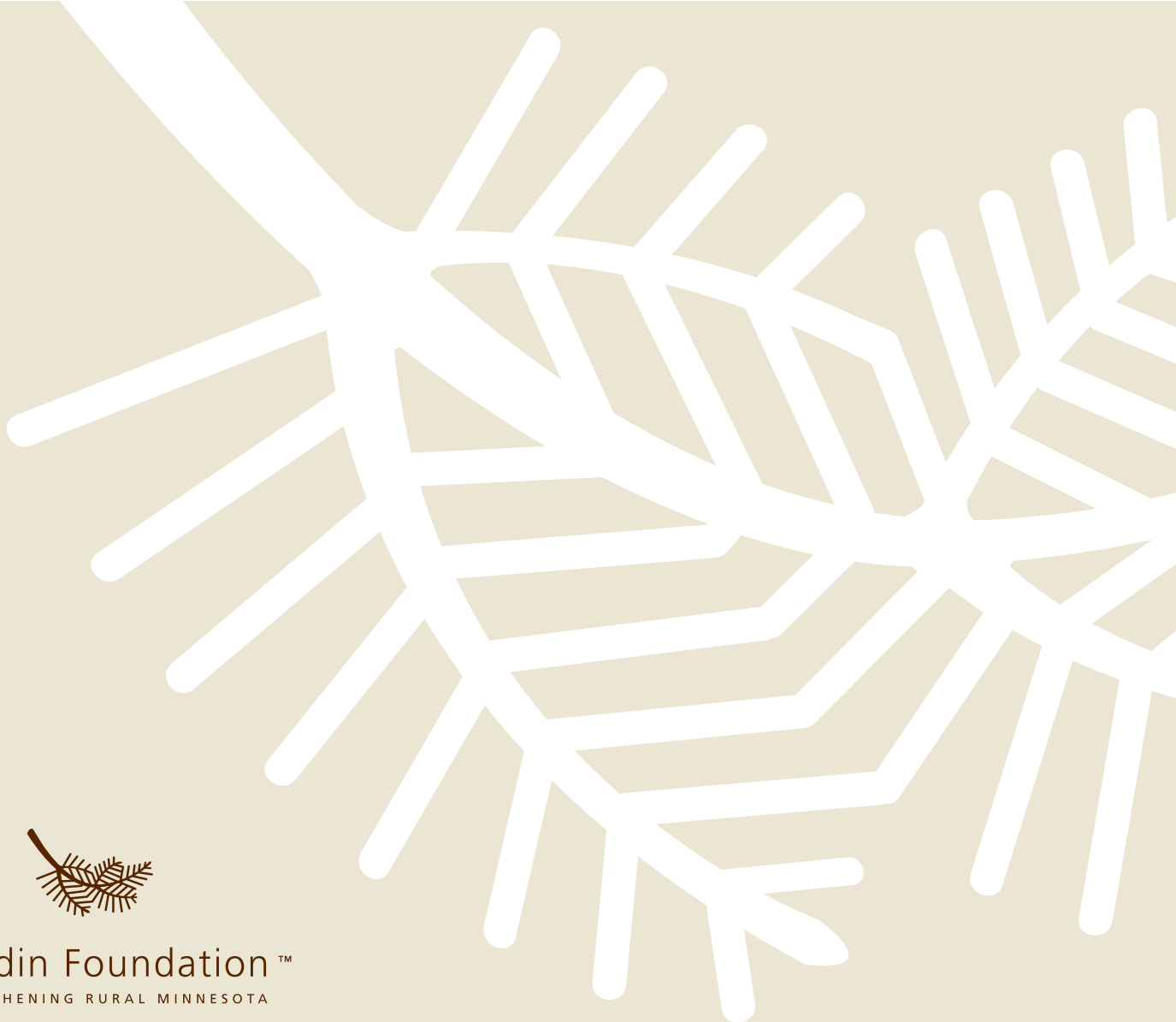


June 2018

Impact of CAF II-funded Networks

Lessons From Two Rural Minnesota
Exchanges Left Underserved



Blandin Foundation™
STRENGTHENING RURAL MINNESOTA

About the Report

Minnesota remains a state of broadband haves and have-nots, with 52.88 percentⁱ of rural communities having access at the level of the state's minimum standard, compared to 70.04 percent of statewide households meeting the state's broadband goalsⁱⁱ. Because Blandin Foundation cares deeply about the vitality of rural communities, we care about these gaps.

Recognizing that both local leaders and policymakers need sound information so that communities, border to border, are positioned for healthy, vibrant broadband-enabled futures, Blandin Foundation, in collaboration with lead researcher Bill Coleman of Community Technology Advisors, offers this case study. It focuses on two rural Minnesota exchanges where major federal investment has been made through the Connect America Fund (CAF II). The intent is that these two examples better illuminate how resources are—and sometimes are not—being woven together in support of rural communities. The report also suggests ways that the tapestry of broadband resources available to rural communities may be improved.

For more than 75 years, Blandin Foundation has worked to strengthen rural Minnesota communities through its grantmaking, community leadership training and community engagement. In 2003, the Foundation formalized its belief that robust access to, and use of, high-speed Internet was key to community strength through the Blandin Broadband Initiative. Since then, Blandin Foundation staff and partners have stood with more than 70 communities as they design and claim their broadband-enabled futures.

Lead researcher Bill Coleman, president of Minnesota-based Community Technology Advisors (www.communitytechnologyadvisors.com), has assisted clients in developing and implementing programs of broadband infrastructure investment and technology promotion and training for nearly two decades. He helps communities make the connection between telecommunications and economic development.



Through the Connect America Fund (CAF II), the Federal Communications Commission (FCC) is providing more than \$85 million dollars to qualifying telecommunications providers in Minnesota to stimulate further broadband deployment to unserved rural customers. CAF II is intended to subsidize network deployments that can deliver service of at least 10 megabits per second **download**/1 megabit per second **upload** (10 Mbps/1 Mbps). Note, the current FCC definition of “broadband” is service at the speed of at least 25 Mbps/3 Mbps.

Minnesota’s near-term (by 2022) speed goal is in sync with the FCC’s current broadband definition of 25 Mbps/3 Mbps. Minnesota also has chosen to aim higher by establishing a speed goal of 100 Mbps/20 Mbps by 2026. Projects receiving “Border to Border” grants from state legislature through Minnesota Office of Broadband must be scalable to meet the 2026 state broadband goal.

Minnesota residents and policymakers are asking, what difference are these CAF II investments making in Minnesota? Because the FCC does not require CAF II recipients to submit network plans or maps, the answer is: it’s hard to tell. And based on the research conducted for this paper, the lack of transparency and accountability in the CAF II program has been challenging and frustrating for residents in CAF II-eligible areas who want a role in determining their broadband future. Similarly, policymakers are at a loss to understand how to leverage the federal government’s CAF II investments when the state’s aspirations are so much greater, as well as how to account for federal investments when determining an appropriate level of state investment in redressing Minnesota’s broadband gaps.

This study’s purpose is to help local and state leaders better understand the kind of networks being built using CAF II funds. The need for this work was confirmed through interaction with GPS 45:93, East Central Minnesota’s regional economic development coalition, as they considered broadband improvement strategies and were unsure of the real impact of CAF II investment. The region’s lack of broadband is documented on state broadband maps. These two exchanges were selected for study based on GPS 45:93 team members’ knowledge of recent CAF II improvements and provided an opportunity to compare the CAF II deployment strategies of the two dominant incumbent telephone companies within the region.

To this end, Right of Way (ROW) permit information was sought for all fiber and electronics installations within the two exchanges and researchers took to the streets and fields to visually identify and document fiber and electronics improvements in these exchanges. We mapped the newly installed network equipment in the exchanges and drew a representation of the network’s coverage based on the location of equipment. To help ensure accuracy, advice was sought on the study’s design, equipment identification and findings from industry experts. In addition, the two telecom providers that deployed these CAF II-funded networks, CenturyLink and Frontier, both were asked to review and offer corrections to the report prior to publication although neither chose to offer substantive comment.

Summary of Findings

- CAF II dollars are being used to deploy Fiber-to-the-Node technology to support distance-sensitive Digital Subscriber Line (DSL) services in and around the cities of Lindstrom and Braham.
- Even after CAF II investment, the vast majority of land within these two exchanges lies more than 3,000 feet from a fiber-fed DSL node, thus limiting the bandwidth available to those customers to something less than Minnesota's 2022 state broadband goal of 25 Mbps/3 Mbps.
- It is unlikely that any customers in these exchanges will be able to receive broadband services that meet the 2026 Minnesota broadband goal of 100 Mbps/20 Mbps without additional provider investment.
- Greater transparency from CAF II recipients would enable more effective collaboration with state elected officials, the Office of Broadband Development, and communities to maximize the value of both CAF II and ACAM (Alternative Connect America Fund) program dollars towards meeting Minnesota's broadband goals. ACAM is another FCC program that supports rural broadband deployment by mid-size telephone companies.
- So far, the networks in this study being built in Minnesota with CAF II funds don't meet state goals of better broadband speeds for everyone. The improvements are inadequate to support broadband-based economic and community development, while discouraging investments by competitive providers. Although some residents indeed welcome CAF II-funded upgrades that improve their service from 'bad' to 'somewhat better,' in the long run, the program's second-class status for rural will cut ever deeper as networks in more densely populated, more profitable-to-serve areas continue to advance. CAF II funding has not been enough to incent participating providers to invest in the kind of world-class networks rural areas need to survive and thrive in an increasingly interconnected world. Absent additional incentives, future upgrades seem unlikely in communities already served by CAF II investment.
- Minnesota can boast of examples where communities, the state's Border to Border Broadband grant program and CAF II recipients have worked together to finance and build networks that offer better service than CAF II-funded networks alone.
- Maximizing the public benefit from public investments is good for everyone.
- Better broadband through better transparency and collaboration is possible.

