subsidy programs are likely to attract millions of new homes to buy home broadband. There is no reason to think that if the low-income programs are funded to be sustainable that Joplin won't move much closer to the national average broadband penetration rates over time.

Other Municipal Fiber Networks

There are not a lot of municipal projects in cities around the size of Joplin. There are about 150 cities that have built fiber everywhere, and most of them are far smaller than Joplin - most under 10,000 residents. Most smaller cities that have built fiber did so because of lousy existing broadband. Following is a short

synopsis of municipal fiber systems that are close in size to Joplin. At the end will be a discussion about the characteristics that are unique to cities of your size.

Wilson, NC[27]

Wilson is a city with a population of roughly 50,000, located in eastern North Carolina. In 2008 Wilson entered the broadband business. Wilson attempted for many years to negotiate for faster speeds from Time Warner Cable and even offered to purchase the cable network in the city. After failed negotiations, Wilson decided to build a fiber network. It was funded using $29 million in Certificates of Participation (COPs) in 2007 and 2008. The network was finished in January of 2009. Wilson operates the fiber network under the brand name Greenlight and operates it through Wilson Energy, the municipal electric utility.

In 2008 Greenlight began by offering 10 Mbps symmetrical speeds to its 1,840 subscribers. In 2015 Greenlight began offering 1 Gbps symmetrical speeds to the entire city and had a total of 7,100 customers. In 2020 Greenlight was nearing a take-rate of 45% and had 11,300 customers.

The unique consequence of Wilson building fiber is that the city used fiber as a catalyst to revitalize the city. Wilson was typical of old industrial towns that had lost all of the large businesses that formerly drove the economy. The downtown was essentially abandoned and an eyesore. The city used fiber and economic development funds to lure businesses back downtown. The city rehabbed an abandoned theater to create a now-vibrant community center. It provided free or cheap rent to restaurants, art galleries, and a brewery to get the downtown restarted. This effort has worked spectacularly, and downtown Wilson is thriving again. The fiber network also helped Wilson attract new businesses, including ExodusFX, a special effects company that relocated from California, and TresBu Digital, a platform developer and technology vendor.

In 2020 Greenlight announced that it is only a few years away from retiring its original debt. However, Greenlight has recently expanded to serve the rural areas of the county around the city. Greenlight is in a unique regulatory position. It was able to become a municipal ISP, but since Greenlight started, the North Carolina legislature has passed prohibitions against further municipal broadband in the state. This makes Wilson the envy of cities around the state that want better broadband.

Greenlight offers a full range of triple-play services. Internet-only plans start at $39.95 for 50 Mbps, $59.95 for 300 Mbps, and $99.95 for 1 Gbps. In 2016 Greenlight began offering discounted broadband to low-income families; the plan is 40 Mbps for $10.

Jackson Energy Authority, TN[28]

Jackson is located in west Tennessee and has a population of 68,000. The business was founded in 2003 and is operated by Jackson Energy Authority (JEA), the municipal electric utility. This early start made this one of the earliest municipal fiber ventures. JEA originally partnered with Wave7 Optics to light the fiber network – a company that is gone from the industry. The first build was to pass 30,000 homes for a cost of $54 million using revenue bonds. The utility provides its broadband service under the brand name Eplus Broadband.

[27] https://www.greenlightnc.com/

[28] https://www.eplusbroadband.com/

JEA signed up its first customer in 2004 and by the end of 2005 had 10,000 customers on its network. In 2014 JEA announced it would upgrade the network by replacing the optical network terminals at each premise. The upgrade was necessary due to the age of the equipment for JEA to offer 1-gigabyte speeds to all of its customers, which was completed in 2015. As of 2021, JEA has 40,000 residential subscribers for its broadband services.

JEA offers triple-play services (cable TV, internet, and phone) to all residents in its service area. JEA offers two broadband speeds, 300 Mbps and 1 Gbps, priced at $64.99 and $79.99, respectively.

Clarksville, TN[29]

Clarksville is located in northern Tennessee and is the fifth-largest city in the state, with a population of roughly 153,000. The fiber network was launched in 2007 by the Clarksville Department of Electricity (CDE), the municipal electric company. To fund the project, the newly founded CDE Lightband department borrowed $17 million from the electric division of CDE. The electric division owns and maintains the fiber network, and CDE Lightband initially paid $10 million per year to lease the fiber network and to cover shared costs.

CDE Lightband now has 1,200 miles of fiber and passes more than 64,000 homes and businesses with fiber to the premise. CDE Lightband has a total subscribership of over 25,000 customers and over 30% penetration in the market. The revenues generated by the business have allowed CDE Lightband to pay off the debt 17 years early. Due to the fiber infrastructure and the availability of cheap electricity from the Tennessee Valley Authority, both Google and Netflix have chosen Clarksville as a regional server hub.

CDE Lightband offers triple-play services (cable TV, Internet, and phone) to its customers. CDE Lightband offers broadband at three speeds 250 Mbps for $45.95, 500 Mbps for $70.95, and 1 Gbps for $90.95.

Longmont, CO[30]

Longmont is located north of Denver and has a population of roughly 99,000. In 1997 Longmont Power & Communications partnered with Platte River Power Authority and installed a 17-mile fiber loop in the city. The state of Colorado had a long-standing prohibition against municipal broadband but eventually passed a law that allows cities to build and operate fiber networks as long as the project is approved by a referendum. In 2011, Longmont's citizens passed the referendum that allowed Longmont Power & Communications to construct the fiber network.

The city originally hoped to be an open-access network but had no luck in attracting willing ISPs to serve the market. The city finally decided to move ahead as a retail ISP, and in 2014 began the construction of the fiber network under the brand Nextlight. The network was constructed in six phases and cost $45 million funded by bonds that were backed by the electricity utility. Nextlight has over 19,000 residential

[29] https://cdelightband.com/

[30] https://mynextlight.com/

subscribers and roughly 1,100 business subscribers, with a 57% take rate of the homes and businesses passed.

Nextlight currently offers broadband and phone services. It provides two internet plans a 100 Mbps for $39.95 and 1 Gbps for $69.95.

Springfield, MO

Springfield is located in southwestern Missouri and has a population of approximately 167,000. City Utilities, the municipal electric company, started building fiber in 1994 to connect utility locations and city government buildings. In 1997 the city launched the ISP Springnet that began selling broadband to businesses. The network grew over time to have 700 miles of fiber and serve over 600 business customers.