Introduction

America is plagued by a stubborn and growing rural-urban digital divide: Thirty-nine percent of rural areas lack access to broadband of 25 megabits per second download/3 Mbps upload, the federal definition of “broadband,” compared to only four percent for urban areas lacking Internet speeds at this basic level.ⁱⁱⁱ

This opportunity gap is a significant barrier for people who live, work and learn in rural communities.^{iv}

In contrast, communities served by Gigabit networks are experiencing clear economic benefits^v compared to places with poorer connectivity.^{vi}

Making the necessary investments to close these rural-urban gaps in their service areas can be a challenge for large, price cap local exchange telephone companies. Publicly traded companies weigh capital investment choices carefully; the return on investments in rural exchanges rarely are competitive with more densely populated areas, as high costs for network infrastructure often outweigh possible short-term economic returns from a small and dispersed customer base.

CenturyLink’s Executive Vice President and Chief Financial Officer Sunit Patel outlined this investment challenge at the Citi 2018 Global TMT West Conference:

“Instead of focusing capital on getting broadband speeds up to 10-20 Mbps, you would focus your money more surgically on areas that have higher population densities and better socioeconomic demographics that are in coexistence with businesses and where wireless infrastructure might be needed to get a better return on capital,” Patel said.

Patel made clear CenturyLink’s reliance on the CAF II funding for rural areas. At the same event, he said, “The other area of broadband expansion would be in rural markets where federal funding is available for you to be able to utilize and offer more speeds.”^{vii}

The Federal Communications Commissions’ Connect America Fund (CAF II) program is designed to close the financial gap so that these large carriers, regulated as price cap carriers, can improve broadband services in areas they otherwise would deem too expensive to serve.^{viii} The question is whether the program is, in fact, helping to close the rural-urban digital divide. Is CAF II funding adequate to encourage providers to deploy networks in less densely populated exchanges that deliver services comparable to the networks they build in more densely populated areas?

By documenting new CAF II-funded networks in the field, this paper attempts to clarify the impact of these investments on connectivity available to the served populations.

Study Methodology

This study's purpose is to help local and state leaders better understand the kind of networks being built using CAF II funds. The need for this work was confirmed through interaction with GPS 45:93, East Central Minnesota's regional economic development coalition, as they considered broadband improvement strategies and were unsure of the real impact of CAF II investment. The region's lack of broadband is documented on state broadband maps. The Lindstrom and Braham exchanges were selected for study based on GPS 45:93 team members' knowledge of recent CAF II improvements and provided an opportunity to compare the CAF II deployment strategies of the two dominant incumbent telephone companies within the region.

To help ensure the accuracy of our findings, advice on this study's design, equipment identification and findings was obtained from several industry experts, including telecommunications engineers, telecom providers, product managers, sales engineers and telecom equipment sales staff.

In addition, the telecom providers which accepted CAF II funding and used it to make improvements in these exchanges, CenturyLink and Frontier, both were asked to review and offer comment on the report prior to publication. Technical documentation of the mapped exchanges, notification of mapping errors in the report, as well as suggestions for alternative examples of CAF II deployments to be included in the study, were specifically invited. Neither company chose to offer substantive comments on the draft. However, CenturyLink did respond to suggest that dissatisfaction with the Connect America Fund program should be directed to the Federal Communications Commission and not those providers that have elected to participate in the CAF program. While saying it had a "number of concerns" about the report, CenturyLink declined to comment substantively, explaining the company did "not want to be associated with something that might be viewed by some as critical of the CAF program." CenturyLink noted, "Providers are merely following the rules and adhering to the commitments made when they agreed to participate in the program."^{ix}

Community Technology Advisors conducted the primary field research in the summer of 2017. Using base maps and a GPS-enabled camera to take pictures of various electronics boxes located in public rights-of-way (ROW), improvements within the two exchanges were mapped. Fiber networks, though clearly marked in the ROW with the standard white and orange poles, were not mapped to simplify the mapping process. While a fiber line may be adjacent to a property, access to that fiber would be dependent on the nearest handhole, a junction box where new fiber links to customers can be connected.

Electronics boxes clearly identified as electric utility, railroads or traffic/lighting control devices were not mapped. Where boxes could not be definitively identified, they were assumed to be Digital Subscriber Line Access Multiplexer or DSLAMs, possibly overstating the deployment of electronics and the resulting service areas. DSLAMs are the field electronics that connect between newly deployed fiber lines and the existing copper lines that connect to customers.

Prospective service areas surrounding the DSLAMs were indicated with 3,000-foot radius and 9,000-foot radius circles. As explained earlier, it is likely that customers within 3,000 feet of a DSLAM would be able to receive broadband services at or above 25 Mbps/3 Mbps level; those within 9,000 feet of the DSLAM would be able to receive at least 10 Mbps/1 Mbps.

If this mapping strategy errs, it likely overstates the availability of broadband for three reasons:

1. Copper lines do not radiate directly from the DSLAM but follow the roads and may, in fact, make multiple turns before reaching the home. Each turn adds distance that in turns limits deliverable capacity. Measurements were made “as the crow flies” as opposed to actual routes likely taken, thereby maximizing the assumption of the radii 3,000/9,000 feet from the node.
2. Broadband speeds vary greatly depending on the condition of the copper lines from the DSLAM to the home. The age of these copper networks is unknown, but according to industry experts, it would not be unusual for copper lines in rural areas to be at or even beyond the end of their expected useful life.
3. It is possible that one or more DSLAMs were missed in this field inventory. However, because the study’s purpose is to improve understanding of the level of broadband service generally available to customers served by CAF II-funded deployments, rather than to provide a definitive service inventory for a particular location, we are confident in its conclusions.

On the other hand, it is possible that higher speeds over longer distances can be achieved than assumed in this report. Factors that would enable these speeds include:

1. High quality, non-degraded copper lines.
2. Availability of spare copper pairs that would allow two or more pairs of copper lines to be bonded together.
3. Ongoing technical improvements in electronics and software could allow for future improvements in DSL capabilities.

Despite these uncertainties, we believe that this methodology provides a reasonably accurate picture of the impact of these deployments funded by CAF II subsidies. This confidence is backed up by ongoing conversations with rural broadband customers across the state in community and regional meetings, with many interactions documented through emails and video testimonials.

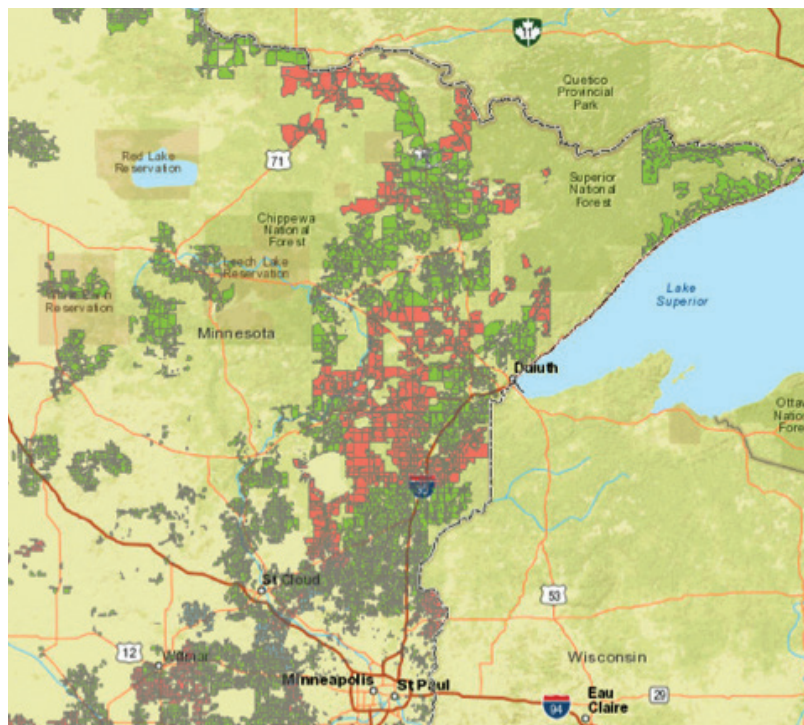
CAF II Background

The FCC's Connect America Fund (CAF II) is designed^x to spur broadband deployment in unserved, high-cost rural areas with phone and sometimes Internet services provided by large telephone companies regulated as price cap carriers. These carriers have accepted payments from the FCC to deploy broadband services to a targeted number of households in their service areas.