In 2019, Springnet announced it was beginning a $120 million plan to bring fiber to every home in the city. The project will add 1,100 miles of fiber to its existing network and will pass 115,000 additional residential and business passings. The project is expected to finish in February 2023. The project got national press when the city struck a deal with CenturyLink to offer services over the fiber network. CenturyLink will pay the cost of connecting customers, and the city said this will save City Utilities between $50 and $80 million. The contract with CenturyLink is not exclusive, and the city hopes to attract other ISPs to use the fiber network.

As discussed above in this section of the report, current Missouri law seems to allow municipalities to build broadband networks and lease the facilities to others or to directly become an ISP.

CenturyLink is offering broadband using the brand Quantum Fiber. It offers 200 Mbps for $49.00 and 1 Gbps for $65.00.

Summary. There are a few takeaways from looking at these cities that have already built fiber networks:

- All of the cities have a municipal electric utility. While this is not mandatory for a municipality to pursue fiber, a large majority of the cities that have built fiber have an existing electric utility. Having a utility means the city likely owns most or all of the utility poles. It also means that the city already has the expertise in building and maintaining a wire network. Finally, it means the city is already engaged in the backoffice portion of operating an ISP – taking orders, billing customers, collecting payments, etc.
- All of the cities currently have regulatory authority to build fiber and be an ISP. However, no other city in North Carolina can duplicate what Wilson has done since the state legislature passed a law that grandfathers Wilson but prohibits other cities from becoming ISPs. There are numerous cities in Tennessee that are operating ISPs, so the law in that state clearly allows it. I do note that even in Tennessee that municipalities have to jump through a few extra hoops compared to any other new ISP, such as demonstrating that rates are not subsidized. Colorado allows municipal broadband as long as citizens approve a referendum to support the idea. The grayest law is in Missouri because the ability to provide broadband hinges upon an interpretation that broadband is not a telecommunications service. It's hard to know what might happen if the FCC or state somehow decided that broadband is a telecommunications service.
- All of these cities except Springfield claim to be successful in the broadband business (Springfield is too new and is still being built). The other systems are generating more revenue than operating

expenses. This is easiest to explain by noting that the broadband business is an economy of scale business. The larger the number of customers, the higher the overall margin. This is because most of the costs of operating an ISP are fixed. There is one general manager to pay, for example, whether the business has 5,000 or 20,000 customers. This is true for the majority of the costs of operating the business.

- All of these businesses have financed a significant portion of the cost of the network. The only exception is Clarksville, but the ISP business fully covers the cost of debt incurred by the electric utility. From a bottom-line perspective, debt cost is another recurring fixed cost of the business.

Historic Restrictions on Broadband Expansion

The RFP asked us to describe the existing factors that are limiting broadband expansion in the city today. We think the following issues contribute to the current broadband situation.

- Joplin looks like most U.S. cities in that the majority of telecom infrastructure was built many decades ago.
    - The telephone copper networks were likely built in the 1950s and 1960s, with a few neighborhoods even possibly older than that. AT&T has subsequently built some fiber to enhance DSL service and to serve a few key businesses. Such fiber is likely relatively small in fiber counts a doesn't have a lot of extra capacity for other purposes.
    - The cable company copper network is also old and would have been primarily constructed in the 1970s. The cable companies have subsequently also built fiber to reach into neighborhoods as they have introduced neighborhood nodes for broadband. These are also likely relatively small fibers.
    - The limited amount of broadband fiber in the city has been built during the last twenty years.
    - It doesn't appear that AT&T has made any significant investments in DSL in the last decade. At about that time, the company invested in faster DSL that could deliver up to 50 Mbps by using two pairs of telephone copper. We see no evidence of that product in any widespread manner in the city. This means that the AT&T DSL electronics are old and obsolete – and proven by the fact that the company won't connect any new customers to DSL.
    - The cable network has undergone several major upgrades since it was constructed. The original network only was used to deliver analog cable TV. Such a network could connect to huge pockets of the city as a single neighborhood node. Just before 2000, the cable industry was able to start providing broadband over the coaxial network. That involved upgrading the electronics to the DOCSIS 2.0 standard and build some fiber to break the city into smaller nodes. The original broadband nodes likely had at least a few hundred customers each, so enough fiber was built to reach into pockets of homes of that number. That meant a little fiber scattered throughout the city. At some point, perhaps 10-12 years ago, the cable company upgraded to DOCSIS 3.0. That allowed broadband speeds up to perhaps 250 Mbps download. Getting those speeds required smaller nodes, so the cable fiber would have been extended to smaller groups of homes, perhaps 100 per node. A few years ago, the cable companies upgraded to DOCSIS 3.1 for download, allowing gigabit broadband speeds. It does look like the upload parts of the network were upgraded to this latest standard.

- Joplin is not unique in wondering why there is not more vigorous competition in broadband speeds and technology, and we think that's the real question you were asking in the RFP. We lived and worked through all of these years of technology upgrades, and we think Joplin was treated much the same as most other cities of similar size. That means the following:
    - When AT&T and the cable companies first introduced broadband, both technologies delivered roughly the same speeds. At first, in 2000, this would have been 1 Mbps download, and over time both technologies were able to increase speeds to the range of about 12 Mbps, still roughly at the same time. In those days, there was rigorous competition to win broadband customers, and households often bounced back and forth between the two companies, chasing marketing special. But eventually, in the later 2000s, the cable company got faster than DSL. DSL eventually grew to be as fast as 25 Mbps, but cable modem speeds greatly surpassed DSL by 2010. Even then, there were DSL customers using older technology that delivered maximum speeds of 6 Mbps, 12 Mbps, or 15 Mbps.
    - In the industry, we refer to the period when the cable and telephone companies competed on an even basis as duopoly competition. People still had only two choices of providers, and the broadband products were nearly identical. Nationwide, the telephone companies and the cable companies seemed to reach a tacit agreement to not compete on price – so the prices of both products were similar. That is one of the key elements of duopoly competition – lack of price competition.
    - The industry changed when the cable company achieved faster broadband. AT&T largely stopped maintaining the copper wire and the electronics. While AT&T had a few price increases, over time, the cable companies started charging more for broadband because they rightfully assumed that people who care about speed will pay more. In practically every market like Joplin, the cable company slowly won the majority of customers, and there has been an annual migration of DSL to cable broadband for the last decade. The cable companies upgraded over tie, but these upgrades were not done due to any market pressure in cities like Joplin. Instead, every big cable company serves some larger towns, and as they upgraded those markets, they eventually upgraded other markets so that technology was the same companywide.
    - Fiber technology is expensive and there are almost no examples of commercial ISPs building citywide fiber in towns the size of Joplin. Joplin is like hundreds of other county seats in that fiber was built to key businesses and anchor institutions, but barely to anybody else. The companies that built small amounts of fiber are commanding a premium price for the better performance.