Over the five-year program, four companies serving rural Minnesota will receive federal funds for broadband deployment. Construction using CAF II dollars began in 2016 and must be complete by the end of 2020. Companies were required to have completed at least 40 percent of the funded network built by the end of 2017.

Company	# of Households	Funds Awarded Annually
CenturyLink	114,739	\$54,035,149
Consolidated Communications	4,266	\$2,516,502
Frontier Communications	46,910	\$27,551,367
Windstream Communications	4,440	\$1,519,856
Total	170,355	\$85,622,874

https://mn.gov/deed/assets/broadband-dev-report_tcm1045-132774.pdf



Not all unserved areas will benefit from this program: Areas where at least 3 Mbps upload speed is currently available or where deployment costs exceed FCC limits are excluded.^{xi} This map illustrates eligible areas in Minnesota, with the two large CAF II recipients noted. CenturyLink areas are shown in green and Frontier in red.

CAF II eligible areas: CenturyLink areas shown in green and Frontier in red^{xi}

Companies accepting CAF II funds must meet the following FCC requirements for voice and broadband services:

- Speed: Service providers must offer broadband at speeds of at least 10 Mbps downstream and 1 Mbps upstream, standards that do not meet the FCC's own current definition of broadband which is 25 Mbps/3 Mbps.
- Latency (the time it takes for a data packet to travel back and forth over a broadband network): Service providers' network latency cannot be higher than 100 milliseconds round trip.
- Usage Allowance: Currently, the carrier must offer at least one plan with a minimum usage allowance of at least 150 gigabytes (GB) per month, or in certain circumstances, a plan with 100 GB of usage.
- Pricing: Service providers must offer service at rates reasonably comparable to rates in urban areas.
- Unlike Minnesota's state broadband grant program recipients, CAF II recipients are not required, nor do they, report network enhancement plans or deployments. This makes it difficult for impacted communities to assess or predict the broadband access that will result.
- The FCC faces a significant challenge in spurring investment in rural broadband networks. While new Fiber to the Premise (FTTP) networks provide the best tech infrastructure platform for robust rural connectivity, rural fiber deployments can range from \$4,000 to more than \$10,000 per passing (depending on population density and terrain). According to page 8, in Minnesota, CenturyLink is receiving \$2,354 per household, whereas Frontier received almost \$2,936 per household.



Understanding the Networks

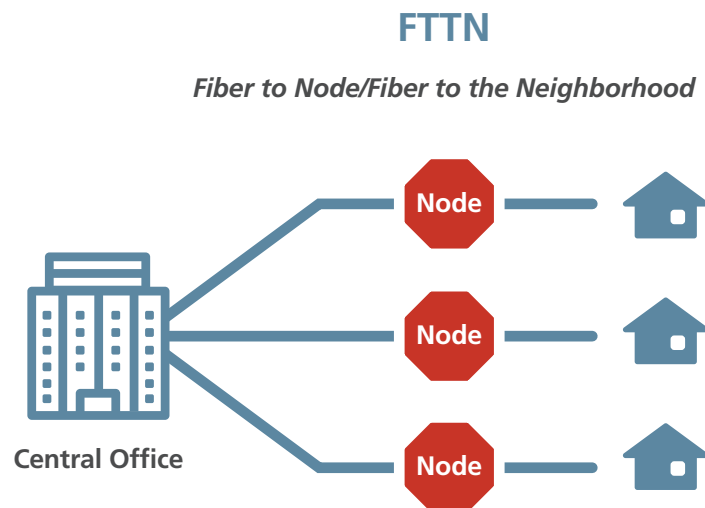
This paper examines CAF II-funded broadband network deployments in two rural Minnesota telephone exchanges, one owned by Frontier and one by CenturyLink. Given that these two companies are the state's largest participants and due to the basic technical requirements of the program (DSL loop lengths of approximately 9,000 feet so as to enable 10 Mbps/1 Mbps service), they are representative of the CAF II investments being made in the state.

The study looked at Frontier's exchange in Lindstrom and CenturyLink's exchange in Braham. The Lindstrom exchange is located entirely within Chisago County. The Braham exchange sprawls across Chisago, Isanti, Kanabec and Pine Counties.

While every rural community is unique, these exchanges contain characteristics seen throughout the state. Both are quite rural with a land use pattern of small cities, farms, exurban and rural homes, wetlands and lakes. Of the two, the Braham exchange is the more rural and less densely populated.

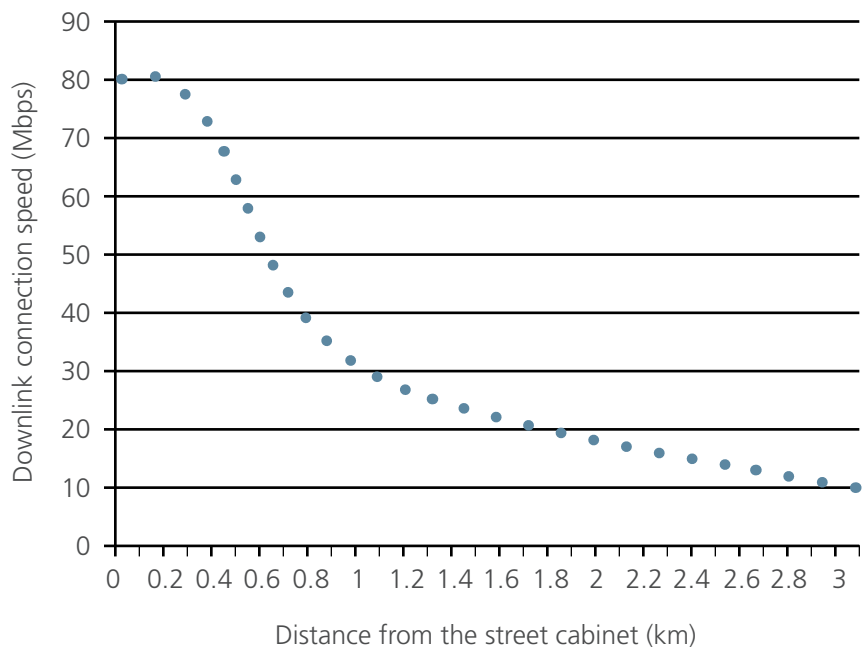
To create a picture of the level of broadband service prospectively available to rural residents and businesses as a result of these CAF II-funded infrastructure investments, CAF II-funded fiber-connected electronics within these service areas were located and mapped.

What was found were "nodes" or DSL Access Modules (DSLAMs). Fiber connects the nodes to the providers' (Century Link and Frontier) central offices; existing copper telephone lines serve as the last mile (or more) to the customer premise. Unlike fiber, the quality of Internet service over copper degrades with distance. That means homes closer to the node will have better quality (faster) service. (Learn more about quality of service in the Appendix.)



<https://www.precisionot.com/5-fiber-deployments-their-role-fttn/>

As illustrated below, homes (or businesses) within 3,000 feet of the node will generally experience sustained speeds of 25 Mbps/3 Mbps or more. Properties within 9,000 feet will generally experience speeds of at least 10 Mbps/1 Mbps. Beyond 9,000 feet, properties generally will experience speeds slower than 10 Mbps/1 Mbps.



xii

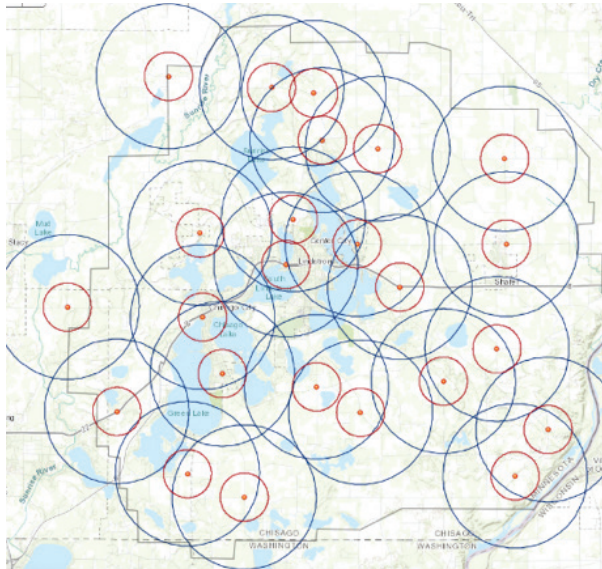
- Directly adjacent to the node, 80 Mbps broadband is possible.
- At half a kilometer (1600 feet), 50-60 Mbps is possible.
- At one kilometer (3,280 feet), up to 30 Mbps can be delivered downstream.
- At three kilometers (10,000 feet), approximately 10 Mbps can be delivered downstream.

Despite several requests, network permits were not available from either public agencies or providers. Instead, the field research went straight to the source—physical, observable installations.