We know of hundreds of county seats that have the same broadband history as Joplin. In a nutshell that is dead and dying DSL. The cable companies have upgraded broadband several times, but this mostly due to competitive pressure in larger markets that pushed for technology upgrades companywide. Nobody saw any financial incentive to build widespread fiber, so fiber was just built to those businesses willing to pay a premium price for broadband.

One of the interesting trends to keep an eye on is that there are huge federal grants aimed at upgrading broadband in the rural areas around Joplin. It's possible over the next 5-10 years that the rural areas around Joplin could get fiber, even if Joplin never does. We still are not seeing any upswelling of ISPs ready to invest in fiber in county seat towns like Joplin.

D. Partnering Potential

The RFP asked us to identify potential ISP partners that might be interested in the Joplin market. We talked to the regional ISPs as part of the project, and we've identified several potential ISP partners. The RFP further asked us to get more specific and discuss details, such as how much investment various ISPs might bring to a Joplin partnership. No ISP will publicly go on the record for a public report like this one with anything specific concerning a partnership. This report includes the key facts that ISPs need to even know if they should be interested – the statistically valid survey and the engineering estimate of the cost of building fiber in the city.

In the recommendation section of the report, we describe how reaching out to potential partners should be one of the first things the city should do after digesting our final report. But for the city to have any meaningful discussions with potential partners, the city must determine what you are willing to bring to a partnership. The discussion below outlines the various ways that we've seen other municipalities successfully identify and negotiate with partners.

There is one potential partner that we can discuss. The report earlier talked about the partnership between the city of Springfield and CenturyLink. We don't know the fine details of the arrangement, but we've gathered the following from the various statements made by the two parties:

- The city is providing dark fiber and CenturyLink will provide all of the electronics to light the connections that the company uses. There have been no public announcements of which party will build and own the fiber drops – but since this is being touted as an expansion of smart-grid, it seems highly likely that the city is responsible for the drops.
- CenturyLink has agreed to lease the network over 15-years at a payment that made the city comfortable enough to build the network. The city says they won't have to raise electric rates since the lease revenue stream justifies the cost of the new $120 million fiber expansion. Since the network will be made available to other ISPs, it's unlikely that the CenturyLink lease will pay all of the debt – but it's hard to know the city's financial parameters for deciding to move forward.
- The arrangement is described as non-exclusive, meaning that other ISPs are free to serve on the network. The announcements don't say that CenturyLink gets a head-start over other ISPs, but there have been no announcements of agreements with other ISPs.

In more normal times, we would be recommending that the city talks to CenturyLink about the same type of arrangement in Joplin. But since the company recently announced that it is selling the networks in Missouri, it's highly unlikely that such conversations can be fruitful until the new company has been in operations for a few years. And that could be three or four years from now.

The following section of the report discusses some steps to consider in engaging the ISPs. The following discussion on partnerships assumes a true partnership between Joplin and an ISP – meaning one where the city is somehow contributing to the venture.

The Best Characteristics for an ISP Partner

Experience. There are several investor-backed companies looking to break into the broadband business. These firms have never built or operated a network. This isn't to say that such a group can't be a good

partner, but it's a higher risk to work with an ISP that doesn't already have customers, and that hasn't worked in a partnership before.

There are a few stories in the industry of public-private partnerships that went awry because of lack of experience by the ISP partner. In the following two examples, the ISP management team was made up of folks with industry experience but who had never worked together as a team before.

- The first example is Utopia in Utah. This is a collaboration of small towns that are working together through the Utopia organization to create economy-of-scale for the business. State law in Utah doesn't allow municipalities to be an ISP, so Utopia works as an open-access network where the cities build the network and various ISPs compete for customers.

  Utopia started by hiring an external management team that had not worked in the open-access environment before. Several things went wrong – the networks were late in getting constructed and came in over budget. The ISPs did not sell as aggressively as the business plan had supposed. Utopia ran out of cash before construction was complete and almost folded, but the business was eventually saved through several rounds of refinancing and is now large enough to be financially stable. It took almost a decade of the business being in financial duress to get to that point.

- Another example is Lake City, Minnesota. The city decided to borrow money to build a city-wide fiber network. This is one of the northernmost cities in the state and quite remote. There are 11,000 residents in 2,100 square miles. They hired an outside firm to construct the network and run the ISP. The project went way over budget, and the project ran out of money with a backlog of almost 1,000 customers they couldn't connect to the network.

  The project was funded through a combination of a $10 million federal grant and a low-interest government loan for $56 million. The city also bonded over $7 million locally for the project plus floated loans to keep the project afloat. The project went completely underwater financially and didn't make enough money to cover debt payments. In 2019 the city sold the network to an ISP for $8.4 million. The federal government had to write off about $40 million in debt, and the city still must cover the original bonds plus the internal loans made to the project.

Experience Working with Municipalities. It's somewhat important to work with an ISP that has worked with local governments before. CCG has witnessed a number of public private partnerships with the recurring theme that the two parties get frustrated with each other over time. This is due to two factors – frustration with the decision-making process and a difference in goals and expectations.

Commercial ISPs become quickly frustrated with the municipal decision-making process. Most local governments have a specified legal process that must be followed to make certain kinds of decisions. This might mean listing the topic for a public meeting, waiting for a period of time, and allowing public comment on the issue. Commercial ISPs are used to making decisions quickly, and they don't like the drawn-out processes that government requires. Government entities get frustrated as well since their commercial partners push them to make decisions quickly when they can't.

A more fundamental issue in public-private partnerships is a fundamental difference in goals. The issue commonly arises when the two parties didn't thoroughly discuss their long-term goals for broadband before a partnership began. Commercial ISPs are often most worried about cash flow and profit margins.

If they've invested equity in a broadband network, they become unhappy if the business doesn't meet their earnings goals. Governments often have a different set of goals – serving every household, offering low-priced broadband to low-income houses, providing subsidized broadband to non-profits and anchor institutions. In many cases, these kinds of fundamental differences can't be overcome and eventually ends up in a dissolution of the partnership.

The differences between the two kinds of entities often surface when there is a discussion of rates. Cities often push back against rate increases – particularly in election years. Cities push partners for low rates and often want an ISP to give low rates for low-income households and even free rates to groups like non-profits.

These kinds of issues are less likely to be a huge problem if the ISP has worked successfully with other municipalities before. A government entity that is working with an ISP that has not partnered in this manner before should have an in-depth discussion upfront about expectations. It's a lot easier if the two parties decide upfront that they aren't compatible instead of getting a divorce after the partnership has been launched.

There is another way to avoid these kinds of issues. The CenturyLink arrangement with Springfield means that CenturyLink leases dark fiber and places its own electronics. This is a partnership in terms of dollars, but the city doesn't have a strong operational role other than to maintain and repair fibers. This means that there are not many operational issues where the two sides are collaborating.

Financial Strength. Municipal entities often have a hard time judging the financial strength of partners. Unfortunately, most public-private partnerships are not with big, well-financed ISPs. The more typical partnerships are with telephone companies, electric cooperatives, or fiber overbuilders. It's typical for commercial ISPs of this type to overstate their financial security – and they may even believe what they say in doing so. But there are a few fundamental things about ISPs that a city should understand:

- Almost every ISP has a natural borrowing limit. There is only so much debt that bankers and other lenders will allow them to carry. By definition, when an ISP nears that lending limit it means that bankers think the company is pushing its financial limitations. Any ISP that has borrowed to its limit can't afford to make financial mistakes, and that means the partnership and all its other ventures need to perform as expected. It's not unusual to see a budding partnership be dependent upon obtaining financing, and it's not uncommon for the ISP to not get the hoped-for funding.
- The biggest issue with ISPs and borrowing is collateral. Banks don't consider fiber networks to be good collateral for loans because there is very little value from repossessing a fiber network. This means the only good collateral that most ISPs have is the value of their existing company. Even surprisingly large ISPs might have to pledge their entire company in order to borrow a sizable amount of money to build an expensive network. It's often necessary for owners of ISPs to make personal guarantees on loans, meaning that both their business and their personal assets are on the line with a new fiber project. ISPs are highly unlikely to disclose to a government partner the details of how they raise money – among other reasons, they fear public disclosure laws and don't want their personal financial position discoverable as a public record.

Capacity to Grow. One of the hardest things to judge is the ability of an ISP to grow quickly. A traditional ISP like a telephone company may have a lot of customers – but they acquired them slowly over decades. ISPs (and all other types of businesses) often get stressed to the breaking point when they try to grow too

fast. It's not unusual for an ISP to somehow assume that existing middle and upper management can handle a growth scenario while still somehow handling the existing responsibilities they've always had.

Just because a company is a great ISP doesn't mean that the company is capable of growing quickly. Unfortunately, there is no way to judge this unless the ISP has already been growing prior to the creation of the partnership.

Fair Recognition of Value. One of the important attributes of a good partnership is the full and fair recognition of the value that each party brings to the partnership. Municipalities should be wary of a partner that overvalues what they bring to and undervalues what the city brings. A government can create value for a public/private partnership in a number of ways:

- Funding. Any amounts paid towards funding a broadband network are valuable. Governments often don't know how to set a value for cash contributions – something that commercial partners routinely figure out. It's been my experience that ISPs don't value government funding as much as they do other funding sources. I think this is because government funding doesn't come with the same stringent strings and responsibilities. A local government is not likely (or even able) to require things that a bank might require, such as collateral or a lien on a partner's assets. If an ISP gets into financial trouble, the first entity they will try not to pay is a government partner. This can be dealt with in creating the partnership agreement, but to some degree, that requires a government to think like a bank.
- Anchor Tenant. Government entities often make good anchor tenants – which is pledging to be an early customer of a network and guaranteeing to buy services with a long-term contract. It's not untypical for a government entity to be one of the largest broadband and telecom customers on a network.
- Other Assets. Governments often have other assets that can benefit a partnership. This could be land for placing equipment; It could be a building to create a central office or a storefront. It might mean towers, empty conduit, or spare existing fiber that can be used to defray the cost of constructing a broadband solution. The value of such assets should be set according to what the partnership would pay to get the same thing from a third party.
- Easier Construction Processes. Local governments often take a significant role during the construction process. They might have to approve permits for rights-of-way. They might be the entity that locates existing utilities. They might require inspection of construction worksites, during and after construction. They might require things like traffic management during construction. Before tackling a major fiber construction project with a partner, a government might review these various requirements to see if they can be streamlined to make it easier to build fiber. Note in doing so that this likely means making any relaxed rules available to any other entity that wants to build fiber.
- Contributed Labor. A government can contribute labor. Using the last example above, a government could agree to conduct permits, locating, or some other service for free as a way to contribute to launching a partnership project.
- Tax Abatements. Tax abatements have always been a tool for economic development. Governments often have it within their power to excuse certain taxes to entities that bring something of economic value to the community. For example, it's common to not charge a large new business any property taxes for some period to lure them into locate in the community. There are numerous taxes and fees that might impact a new broadband network, such as property taxes,

sales taxes, or right-of-way fees that a government might be willing to waive to help a new network get established.

The bottom line is that a government can bring significant value to a partnership and that contribution should be fairly valued. Even when a government brings tangible value, such as contributing funding, it's not unusual for an ISP to undervalue that contribution. It's even more prevalent for an ISP to not assign a realistic value to the more intangible contributions.

How do You Find Potential Partners?

We've seen almost every partnership we know develop through on of the following processes:

- Request for Information (RFI). It's typical for communities that want broadband to issue an RFI aimed specifically at soliciting potential ISP partners. These RFIs typically describe the situation in the community, typically describe whatever work has already been accomplished (such as this feasibility study) and describe the role the municipality wants to take in a partnership.

  An RFI then asks ISPs to describe themselves and their capabilities. The RFI generally doesn't go so far as to request a specific solution but rather asks the ISPs to discuss how they might tackle broadband issues in the community.

  And RFI is generally the first step to determine which ISPs might be interested in partnering. After the RFI, the process typically moves to one of the two processes described below.