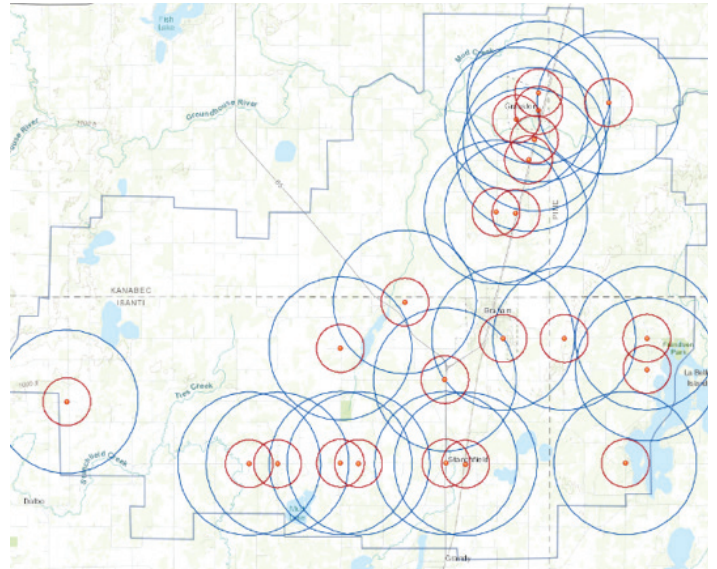
The equipment installed in each exchange as part of the CAF II-funded build was located and mapped, and circles were drawn at 3,000-foot and 9,000-foot radius to show the tiered service available by distance.

Each dot represents an identified node. Each red circle has a 3,000-foot radius; blue circles have a 9,000-foot radius.

Frontier's Lindstrom Exchange



CenturyLink's Braham Exchange



As illustrated above, the areas within the red circles should have access to broadband of speeds of 25 Mbps/3 Mbps or more. The areas within the blue circles but outside the red (donut shape) will have access to between 25 Mbps/3 Mbps and 10 Mbps/1 Mbps. Areas outside of a circle will have slower speeds based on their distance from the node.

These maps suggest two challenges for communities in CAF II areas:

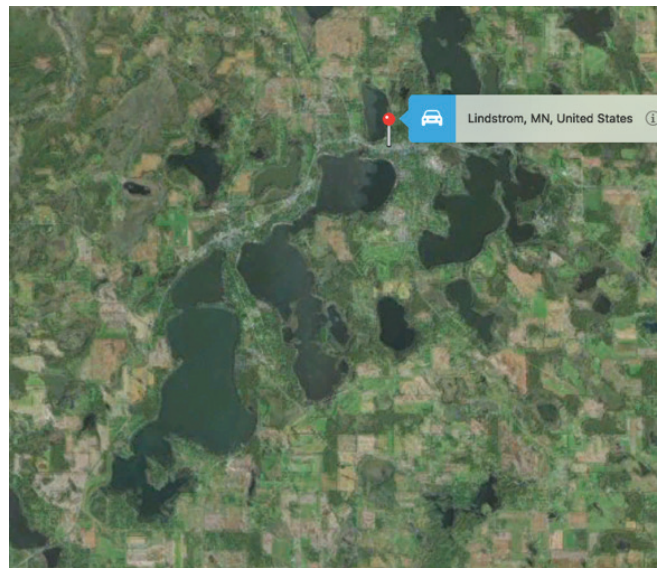
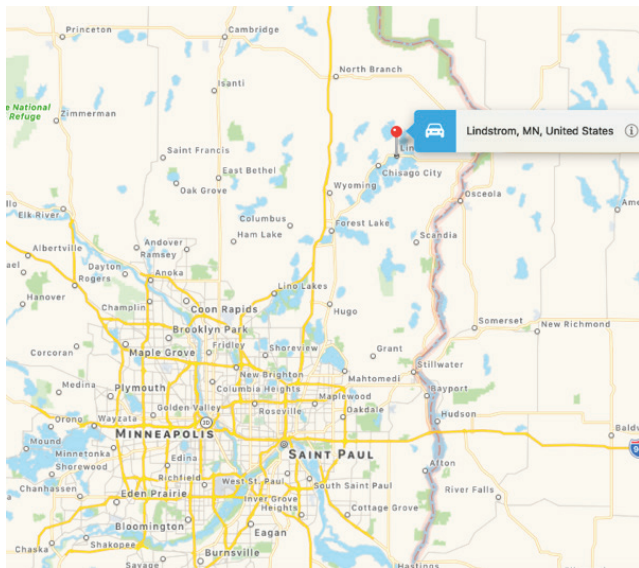
First, the newly built CAF II-funded networks do not provide service to all households served by the exchange that meets Minnesota's state speed goals:

- (1) no later than 2022, all Minnesota businesses and homes have access to high-speed broadband that provides minimum download speeds of at least 25 megabits per second and minimum upload speeds of at least three megabits per second; and
- (2) no later than 2026, all Minnesota businesses and homes have access to at least one provider of broadband with download speeds of at least 100 megabits per second and upload speeds of at least 20 megabits per second.^{xiii}

Second, the lack of transparency from CAF II recipients about their network deployment plans makes it difficult for communities to do their own planning and leverage public investment.

Let's take a closer look at the communities.

Frontier's Lindstrom Exchange



The Lindstrom exchange includes most of the area known as Chisago Lakes, a scenic area straddling US Highway 8, including the towns of Chisago City, Lindstrom, Center City and Shafer.

The community has a small-town or exurban feel with an excellent school system and easy access to Twin Cities metropolitan area work opportunities. The numerous lakes, wetlands, woods and small farms make living outside the boundaries of incorporated cities attractive. The rural residents are widely and generally evenly dispersed across the exchange with higher densities around the many recreational lakes. This satellite view highlights the geography of the region.

In a 2015 survey conducted by Chisago County^{xiv} of more than 800 county households regarding their Internet services, respondents said:

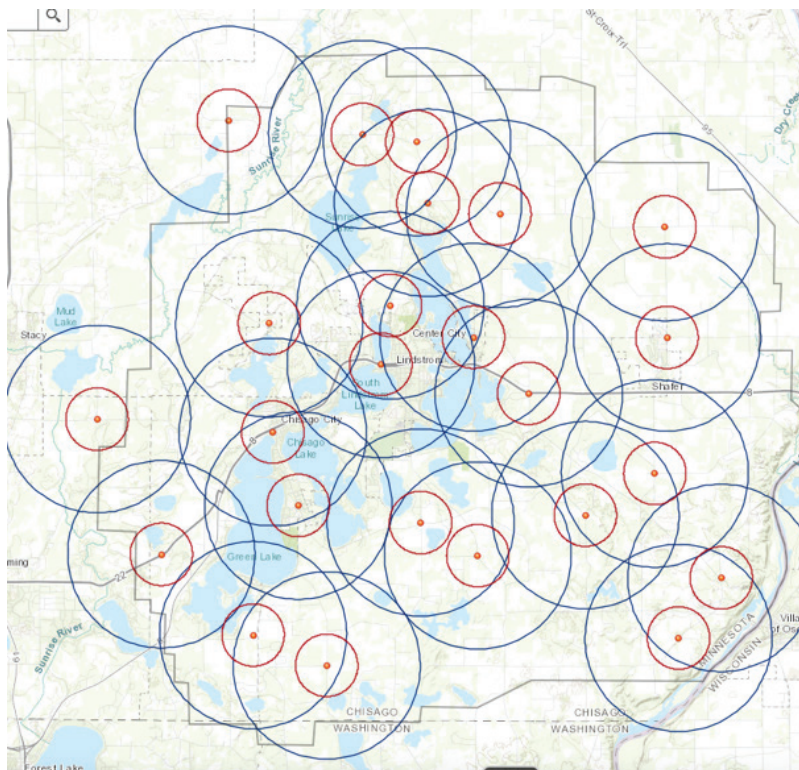
- 27% already use the Internet to operate their businesses
- 31% said that they would start a home business with better Internet
- 35% said that they would telecommute with better Internet service
- 45% would use the Internet for educational purposes
- 86% would make use of the Internet for all kinds of purposes if it was available.

Based on current population density, demographics and geography, the Lindstrom exchange has the components of an attractive Minnesota rural exchange for business development opportunities and a profitable operation for Frontier.^{xv}

Frontier's Infrastructure Investment Strategy

The map below illustrates the results of field examination of Frontier's CAF II network deployment for the Lindstrom exchange (outlined on the map in grey). As described earlier, each dot represents an identified DSL Access Module (DSLAM). Each red circle has a 3,000-foot radius; blue circles have a 9,000-foot radius.

Distance from node
Less than 3,000 ft
Less than 9,000 ft
Broadband speeds
25 Mb /3 Mb
10 Mb /1 Mb
Color on map
Red circle
Blue circle

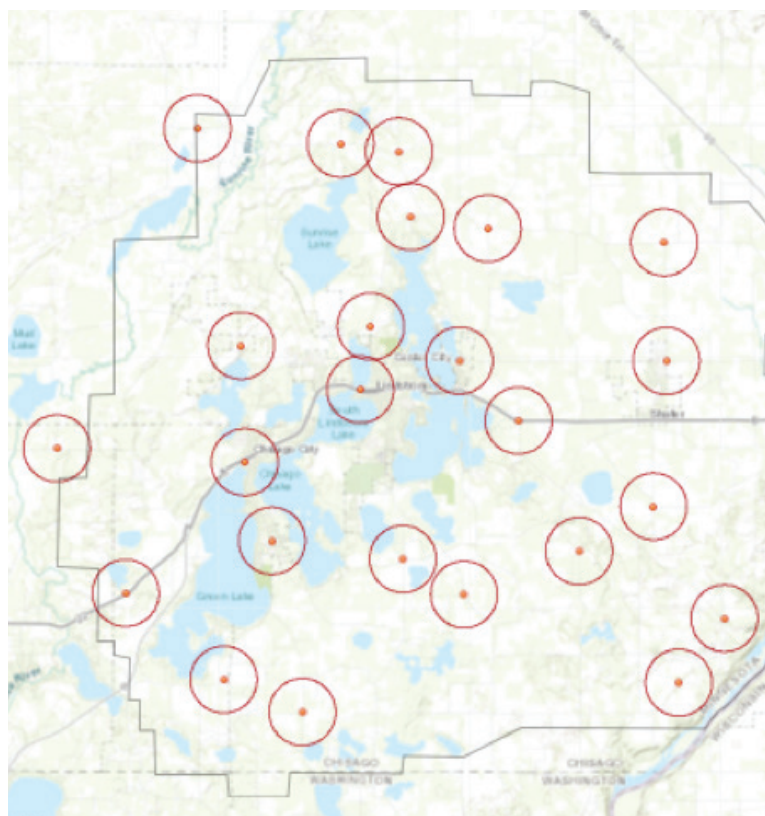


Each Frontier DSLAM connected by fiber optic cabling was verified based on the easily identifiable fiber optic cable pole markers consistently present. Frontier fiber was generally installed along each paved county road in the exchange. There are few unpaved roads in this exchange. For the most part, Frontier utilized a standardized equipment installation throughout the exchange as the picture here shows, with the DSLAM on the right, the cross-connect in the center and the power meter on the left.

To illustrate the impact of CAF II investments towards meeting the 2022 state broadband goal of 25 Mbps/3 Mbps, the map below includes only the 3,000-foot radius circles.

As noted earlier, customers within 3,000 feet of the fiber node can receive services at the 25 Mbps/3 Mbps level and possibly much faster if the provider deploys either vectoring or pair bonding technology. (Learn more about G.fast, vectoring and pair bonding in the Appendix.)

There is another prospective opportunity for vastly improved services - direct fiber connections – for those customers seeking higher levels of broadband services. This option - in this exchange or in future deployments by any provider - would be dependent on the proximity of the customer to the fiber routes and the provider's network design. If handholes (which provide easy access to fiber underground in the same way a manhole provides access to tunnels under a road) were installed along the route between the nodes, especially at driveways leading to farms, rural businesses or higher-end homes, the provider would be able to offer solutions to customers with high demands for bandwidth and willingness to pay for installation and improved services. It should be noted that with fiber construction costs of \$20,000 per mile^{xvi}, proximity to a handhole is critical. At this time, it is unknown if handholes were part of the network design. Industry experts consulted for this study also note that such subsequent enhancements would add operational complexity to the network ranging from electronics to technician training.



These maps suggest the following:

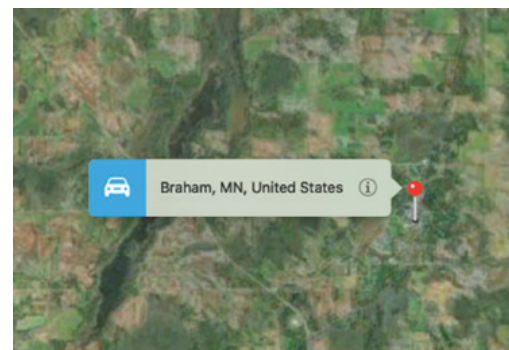
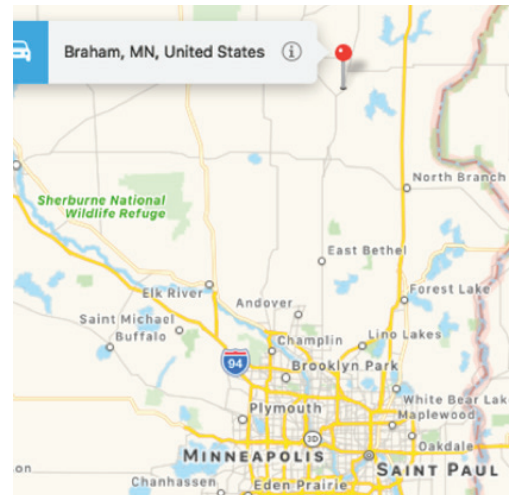
- Approximately 10 – 15 percent of the land area is within a 3,000-foot circle and thus capable of receiving 25 Mbps/3 Mbps or better.
- There are relatively few areas in this exchange that are outside of the 9,000-foot radius circles where available service is likely to be less than 10 Mbps/1 Mbps.
- Most of the land within the exchange is within a 9,000-foot circle, but outside of a 3,000-foot circle, indicating that for most customers, broadband service availability would be between 10 Mbps/1 Mbps and 25 Mbps/3 Mbps.

CenturyLink's Braham Exchange

Braham is located in east central Minnesota directly north of Minneapolis-St. Paul. The exchange straddles four counties – Chisago, Isanti, Kanabec and Pine. It is farther north than the Lindstrom exchange, considerably more rural (less densely populated) and observably less prosperous.

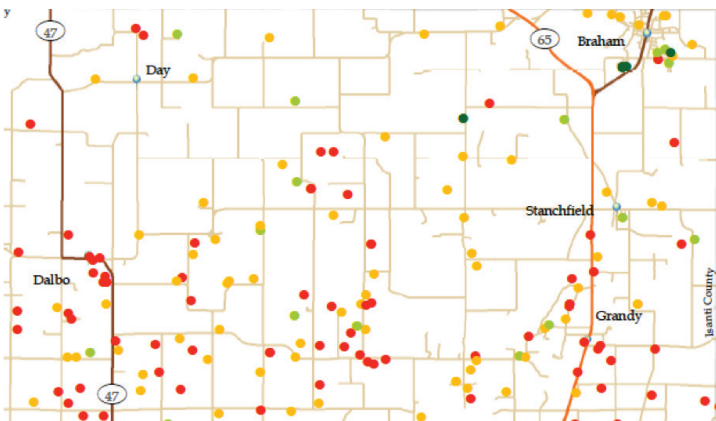
While data is not available by exchange, city data indicates that both income and house values are lower here than in the Lindstrom area. Population growth is slower here. Braham is classified as 100 percent rural whereas Lindstrom is only 6 percent rural; there is little, if any, pressure here for suburban-like development. The distance to the Twin Cities is greater so residents are more likely to be employed locally in the small regional center communities of Cambridge, Pine City, North Branch and Mora^{xvii}.

This satellite picture (right) shows small towns (Braham is the largest community and has just under 2,000 people), wetlands, small lakes and relatively small farms. There are also significant numbers of people living in the rural countryside distributed along county and township roads.



While business development opportunities for CenturyLink in the Braham exchange may seem limited, the City of Braham recently partnered with a smaller wireless ISP to bring fiber-based Internet services to their new business park on the north side of Braham in response to the location requirements of a prospective business park tenant.

Results from an Isanti countywide broadband survey conducted by Design Nine, a national broadband consulting firm in fall/winter of 2017, also suggest a need for network improvements. The map below of survey results illustrates customer broadband satisfaction in the Isanti County portion of the Braham exchange. Red and gold colors indicate dissatisfaction or lower satisfaction.



- Not at all satisfied
- Somewhat satisfied
- Satisfied
- Very satisfied

CenturyLink's Infrastructure Investment Strategy

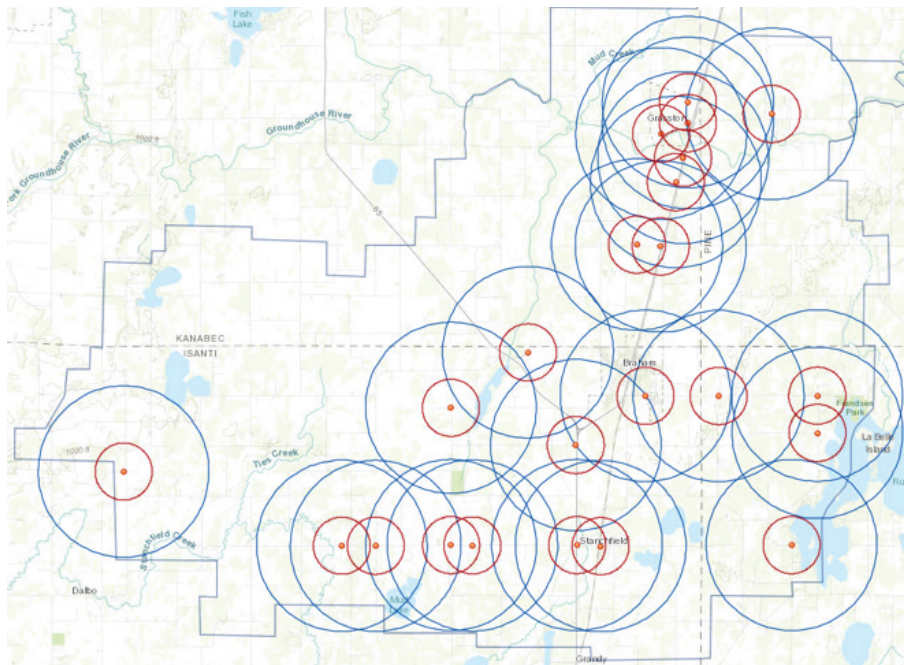
CenturyLink has focused its CAF II infrastructure investments in the more densely populated portions of the Brahm exchange. Most of the identified deployment is in the eastern and southern portions of the exchange.