- Request for Proposal (RFP). An RFP is typically a lot more in-depth. In addition to asking ISPs to introduce themselves, an RFP might ask for specific proposed solutions. It might go into further in detail asking about the financial strength of the ISP business and details of how they operate in other markets.

- Direct Negotiation. It's routine for governments to interact directly with potential ISP partners rather than go through an RFI or RFP. This might involve a local government reaching out to ISPs in the area, or it might be in response to an ISP making an unsolicited proposal to a local government to bring broadband.

Comparing the Three Options.

It's first worth considering the issue from the perspective of an ISP. ISPs are leery of public records laws. They are often highly reluctant to provide financial information, customer lists, or other information that they feel is confidential. They don't trust that local governments will fight to keep such information confidential. ISPs are leery about spelling out specific details of their business plan and how they approach a broadband market – they don't want that information to be available to their competitors.

Many ISPs are not willing or able to respond to an RFI or an RFP that asks for lengthy written responses to a long list of questions. Businesses that sell equipment and services are used to the idea of making proposals and usually have a pile of pre-prepared canned responses to the typical questions they are asked by a prospective customer. However, an ISP may never have been asked to make a proposal in writing in the specific and detailed way that might be needed to respond to an RFI or an RFP. There are ISPs that

refuse to participate in an RFI or RFP for this and related issues. We know there are ISPs that eliminate cities from consideration if they insist on going through the formal RFP process. They know there are other communities that will talk to them directly without the formal process.

ISPs prefer direct discussions where nothing is put into writing during the negotiation stage. That's the same process that ISPs typically use when they partner with other ISPs – they sit and talk out the pros and cons and mutually decide if there is a potential for a partnership. As often as not, such discussions end up with the realization that a partnership is not a good idea, and the parties amicably go their separate ways, and nothing they discussed is in writing.

Here is the process that I like best, having been through a lot of discussions between governments and ISPs:

> For most local governments, the best first step is to invite known ISPs for a high-level discussion about whether any kind of partnership makes sense. This process might involve several meetings where an ISP might come back with ideas and then another meeting where the local government reacts. Finley Engineering talked with regional ISPs that are engaged in the fiber-to-the-home business. Not surprisingly, none of those ISPs want to be identified in this study. However, we know that several will be interested in talking to the City about partnership ideas, and we will introduce them to the City at the appropriate time.
>
> I like the RFI process when it makes sense. For example, I was working with a geographically isolated community where there was no local ISP candidate within fifty miles. An RFI made sense since the community didn't have a wish list of local ISPs to consider. An RFI also might make sense for larger communities. In this case, I define larger to mean that the cost of the project is large – perhaps more than $25 million. I've known communities that found an ISP partner through an RFI that they would never have otherwise found.
>
> If a city issues an RFI, it should ask for basic information only. That might include asking an ISP to provide its history, about the products it normally sells, and about the management team. While cities might have a hundred questions for a prospective partner, the ISP is going to be a lot happier if the details of their business are not put into writing at the early stage of meeting and negotiating.
>
> I think RFPs only make sense for larger cities – probably those with network costs over $100 million. It's not likely that a small ISP will respond to such an RFP. Even in an RFP, I recommend not asking for sensitive financial information about the ISP – that can always be provided if the likelihood of a partnership develops.

Establishing Compatible Goals

At some point during the early stages of the process, it's vital for both sides to thoroughly discuss their goals for the project. Misalignment of goals is the number one issue that plagues any partnership eventually. Both parties need to fully hear, understand, and be fully comfortable with the goals of the other partner.

Goals generally can be stated simply and don't have to be complicated. Goals for a municipality might be things such as serving the entire community, not needing to subsidize the project, keeping rates low, and so forth. Goals for an ISP might be to generate a specific target of cash flows and profits. It wouldn't be unusual for an ISP partner to eventually want the option to buy the business. An ISP also might want just the opposite and might want to capitalize on the success of the business by selling out after some period of time.

It's important to not only see each other's goals, but it's vital for a municipality to understand the ISP's goals. This is one situation where a municipality might want to discuss these goals with a consultant or somebody with broad industry experience. It's not unusual for two partners to be talking a different language when discussing financial issues, and it's vital to fully comprehend what a partner is telling you about their goals.

The alignment of goals is a make-or-break point in a potential partnership. Many of the differences that a municipality and an ISP might have can be negotiated, but you can't negotiate a difference in philosophy. If an ISP has a goal that a municipality can't live with, such as selling out in 10 years – then our advice is to not pursue the partnership. When an ISP tells you a goal of that nature, they mean it.

How to Rank Potential Partners?

There are hundreds of questions that a local government might ask an ISP that might range from big important questions like, "Can you bring funding to this project?" to questions that are important but have less impact on creating a partnership, such as, "What's your process of disconnecting customers who don't pay?"

I advise prospective partners (government or otherwise) to place their questions into three categories, 1) make or break questions, 2) questions that might disqualify a potential partner, and 3) all other questions.

Every community will have its own list of make-or-break questions based upon their own priorities for what a partner should bring to the table. Make or break questions might be things like 1) "How much funding can you bring to the project?", or 2) "Are you willing to serve everybody in the community?"

Questions that might disqualify a potential partner might be similar questions, again based on the specific priority and goals of a given community. Keep in mind that some of the items in this category might be subject to negotiation – something that should be asked.

The first two categories of questions are the important ones that should be used to qualify and rank potential partners. Other less critical questions are important but probably don't get considered unless it's close between two candidates. You choose a partner based upon the most important aspects of the relationship.

There are several techniques that are used to compile rankings. Most rankings of this sort are done by compiling the rankings by a team of reviewers. The most important questions might get weighted somehow to have the biggest impact on the composite answer. At the end of this process is a numerical answer that reflects the composite opinion of those doing the ranking. It's likely that such rankings are not the final answer, and often the ranking process will send a government back to ask more questions.

Since this is not a purchase of service, but a partnership, it's also highly unlikely that it would be mandatory to take the ISP that ranked the best.

Defining the Roles of Each Partner

It's vital to define the specific roles and responsibilities of each partner. Ideally, this should be done before formalizing the partnership arrangement.

CCG has often used a technique that seems to work ideally in defining a partnership. It starts with a list of all of the tasks needed for launching and operating the upcoming broadband business. The level of detail usually becomes readily apparent. For example, if it is clear that the ISP is going to have 100% of the interactions with customers, then having a task called "interface with customers" would be sufficient rather than listing all of the various ways that somebody might interface with customers.