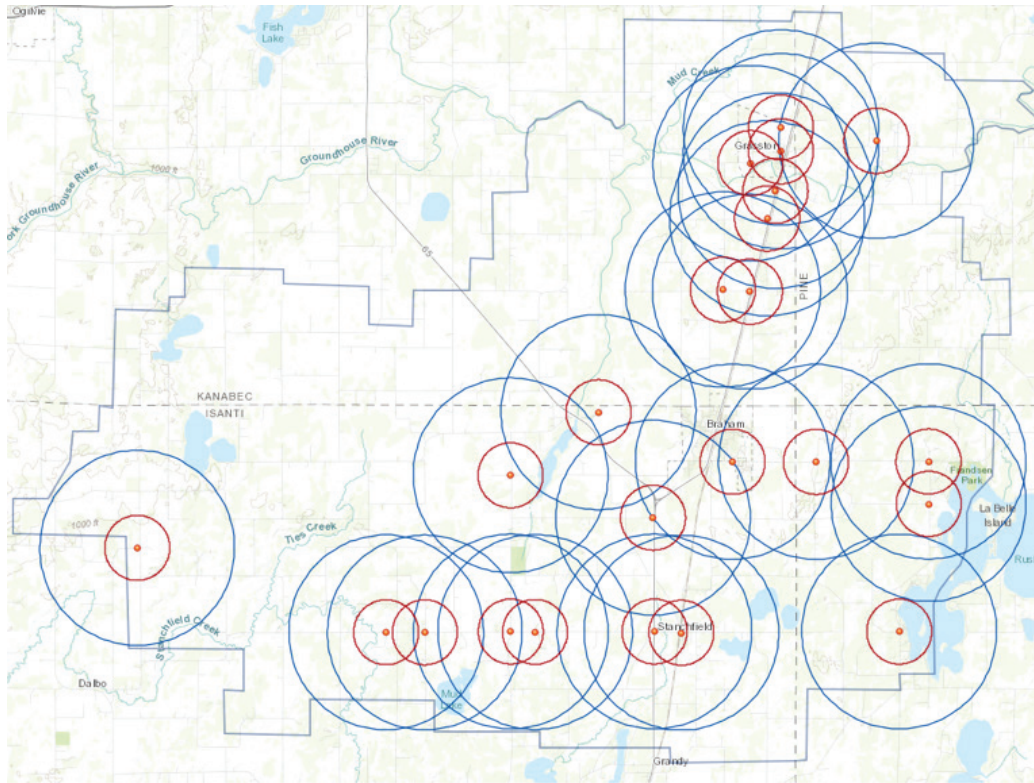
While new fiber routes were clearly marked with the traditional white and orange posts, large areas of the exchange seem to depend on buried copper lines. Based on the "buried cable" warning signs and the older pedestals, industry experts consulted for this study advised that fiber connectivity was highly unlikely.

A variety of equipment has been installed, seemingly dependent on population density. In the denser areas, DSLAMs were larger with varying numbers of ports. In the less dense areas, 24 port DSLAMs were common.



In the field, we saw equipment that was new and some DSLAMs that appeared to be older and to have been installed in earlier years. In some areas west of Highway 65, DSLAMs appeared to be connected to copper lines rather than fiber. Given their apparent age, it is likely that these older DSLAMs might be fed by bonded T-1 lines with far less bandwidth capacity than new fiber-fed DSLAMs. It is also possible that some of these older DSLAMs were taken out of service, but not removed, when the new equipment was installed. This is most likely to have occurred in the areas on the map below where the DSLAMs are quite close together. Compared to Frontier's Lindstrom exchange, CenturyLink has numerous interlocking red circles on the map below, with DSLAMs located less than one mile apart. Unfortunately, it was not possible to determine which, if any, DSLAMs are now inactive. Because neither provider responded to requests for comments and corrections on this report, our conclusions are based on observations of field deployments.

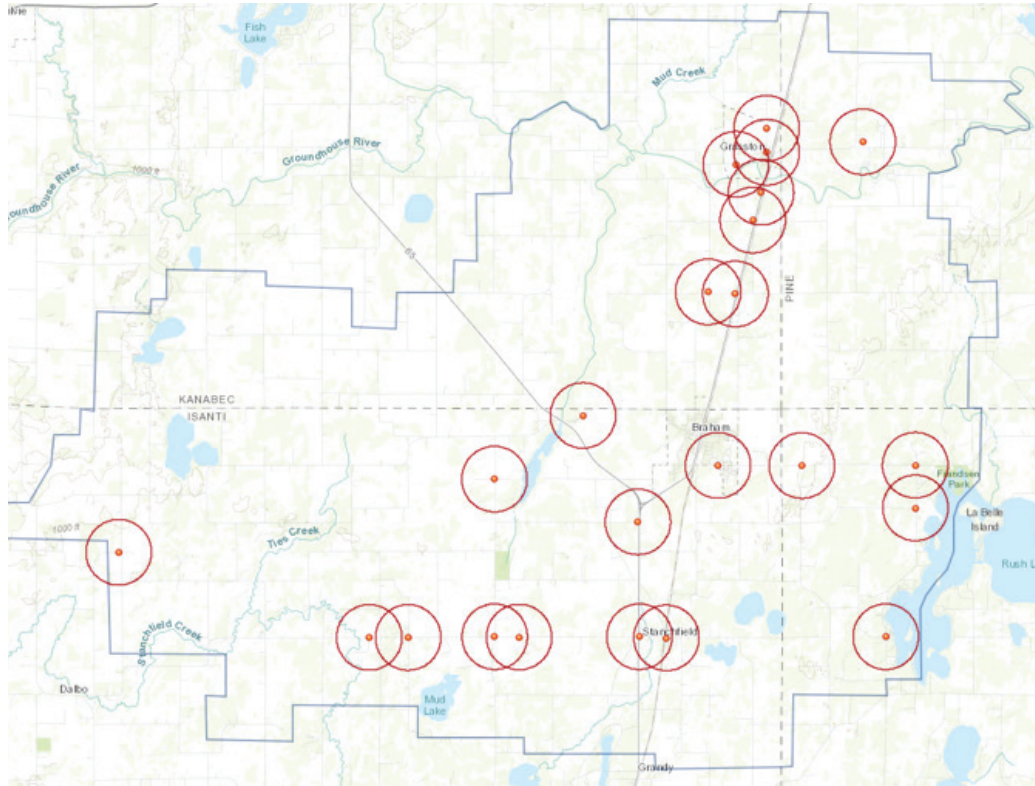




Reviewing the maps above, the following characteristics emerge in the Braham exchange:

- Significant portions of the Braham exchange are outside of the blue circles indicating that less than 10 Mbps/1 Mbps Internet service would be available to residents and businesses in these locations.
- In the areas where CAF II investments were made, there is relatively consistent coverage within the 9,000-foot radius circles. This suggests that where there is a concentration of improvements, customers should have access to sustained 10 Mbps/1 Mbps speeds based on overlap of the 9,000-foot radius circles.

The map below shows the relatively limited areas to receive broadband coverage of at least 25 Mbps/3 Mbps as a result of CenturyLink's CAF II-funded upgrades to date. Again, note that actual speeds within these red circles could range up to 80 Mbps depending on proximity to electronics, vectoring and pair bonding. Vectoring is generally not effective at distances greater than 3,000 feet.



Without feedback from CenturyLink, it is unknown whether or not the carrier has completed its CAF II-funded deployments in this area. It is possible that CenturyLink will install additional fiber and electronics in the future. From the consumer and community perspective, however, the upgrades deployed to date leave many areas unserved. People living in areas left behind see their neighbors getting service but don't know whether, or if, they too eventually will be served.

Challenges for CAF II Communities: Network Capacity and Process Transparency

This study raises two challenges for CAF II-eligible rural communities and policymakers: first is whether CAF II-funded networks are adequate to meet the community's present and future needs; second, the need for greater transparency in how and where and when the networks are built.

Are 10/1 speeds adequate?