The items on the list would include financial and other contributions as discussed earlier, issues having to do with construction the new network, issues having to do with governance, issues having to do with operating the business.

A responsible party must be assigned for each task on the list. The choices for each task are 1) the task is the responsibility of the government, 2) the task is the responsibility of the ISP, 3) the task is a joint responsibility of both parties (in which case that needs to be fully described), or 4) the task is the responsibility of some third party (like an outsourced arrangement). This kind of process quickly shows if the two parties are aligned and agree on all of the responsibilities and if there are tasks where the two sides have a different view. The example used earlier involved the setting of rates – this is a good way to get it in writing from both parties about the roles in setting rates.

Making this list serves two purposes. It's a great tool for getting both parties to acknowledge the specific roles of each partner. It also then serves as a great template for developing a contract between the partners.

Maintaining Local Control

One of the big challenges is how a community can create partnership and still maintain some local control over the policies and operations of the ISP business. This is probably the most challenging aspect of a partnership. The following issues all have bearing on the level of control a municipality might have for an ongoing broadband business.

Before answering the question, I would challenge a municipality to make a list of items they would like to have some control over. It's likely that a list will include major aspects of operating the business such as rates, installation intervals, business hours, priorities of repairing customers after an outage, etc. I then ask the municipality to change hats and look at these same issues from the ISP perspective. This often highlights requests for control that are unreasonable.

One of the stories I tell about politics and the broadband business concerns Bristol Virginia Utilities, which was one of the first cities to enter the broadband business. The business was operated by the electric utility, which was a branch of the local government, but which had a full standalone operating authority. The

bonds were fully backed by the electric utility, but since the city had to approve any bond issue, the city reserved the right to set and approve rates. A few years after launching the business, and during an election year, the city council voted to slash all the rates by 15%. The utility warned them this would put the business underwater, and sure enough, the business was unable to meet a bond payment due six months later. The city got the message and ended up raising the rates to a higher level than the original rates to correct the shortfall, and the city also created an ordinance so that no future city council could change rates.

There are numerous other examples of negative ways that local governments have meddled in a broadband business. Politicians might make promises to constituents on behalf of the ISP. Politicians often press to give special rates to friends or to forgive bad debts for a constituent. It's not unusual for politicians to go further and interfere in things like personnel decisions. It's incredibly important to have clearly defined boundaries and lines so that an ISP can say no to meddling.

ISPs are highly wary of ceding any control to a government entity. ISPs fully comprehend that a partnership with a municipality is always tentative and can change drastically after an election. There are plenty of examples of a council or board that changed from pro-broadband utility to anti after an election. Political changes can put a huge strain on the business relationship even if there are no control issues. ISPs know that the municipality they partner with today may not be the same in the future.

This is not to say that a municipality shouldn't have any control over the business. One of the more obvious aspects of maintaining control depends upon who funds the network. A municipality is going to get little or no say in how to operate a network that includes significant funding from a commercial ISP. If an ISP brings money to a project, they generally will not take the risk of letting a municipality tell them how to operate the business – since the ISPs primary goal will be in getting a good return on their investment.

But even funding doesn't always determine control. Many ISPs will only partner if they get to make all the business decisions – even if the government funded the network. This is why potential partners need to ask all of these questions before they create the partnership.

The only sure-fire way for a municipality to have control is to fund and operate the network. It's going to be difficult to find an ISP partner that will want a city to influence business decisions once the business is operating. This is a case where a little authority is a bad thing. If a municipality has any authority to control the business, then eventually somebody at municipality will go too far.

EXHIBIT I: SUMMARY OF RESIDENTIAL TELEPHONE SURVEY

Joplin, MO
Residential Broadband Survey Results
From June 2021

1. Who provides Internet service to your home now?

	Number	Percent
Sparklight	135	36%
AT&T	98	26%
MediaCom	30	8%
Only use Cellphone	38	10%
Do not have Internet	71	19%
Other –HughesNet, DirectTV	5	1%

2. What's the primary reason you don't have home Internet service today?

	Number	Percent
It's too expensive	14	20%
I'm not comfortable using the Internet	0	0%
I'm afraid of being hacked.	0	0%
I can't afford a home computer	5	7%
I get Internet access outside of my home	4	6%
Not interested in the Internet	48	67%

3A. Do you mind telling us why you can't afford home broadband?

	Number	Percent
I'm on a fixed income	10	72%
I'm not currently working	1	7%
I'm disabled	1	7%
I have too many other expenses	2	14%

3A1. How much could you afford to pay per month for home broadband?

	Number	Percent
$30 - $35	8	58%
Less than $30 per month	2	14%
Can't afford Internet	1	7%
Would want to see cost first	1	7%
Other	2	14%

3B. Would you buy home broadband if somebody gave you a computer?

	Number	Percent
Yes	1	20%
No	4	80%

4. Who is your current cable provider?

	Number	Percent
Sparklight	25	7%
MediaCom	14	4%
AT&T	47	12%
Satellite Dish	81	22%
Watch only online (such as Netflix)	95	25%
Use an antenna	27	7%
Do not watch TV/or have cable	88	23%

5. If you have a telephone landline, who provides your telephone service?

	Number	Percent
AT&T	102	27%
Sparklight	33	8%
Mediacom	12	3%
Don't have a landline	229	61%
Other	1	1%

6. What do you currently pay for the following?

Bundle

`	Number	Percent
$50- $75	7	5%
$76 - $100	32	25%
$101 - $125	14	11%
$126 - $150	24	18%
$151 - $200	31	24%
$201 - $250	19	15%
$250+	3	2%

Standalone Cable TV:

	Number	Percent
$25 - $50	1	2%
$51 - $75	6	10%
$76 - $100	27	46%
$101 - $125	19	32%
$126+	6	10%

Standalone Telephone:

	Number	Percent
$20 - $50	37	90%
$56 - $75	4	10%

Standalone Internet:

	Number	Percent
$26 - $50	10	7%
$51 - $75	52	39%
$76 - $100	56	41%
$101 - $125	8	6%
$126+	10	7%

7. Does anybody in your household use the Internet connection to work from home?

	Number	Percent
Full Time	49	13%
Several Days per week	51	14%
Occasionally	31	8%
No	246	65%

8. Is your internet connection adequate for working from home?

	Number	Percent
Yes	84	64%
No	47	36%

9. If no, what kind of problems do you experience?

	Number	Percent
Too slow to connect to office	46	98%
Inconsistent bandwidth	47	100%
Cannot connect to video calls	18	38%
Have to take turns with broadband	22	47%

10. Is your home broadband network used by anybody doing schoolwork?

	Number	Percent
Yes	82	22%
No	295	78%

11. How many people are using the broadband for school purposes?

	Number
K-12 Students	
1 Student	29
2 Students	25
3 Students	19
College or graduate school students	17
College or Graduate school	2

12. Did the students have any problems using the broadband for schoolwork during the pandemic?

	Number	Percent
Yes	42	57%
No	31	43%

13. What kind of problems did students have during the pandemic?

	Number	Percent
Too slow to connect to office	37	88%
Inconsistent bandwidth	38	91%
Cannot connect to video calls	16	38%
Have to take turns sharing broadband	20	48%

14. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Provider on the following?

DOWNLOAD SPEED

	Number	Percent
1 Very Dissatisfied	4	1%
2 Somewhat Dissatisfied	49	18%
3 Neutral	91	34%
4 Somewhat Satisfied	70	26%
5 Very Satisfied	54	21%

CUSTOMER SERVICE:

	Number	Percent
1 Very Dissatisfied	9	3%
2 Somewhat Dissatisfied	46	17%
3 Neutral	102	38%
4 Somewhat Satisfied	59	22%
5 Very Satisfied	52	20%

RELIABILITY:

	Number	Percent
1 Very Dissatisfied	5	2%
2 Somewhat Dissatisfied	44	16%
3 Neutral	102	38%
4 Somewhat Satisfied	68	26%
5 Very Satisfied	49	18%

VALUE I GET COMPARED TO THE PRICE I PAY:

	Number	Percent
1 Very Dissatisfied	17	6%
2 Somewhat Dissatisfied	78	29%
3 Neutral	81	30%
4 Somewhat Satisfied	53	20%
5 Very Satisfied	39	15%

15. The City is thinking about investing in a fiber network to increase Internet options and availability in the city How do you feel about the idea of the city working to get better Internet access?

	Number	Percent
I support the idea	251	67%
I do not support the idea	72	19%
I need more information.	54	14%

16. What are the reasons for your support?

	Number	Percent
More competition	224	89%
Lower prices	246	98%
Better Customer Service	152	61%
More reliable service	144	57%

17. Can you explain why you don't support the idea?

	Number	Percent
Broadband in the city is adequate	13	18%
Shouldn't compete with business	1	1%
I'm worried my taxes will go up.	3	4%
I don't care about broadband	55	77%

18. Would you buy internet services from a new fiber network if they offer faster speeds than the competition at rates similar to what is currently available?

	Number	Percent
Yes, definitely	168	45%
Probably	68	18%
Maybe	58	15%
Probably not	50	13%
Definitely not	33	9%

19. Would you change to a new internet provider if they don't offer cable TV?

	Number	Percent
Yes, definitely	160	43%
Probably	57	15%
Maybe	68	18%
Probably not	65	17%
Definitely not	27	7%

20. Would you buy landline telephone from a new network if was affordable?

	Number	Percent
Yes, definitely	64	17%
Probably	12	3%
Maybe	45	12%
Probably not	73	19%
Definitely not	183	49%

Joplin, MO
Online Residential Broadband Survey
From July - August 2021

1. Do you have Internet access to your home today?

	Number	Percent
Yes	268	91%
No	27	9%

2. What's the primary reason you don't have home Internet service today?

	Number	Percent
It's not available at my home	5	21%
It's too expensive	20	83%
I don't have a computer	4	17%
I don't know how to use the Internet	1	4%
I have no need for internet at home	1	4%

3. Who provides internet service to your home today?

	Number	Percent
Cable One (Sparklight)	149	70%
Mediacom	10	5%
AT&T	29	13%
Wisper ISP	5	2%
Satellite	4	2%
Other	5	3%
Only use my cellphone data	10	5%

4. Are you receiving the speed you are paying for?

	Number	Percent
Yes	72	34%
No	70	33%
I'm not sure	69	33%

5. What Internet speed are you supposed to be getting today in your home?

	Number	Percent
1 – 25 Mbps	8	9%
26 – 50 Mbps	7	8%
51 – 100 Mbps	27	32%
101 – 200 Mbps	16	19%
201- 400 Mbps	24	28%
400 + Mbps	3	4%

6. What is the actual download speed you are getting in your home?

	Number	Percent
1 – 25 Mbps	12	15%
26 – 50 Mbps	14	18%
51 – 100 Mbps	17	22%
101 – 200 Mbps	17	22%
201 – 400 Mbps	17	22%
400 + Mbps	1	1%

7. Using a scale from 1 to 5, where 1 is "very dissatisfied" and 5 is "very satisfied", please rate your Internet Provider on the following?

DOWNLOAD SPEED

	Number	Percent
1 Very Dissatisfied	23	11%
2 Dissatisfied	21	10%
3 Neutral	65	31%
4 Satisfied	57	27%
5 Very Satisfied	45	21%

CUSTOMER SERVICE:

	Number	Percent
1 Very Dissatisfied	24	11%
2 Dissatisfied	41	20%
3 Neutral	62	30%
4 Satisfied	47	22%
5 Very Satisfied	36	17%

VALUE I GET COMPARED TO THE PRICE I PAY:

	Number	Percent
1 Very Dissatisfied	56	27%
2 Dissatisfied	42	20%
3 Neutral	50	24%
4 Satisfied	41	19%
5 Very Satisfied	21	10%

8. Who is your current cable provider?

	Number	Percent
Cable One (Sparklight)	23	10%
Mediacom	3	1%
AT&T	5	2%
Other	2	1%
Satellite	41	18%
Watch only online (such as Netflix)	108	47%
Antenna/Over-the-air	21	10%
Do not watch TV	10	4%
Do not have any TV service available	15	7%

9. If you have a telephone landline, who provides your telephone service?

	Number	Percent
Cable One (Sparklight)	8	3%
Mediacom	2	1%
AT&T	21	10%
Don't have a landline	182	84%
Other	4	2%

10. What do you currently pay for the following?

Bundle

`	Number	Percent
$50- $75	4	11%
$76 - $100	8	22%
$101 - $125	3	8%
$126 - $150	1	3%
$151 - $200	10	28%
$201 - $250	6	17%
$250+	4	11%