CAF II program critics have roundly derided the FCC's 10 Mbps/1 Mbps requirement as inadequate at a time when the FCC's own minimum broadband standard is 25 Mbps/3 Mbps and when providers in competitive markets are regularly delivering Gigabit (1,024 Mb) symmetrical service.

Doug Dawson, a nationally recognized telecommunications consultant and president of CCG Consulting, elaborates:^{xviii}

These upgrades will improve broadband in the affected areas, but only by a small amount. Some residents in these areas today can get very slow DSL, under 1 Mbps. There are also numerous WISPs (wireless internet service providers) operating in the area offering speeds under 5 Mbps. And everybody always has the option of satellite broadband, which is universally disliked due to the latency and data caps.

The really bad news for these areas is that this upgrade is going to be in place for a long time. The FCC is probably not going to think about the CAF II areas again until well past the end of the CAF timeline, perhaps not until 2025. By 2025 the average household in the country is going to probably want a 100 Mbps connection if the current broadband growth trends continue.

In response, the FCC has pointed to the fact that the federal broadband standard was 4 Mbps/1 Mbps at the time when the CAF II program was being designed^{xix}. Defenders^{xx} of the program also point out that the limited federal funds available should be used to provide some level of broadband to the largest number of households.^{xxi}

To address concerns about the capability of the technologies used in these CAF II-funded upgrades, Internet service providers often point to new and emerging technologies that can greatly enhance capacity of DSL over copper, such as G.fast, vectoring and pair bonding. In the case of G.fast, however, a review of the online literature indicates that its successful deployment requires so much fiber that it is most suitable for use in urban settings with multiple dwelling units where fiber optic cabling is just outside the building. Even if G.fast and vectoring did work well in the rural settings where CAF II networks are being built, upgrading the networks to incorporate these more advanced technologies would require additional investment on the part of the provider.

Another defense of the 10 Mbps/1 Mbps expansion is that it is good enough, or at least better than nothing. While true that the CAF II-funded upgrades do result in some rural residents getting access to broadband services of at least 25/3, many more residents served by these upgrades will end up with access to speeds much slower than that. In fact, the FCC's minimal requirements for these networks do not meet the FCC's own definition of broadband. The 10 Mbps/1 Mbps access requirements also does not satisfy Minnesota broadband goals. Accepting lower speeds for some parts of Minnesota creates second class status for rural.

Lack of Transparency Disadvantages Communities

Another issue with the CAF II program is its lack of transparency: CAF II does not require participating providers to share or report on any specifics in their network plans beyond the total number of households to be served. The program does include some interim milestones, beginning with 40% of the recipients' statewide build commitment be completed by the end of 2017.^{xxii} (CenturyLink reports it is on track to have completed 60% of its CAF commitments by the end of 2018.)^{xxiii}

Policymakers have asked the FCC to improve transparency of CAF II plans and projects, so far to no effect.^{xxiv}

This puts community leaders of unserved areas in a quandary. CAF II upgrades do not meet the state speed goals, but they are better than what their residents currently can get. But how much better?

In public meetings and statements, CAF II recipients underscore their commitment to offer broadband speeds that meet or exceed the CAF II 10/1 requirements, often emphasizing the faster speeds available only closest to the node.

Nationally, CenturyLink claims that about 70% of the homes in their target areas served to date with CAF II enabled networks have speeds of 20 Mbps or higher.^{xxv}

Here in Minnesota, community leaders and policymakers are evaluating these statements in the absence of an on the ground picture of what's actually being built.

This lack of clarity about how participating carriers are spending their CAF II funds inhibits planning and informed stewardship of public resources.

Conclusion

With the firm link established between quality broadband availability and community economic vitality^{xxvi}, community leaders want to ensure that their residents, businesses and institutions are not left behind, whether located downtown in the county seat or miles from town on a farm or on a lake. It is a shrinking demographic that does not want access to broadband at adequate levels. Next generation people and technologies will demand an even higher standard of broadband quality.^{xxvii}

This case study documents the real-world footprint of CAF II-funded networks in two rural Minnesota exchanges. CAF II funding increases Internet speed to some customers, but for many the increase is not enough to meet the state's broadband goals for either 2022 or 2026. In sum, CAF II investments in Minnesota are being spent to build networks that don't meet today's federal definition of broadband and won't meet state goals for the future. Moreover, lack of transparency in proposed CAF II network plans and timelines is making it difficult for impacted communities to plan accordingly to ensure their broadband needs are being adequately met.

Despite these challenges, Minnesota can boast examples of communities and CAF II recipients working together to finance networks that offer better service than CAF II-funded networks alone.

Projects in Martin County and in Chisago County's Sunrise^{xxviii} and Fish Lake Townships^{xxix} have combined state and CAF II funding to build networks that meet state goals. To qualify for state grants, providers were required to commit to high-speed networks (25 Mbps/3 Mbps with scalability to 100 Mbps), far higher levels of service than the CAF II-funded projects in the Lindstrom and Braham exchanges:

- Frontier has committed to delivering ubiquitous 25 Mbps/3 Mbps service with more densely deployed fiber and DSLAMs in Nobles County.
- CenturyLink, using bond funds from the township residents in addition to CAF II and DEED funds, is deploying a fiber to the home network capable of Gigabit speeds in Fish Lake and Sunrise Townships in Chisago County.

These projects demonstrate the potential of Minnesota's nationally renowned Border to Border Broadband grant program as an effective tool for leveraging state funds to impose state requirements – geared toward state goals – to ensure maximum public benefit from public investments.

In addition, greater transparency on the part of CAF II recipients would benefit communities and providers alike. While recognizing that plans sometimes change, maps showing planned CAF II deployments over the next three years (through the end of the program) would help communities partner with their providers for better networks, as in the examples above. The same holds true of the FCC's Alternative Connect America Cost Model (A-CAM)^{xxx} subsidies to medium size rate-of-return carriers.

With greater transparency from CAF II recipients, state elected officials and the Office of Broadband Development could build effective strategies for maximizing the value of the CAF II and A-CAM dollars for the benefit of Minnesotans, including designing programs that require a fair mix of public resources – federal, state and local – to spur even more and better rural deployment in a predictable way.

Maximizing the public benefit from public investments is good for everyone.

Better broadband through transparency and collaboration is possible.



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Appendix: Quality of Service

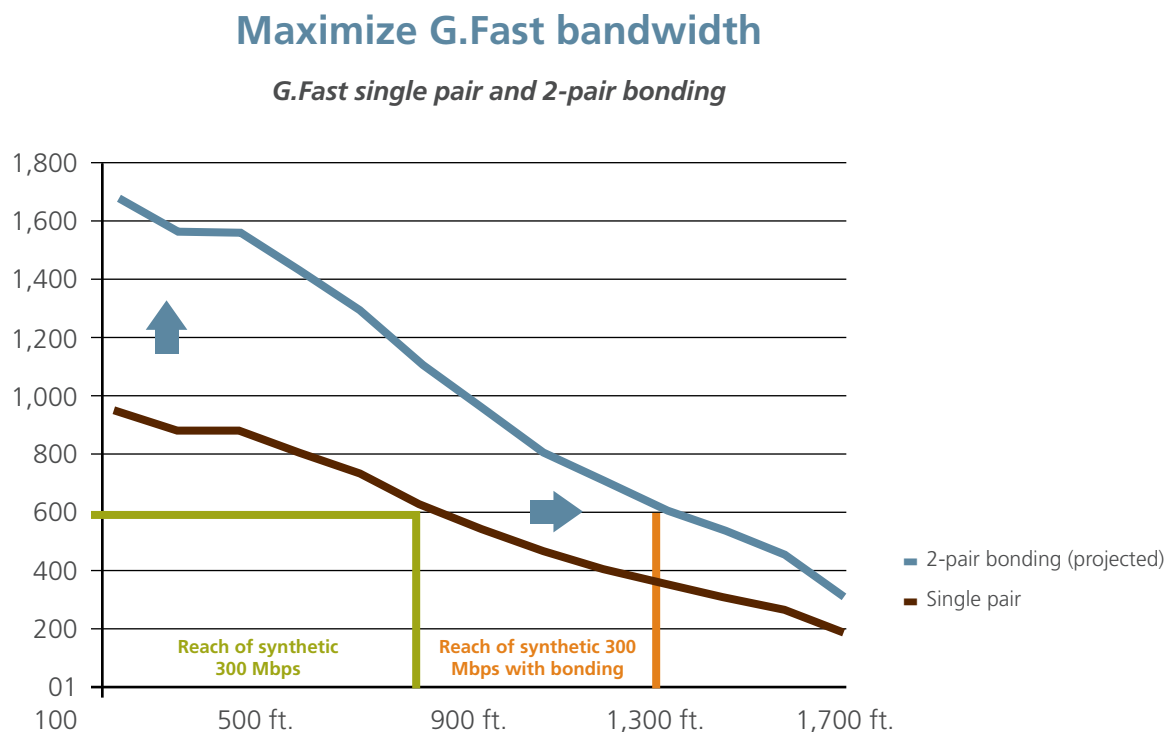
The following factors typically are used to determine Internet quality:

- Download speed – Increasing numbers of devices and higher quality video technologies require fast download speeds
- Upload speed – fast upload speeds are essential for making effective use of cloud-based technologies and for economic development; they allow users to be creators of content, not just consumers.
- Reliability – some technologies are noticeably affected by weather, topography and trees while legacy twisted-pair copper loops still in the ground today typically are near or at their expected life span and will limit future service upgrades no matter what electronics are installed.
- Data caps – low data caps limit effective and regular use; a well-connected average household uses approximately 250 GB of data per month
- Expense – Some services are more expensive and can be unaffordable as a primary connection for many families. Price per GB varies widely by technology with high-capacity wired networks offering extremely low costs for both bandwidth and use, especially compared to satellite and cellular services.
- Latency – Effective use of interactive applications, such as Skype, require low latency (delay) making satellite a poor option for many users.



Appendix: G.fast, Vectoring and Pair Bonding

The chart below illustrates the possible speeds that can be delivered over fiber-fed copper using G.fast.



G.fast performance single and bonded.

Source: www.isemag.com/2017/03/copper-will-not-be-outclassed/

Vectoring is another technology that can improve DSL speeds over copper, particularly for those closer than 3,000 feet from the DSL cabinet. This online FAQ is an excellent tutorial on different capabilities and issues with DSL technology: www.versatek.com/blog/most-frequently-asked-vdsl2-questions/.

It is also possible to improve DSL speeds using pair bonding, a proven technology. By using two sets of copper wires, broadband capacity can be doubled. Pair bonding is reliant on the availability of copper pairs in a given location. That may or may not be available in every electronics cabinet; bonding is only possible where pairs are available. Copper line quality is an important determinant of broadband capacity as well. Older weathered copper will not be as fast as newer, well maintained copper.

ENDNOTES

i Connected Nation. (2017, October). Rural Availability Estimate of Broadband Service in the State of Minnesota. Retrieved March 5, 2018, from https://mn.gov/deed/assets/bb-speed-tiers-county-fixed-nonmobile_tcm1045-190760.pdf

ii *ibid*

iii FCC. (2016, January 29). 2016 Broadband Progress Report. Retrieved March 5, 2018, from <https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report>

iv West, D. M., & Karsten, J. (2016, July 18). Rural and urban America divided by broadband access. Retrieved March 5, 2018, from <https://www.brookings.edu/blog/techtank/2016/07/18/rural-and-urban-america-divided-by-broadband-access>

v Treacy, A., & Coleman, B. (2017, October). Measuring Impact of Broadband in 5 Rural MN Communities. Retrieved March 5, 2018, from <http://mnbroadbandcasestudies.com>

vi Mississippi State University Extension Service. (2017, April 4). Digital Divide Index (DDI). Retrieved March 5, 2018, from <http://ici.msucare.com/resources/ddi>

vii Buckley, S. (2018, January 10). CenturyLink's Patel: Broadband expansion will focus on higher speeds, dense areas. Retrieved March 5, 2018, from <https://www.fiercetelecom.com/telecom/centurylink-s-patel-broadband-expansion-will-focus-higher-speeds-dense-areas>

viii FCC. (2017, November 30). Connect America Fund Phase II FAQs. Retrieved March 8, 2018 from <https://www.fcc.gov/consumers/guides/connect-america-fund-phase-ii-faqs>

ix Email correspondence between Bill Coleman, Community Technology Advisors, and Andrew Schriener, Director of Government Affairs, CenturyLink, dated January 9-10, 2018.

x "The FCC has adopted comprehensive reforms of its Universal Service Fund (USF) and Intercarrier Compensation (ICC) systems to accelerate broadband build-out to the approximately 23 million Americans (as of December 31, 2013) who lack access to infrastructure capable of providing 10/1 Mbps fixed broadband" FCC. (2017, February 2). Connect America Fund <https://www.fcc.gov/general/connect-america-fund-caf>

xi Increase Your Broadband Speed. (n.d.). Increase Your Broadband Speed. Retrieved March 5, 2018, from <https://www.increasebroadbandspeed.co.uk/2013/chart-bt-fttc-vdsl2-speed-against-distance>

xii FCC. (2014, September). Connect America Phase II - Initial Eligible Areas Map. Retrieved March 5, 2018, from <https://www.fcc.gov/reports-research/maps/connect-america-phase-ii-initial-eligible-areas-map>

xiii MN Office of Broadband Development. (n.d.). Minnesota Broadband Goals. Retrieved March 5, 2018, from <https://mn.gov/deed/programs-services/broadband/goals>

xiv Treacy, A. (2016, May 27). Chisago County Broadband Summit: Surveys results and stories of a community that wants more. Retrieved March 05, 2018, from <https://blandinonbroadband.org/2016/05/27/chisago-county-broadband-summit-surveys-results-and-stories-of-a-community-that-wants-more>

xv City Data. (n.d.). Lindstrom, Minnesota. Retrieved March 5, 2018, from <http://www.city-data.com/city/Lindstrom-Minnesota.html>



xvi Steil, M. (2018, February 12). Wireless internet to the rescue? New tech could help close connectivity gap. Retrieved March 5, 2018, from <https://www.mprnews.org/story/2018/02/12/new-technology-could-help-close-connectivity-gap>

xvii City Data. (n.d.). Braham, Minnesota. Retrieved March 5, 2018, from <http://www.city-data.com/city/Braham-Minnesota.html>

xviii Dawson, D. (2016, September 16). AT&T's CAF II Plans. Retrieved March 5, 2018, from <https://potsandpansbyccg.com/2016/09/16/atts-caf-ii-plans/comment-page-1>

xix FCC. (2014, December 11). FCC INCREASES RURAL BROADBAND SPEEDS UNDER CONNECT AMERICA FUND . Retrieved March 5, 2018, from https://apps.fcc.gov/edocs_public/attachmatch/DOC-330989A1.pdf

xx Blandin on Broadband (Director). (2016, May 26). CenturyLink on broadband plans in Chisago County [Video file]. Retrieved March 5, 2018, from https://youtu.be/iUc7KidFh_A?t=5m10s

xxi Buckley, S. (2016, September 22). CenturyLink: We can achieve 50% penetration in areas served by CAF-II. Retrieved March 5, 2018, from <https://www.fiercetelecom.com/telecom/centurylink-we-can-achieve-50-penetration-areas-served-by-caf-ii>

xxii FCC. (2017, November, 30). Connect America Fund Phase II FAQs. Retrieved March 24, 2018, from <https://www.fcc.gov/consumers/guides/connect-america-fund-phase-ii-faqs>

xxiii Buckley, S. (2018, February 2). CenturyLink, Frontier take lead in CAF-II race, seek complementary wireless technologies. Retrieved March 5, 2018, from <https://www.fiercetelecom.com/telecom/centurylink-frontier-take-lead-caf-ii-race-seek-wireless-complementary-technologies>

xxiv Bennet, M. (2017, November 2). Letter from Senator Bennet to Kris Anne Monteith. Retrieved March 5, 2018, from <http://nwccog.org/wp-content/uploads/2015/03/CAF-II-tranparency-letter.pdf> and King, A. (2015, November 18). King, Capito, Daines Call on FCC to Increase Transparency, Enforcement for Rural Broadband Funding. Retrieved from <https://www.king.senate.gov/newsroom/press-releases/king-capito-daines-call-on-fcc-to-increase-transparency-enforcement-for-rural-broadband-funding>

xxv Buckley, S. (2018, January 18). CenturyLink extends broadband to 600K homes, businesses via CAF-II program. Retrieved March 5, 2018, from <https://www.fiercetelecom.com/telecom/centurylink-extends-broadband-to-600k-homes-businesses-via-caf-ii-program>

xxvi Mississippi State University Extension Service. (2017, April 4). Digital Divide Index (DDI). Retrieved March 5, 2018, from <http://ici.msucare.com/resources/ddi>

xxvii Pew Research Center. (2015, August 3). Pew Reveals Who Isn't Online and Why. Retrieved March 5, 2018, from <https://www.ncta.com/whats-new/pew-reveals-who-isnt-online-and-why>

xxviii Treacy, A. (2018, February 04). Public-Private Partnership is working with Sunrise Townships, CenturyLink & MN State Grant. Retrieved March 05, 2018, from <https://blandinonbroadband.org/2018/02/05/public-private-partnership-is-working-with-sunrise-townships-centurylink-mn-state-grant>

xxix Treacy, A. (2017, November 21). DEED announces Border to Border grant recipients for 2017 – \$26 Million for 39 Broadband Projects Across Greater Minnesota. Retrieved March 05, 2018, from <https://blandinonbroadband.org/2017/11/21/deed-announces-border-to-border-grant-recipients-for-2017-26-million-for-39-broadband-projects-across-greater-minnesota>

xxx FCC. (2015, May 6). Alternative Connect America Cost Model (A-CAM). Retrieved March 5, 2018, from <https://www.fcc.gov/reports-research/maps/acam-ror-sa-map>