Standalone Cable TV:

	Number	Percent
$25 - $50	3	12%
$51 - $75	4	16%
$76 - $100	4	16%
$101 - $125	5	20%
$126+	9	36%

Standalone Telephone:

	Number	Percent
$1 - $25	2	9%
$26 - $50	2	9%
$56 - $75	7	30%
$75+	9	52%

Standalone Internet:

	Number	Percent
$25 - $50	5	4%
$51 - $75	49	36%
$76 - $100	51	37%
$101 - $125	20	14%
$126+	12	9%

11. In general how do you feel about the idea of a new broadband network in the city?

	Number	Percent
I support the idea	142	62%
I do not support the idea	7	3%
I need more information.	80	35%

12. What are the reasons for your support?

	Number	Percent
More competition	131	94%
Lower prices	114	81%
Faster Speeds	122	87%
Better Customer Service	62	44%

13. What are the reasons you do not support the new fiber network?

	Number	Percent
Happy with current providers	2	50%
The city should not be involved in a commercial business	2	50%

14. What factors would influence your decision to move your services to a new network?

	Number	Percent
Faster internet speeds for the same price I pay today	151	70%
Lower price than I pay today	169	78%
Same price but better customer service	46	21%
Availability	4	2%
Competition	4	2%

15. Would you buy Internet service from a new network if it guaranteed faster speeds than the competition at rates similar to what is currently available?

	Number	Percent
Yes, definitely	99	46%
Probably	57	26%
Maybe	46	21%
Probably not	12	6%
Definitely not	3	1%

16. Would you buy a landline telephone service from a new network in the city if they could offer affordable prices?

	Number	Percent
Yes, definitely	11	5%
Probably	9	4%
Maybe	27	12%
Probably not	70	32%
Definitely not	102	47%

17. Do you currently subscribe to cell phone service?

	Number	Percent
Yes	216	99%
No	3	1%

18. Is the cellular coverage at your home adequate?

	Number	Percent
Yes	173	79%
No	46	21%

19. Does anyone in your family ever work at home using Internet access?

	Number	Percent
Yes, full-time	34	16%
Yes, a few times a week	63	29%
Yes, a few times a month	33	15%
Yes, very occasionally	31	14%
No	58	26%

20. Would you or your family member work from home more if you had faster Internet?

	Number	Percent
Yes	74	35%
No	140	65%

21. Do you have school-age children at home who use the internet to do their homework?

	Number	Percent
Yes	77	35%
No	141	65%

22. If the answer is yes, is your Internet connection good enough to support their homework?

	Number	Percent
Yes	55	59%
No	39	41%

EXHIBIT II: SUMMARY OF FINANCIAL RESULTS

		Year 5 Assets	Take Rate	Loan	Equity	Total Financing	Year 10 Cash	Year 20 Cash
	Commercial ISP							
1	**Base**	$70.78 M	50%	$65.6 M	$ 9.8 M	$75.4 M	$ 8.26 M	$20.07 M
2	**Higher Interest Rate**	$70.78 M	50%	$66.1 M	$ 9.9 M	$76.0 M	$ 6.91 M	$17.13 M
3	**Lower Interest Rate**	$70.78 M	50%	$65.1 M	$ 9.8 M	$74.8 M	$ 9.09 M	$22.90 M
4	**15-Year Term**	$70.78 M	50%	$67.6 M	$10.1 M	$77.8 M	-$ 0.43 M	$19.52 M
5	**30-Year Term**	$70.78 M	50%	$63.6 M	$ 9.5 M	$73.2 M	$15.93 M	$41.73 M
6	**55% Penetration**	$72.00 M	55%	$65.9 M	$ 9.9 M	$75.8 M	$11.72 M	$30.35 M
7	**60% Penetration**	$73.22 M	60%	$66.2 M	$ 9.9 M	$76.1 M	$15.01 M	$40.42 M
8	**45% Penetration**	$69.57 M	45%	$65.2 M	$ 9.8 M	$75.0 M	$ 3.71 M	$ 9.84 M
9	**Breakeven Penetration**	$68.84 M	42%	$64.9 M	$ 9.7 M	$74.6 M	$ 0.86 M	$ 3.75 M
10	**Higher Prices**	$70.78 M	50%	$64.7 M	$ 9.7 M	$74.4 M	$11.41 M	$29.35 M
11	**Lower Prices**	$70.78 M	50%	$66.4 M	$10.0 M	$76.3 M	$ 4.00 M	$10.78 M
12	**5% Higher Fiber Costs**	$72.85 M	50%	$67.6 M	$10.1 M	$77.8 M	$ 7.49 M	$18.20 M
13	**5% Lower Fiber Costs**	$68.72 M	50%	$63.5 M	$ 9.5 M	$73.0 M	$ 8.87 M	$21.93 M
	City as ISP							
14	**GO Bond**	$71.28 M	50%	$83.4 M		$83.4 M	$10.21 M	$29.43 M
15	**Revenue Bond**	$71.28 M	50%	$88.9 M		$88.9 M	$ 8.75 M	$25.47 M
16	**Using Alternate Tax**	$71.28 M	50%	$81.4 M		$81.4 M	$16.76 M	$38.42 M
17	**One-Time $10M**	$71.28 M	50%	$75.0 M		$75.0 M	$12.55 M	$37.39 M
18	**Operator for Hire**	$71.28 M	50%	$86.2 M		$86.2 M	$ 3.57 M	$13.37 M
	Open-access							
19	**City Financials**	$68.60 M	50%	$81.8 M		$81.8 M	($12.49 M)	($41.12 M)
20	**Collective ISP Financials**	$ 2.43 M	50%	$ 1.8 M	$ 0.9 M	$ 2.6 M	$16.58 M	$48.83 M

	ISP Leases the Network							
21	**City Financials**	$68.42 M	50%	$74.3 M		$74.3 M	$ 0.10 M	$ 0.08 M
22	**Partner Financials**	$ 2.67 M	50%	$ 5.7 M	$ 1.1 M	$ 6.8 M	$ 4.66 M	$17.62 M
	ISP Leases Dark Fiber							
23	**City Financials**	$60.48 M	50%	$69.4 M		$69.4 M	$ 2.69 M	$ 0.00 M
24	**Partner Financials**	$11.24 M	50%	$13.6 M	$ 2.7 M	$16.3 M	$ 1.15 M	$14.25 M